

RESULTS AND DISCUSSION

1. Diversity and distribution of *Talaromyces*

Three hundred and forty-two isolates of the genus *Talaromyces* comprising 11 species, 2 unidentified species and 1 variety were found from 45 soil samples collected from 38 provinces in Thailand. *Talaromyces flavus* and *T. macrosporus* were the dominant species followed by *T. stipitatus*, *T. trachyspermus*, *T. wortmannii*, *T. bacillisporus*, *T. rotundus*, *T. indigoticus*, *T. helicus* var. *major*, *T. austrocalifornicus*, *T. luteus*, *Talaromyces* sp. 1 (KUFC 3399) respectively, whereas only one isolate of *Talaromyces* sp. 2 (KUFC 3383) was found from agricultural soil, Chon Buri (Table 8, Figure 5).

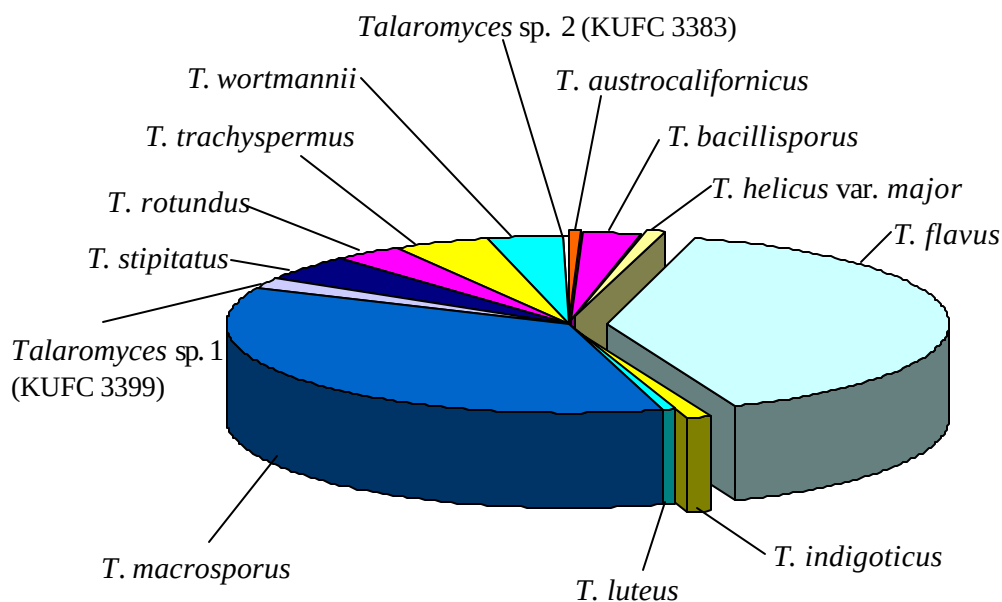


Figure 5 Occurrence of *Talaromyces* species from various soil samples at different locations

Talaromyces flavus and *T. macrosporus* were found from 45 soil samples in 38 provinces (Tables 8-9). Most isolates of both species were derived from heat treatment and alcohol treatment methods followed by the soil plate and dilution plate methods

(Table 9). Similar result was recorded by Udagawa *et al.*, (1996) when they isolated microfungi from house dust in Kobe using heat treatment method, a number of *T. flavus* were isolated. It has been also recorded as a heat resistant fungus in food products (Udagawa, 2000). *Talaromyces flavus* and *T. macrosporus* were commonly found in nonagricultural soil followed by agricultural soil and forest soil (Table 9). Isolates were obtained most frequently from Chiang Mai, Mae Hong Son, Krabi and Bangkok. In Trat province, *T. flavus* was predominantly found from nonfertile, dry soil by the roadside.

Two isolates of *Talaromyces luteus* and *T. helicus* var. *major* were found from hot spring soil at Mae Hong Son and agricultural soil at Chanthaburi respectively. In addition, two isolates of *T. austrocalifornicus* were isolated from forest soil at Mae Hong Son and nonagricultural soil, Chiang Mai whereas 4 isolates of *T. indigoticus* were found from Sakon Nakhon, Chiang Mai, Nakhon Pathom and Chon Buri (Table 9). For Unidentified species, *Talaromyces* sp.1 (KUFC 3399) was isolated from forest soil at Trat and nonagricultural soil, Chiang Mai, whereas only one isolate of *Talaromyces* sp. 2 (KUFC 3383) was found from forest soil, Trat (Table 9).

Nine species and two varieties of *Talaromyces* were previously recorded from Thailand including *T. flavus* var. *flavus*, *T. flavus* var. *macrosporus*, *T. bacillisporus*, *T. byssochlamydoides*, *T. emersonii*, *T. rotundus*, *T. striatus*, *T. stipitatus*, *T. trachyspermus* and *T. wortmannii*. They were isolated from forest, agricultural, mangrove soil, soil at termite mounds, dungs and decomposing starters from eighteen provinces (Chana, 1974; Cruesrisawath, 1985; Kanjanamaneesathian, 1988; Manoch, 2004; Manoch *et al.*, 2004, 2005; Sudpro, 1999; Wongthong, 2001; Busarakum, 2002; Ito *et al.*, 2001; Jeamjitt, 2007). In this study, *Talaromyces austrocalifornicus* and *T. indigoticus* are new record for Thailand.

Table 8 Frequency and number of isolates of *Talaromyces* species from various soil samples at different locations

Fungal species	KUFC	Total isolates
<i>Talaromyces austrocalifornicus</i>	3351, 3401	2
<i>Talaromyces bacillisporus</i>	3350, 3378, 3393, 3404, 3417, 3493, 3580, 3590, 3633, 3652	10
<i>Talaromyces helicus</i> var. <i>major</i>	3593, 3595, 3598	3
<i>Talaromyces flavus</i>	3332, 3334, 3335, 3336, 3337, 3338, 3340, 3341, 3344, 3358, 3360, 3361, 3362, 3368, 3369, 3370, 3375, 3376, 3381, 3382, 3388, 3389, 3390, 3391, 3392, 3394, 3395, 3400, 3402, 3403, 3405, 3406, 3407, 3408, 3409, 3411, 3412, 3414, 3415, 3416, 3418, 3419, 3420, 3424, 3426, 3427, 3429, 3430, 3431, 3432, 3433, 3434, 3435, 3436, 3441, 3442, 3445, 3446, 3455, 3456, 3457, 3458, 3459, 3466, 3467, 3473, 3474, 3477, 3478, 3479, 3480, 3481, 3482, 3491, 3492, 3502, 3503, 3507, 3508, 3509, 3510, 3516, 3517, 3521, 3530, 3533, 3536, 3537, 3538, 3539, 3542, 3543, 3544, 3549, 3550, 3554, 3555, 3556, 3557, 3558, 3559, 3565, 3571, 3576, 3585, 3586, 3587, 3588, 3600, 3601, 3603, 3604, 3605, 3614, 3617, 3618, 3619, 3627, 3628, 3639, 3640, 3646, 3647, 3651, 3652, 3659, 3660, 3661, 3662, 3663, 3664, 3665, 3666, 3667, 3668, 3669, 3670, 3671, 3672	139
<i>Talaromyces indigoticus</i>	3366, 3562, 3592, 3611	4
<i>Talaromyces luteus</i>	3331, 3364	2
<i>Talaromyces macrosporus</i>	3339, 3342, 3343, 3345, 3346, 3347, 3348, 3349, 3356, 3363, 3365, 3367, 3371, 3373, 3374, 3377, 3384, 3385, 3386, 3387, 3396, 3397, 3398, 3437, 3438, 3439, 3440, 3443, 3444, 3448, 3450, 3451, 3452, 3453, 3454, 3460, 3461, 3462, 3463, 3465, 3468, 3469, 3470, 3471, 3476, 3483, 3484, 3485, 3486, 3494, 3497, 3498, 3499, 3500, 3501, 3504, 3505, 3506, 3511, 3512, 3513, 3518, 3520, 3522, 3523, 3524, 3525, 3526, 3527, 3528, 3529, 3531, 3532, 3534, 3535, 3540, 3541, 3545, 3546, 3547, 3548, 3552, 3563, 3564, 3566, 3567, 3568, 3569, 3570, 3572, 3573, 3674, 3575, 3577, 3578, 3579, 3581, 3582, 3583, 3584, 3589, 3591, 3597, 3599, 3602, 3606, 3607, 3608, 3610, 3612, 3613, 3623, 3624, 3625, 3626, 3629, 3630, 3631, 3632, 3638, 3642, 3643, 3644, 3645, 3653, 3654, 3655	127
<i>Talaromyces rotundus</i>	3359, 3379, 3410, 3447, 3475, 3609, 3620	7
<i>Talaromyces stipitatus</i>	3357, 3422, 3449, 3464, 3472, 3487, 3514, 3515, 3551, 3553, 3560, 3561, 3594, 3636, 3641, 3648, 3658	17
<i>Talaromyces trachyspermus</i>	3352, 3353, 3355, 3372, 3380, 3421, 3423, 3425, 3428, 3495, 3596, 3621, 3635, 3649, 3657	15
<i>Talaromyces wortmannii</i>	3333, 3354, 3488, 3489, 3490, 3519, 3615, 3616, 3622, 3634, 3637, 3650, 3656	13
<i>Talaromyces</i> sp. 1	3399, 3413	2
<i>Talaromyces</i> sp. 2	3383	1
Total		342

Table 9 Distribution of *Talaromyces* spp. from various locations using different isolation methods

KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location	KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location
<i>Talaromyces austrocalifornicus</i>				3381	ht	A	Bangkok
3351	ht	F	Mae Hong Son	3382	ht	A	Suphan Buri
3401	ht	NA	Chiang Mai	3388	ht	F	Chiang Mai
<i>Talaromyces bacillisporus</i>				3389	ht	NA	Phatthalung
3350	ht	NA	Bangkok	3390	ht	NA	Surat Thani
3378	ht	NA	Kalasin	3391	ht	A	Suphan Buri
3393	ht	NA	Chiang Mai	3392	ht	A	Nonthaburi
3404	alc	F	Loei	3394	alc	NA	Nakhon Ratchasima
3417	alc	NA	Chiang Mai	3395	alc	NA	Chiang Mai
3493	alc	A	Chiang Mai	3397	ht	A	Nonthaburi
3580	sp	F	Mae Hong Son	3402	ht	NA	Chiang Mai
3590	alc	NA	Sakon Nakhon	3403	ht	NA	Chiang Mai
3633	ht	A	Chiang Rai	3405	alc	NA	Chiang Mai
3652	ht	A	Chiang Rai	3406	alc	F	Mae Hong Son
<i>Talaromyces helicus</i> var. <i>major</i>				3407	alc	F	Mae Hong Son
3593	alc	A	Chanthaburi	3408	ht	NA	Nakhon Ratchasima
3595	sp	A	Chanthaburi	3409	ht	NA	Chiang Mai
3598	alc	A	Chanthaburi	3411	ht	NA	Nakhon Si Thammarat
<i>Talaromyces flavus</i>				3412	ht	NA	Tak
3332	alc	NA	Bangkok	3414	alc	NA	Krabi
3334	alc	F	Mae Hong Son	3415	ht	NA	Krabi
3335	alc	NA	Krabi	3416	ht	NA	Nakhon Ratchasima
3336	alc	A	Nakhon Ratchasima	3418	ht	NA	Krabi
3337	alc	A	Chonburi	3419	ht	NA	Nakhon Ratchasima
3338	sp	A	Chonburi	3420	ht	NA	Rayong
3340	alc	A	Lop Buri	3424	ht	NA	Nakhon Si Thammarat
3341	ht	A	Chiang Rai	3426	sp	NA	Phang Nga
3344	ht	A	Chiang Rai	3427	alc	F	Chiang Mai
3358	alc	NA	Bangkok	3429	alc	A	Bangkok
3360	alc	NA	Bangkok	3430	ht	NA	Bangkok
3361	sp	NA	Bangkok	3431	ht	NA	Roi Et
3362	alc	A	Lop Buri	3432	ht	F	Chiang Mai
3368	ht	A	Lumpang	3433	ht	F	Mae Hong Son
3369	ht	A	Chiang Rai	3434	ht	NA	Chiang Mai
3370	alc	F	Pitsanulok	3435	ht	F	Mae Hong Son
3375	sp	A	Chiang Mai	3436	ht	NA	Kalasin
3376	alc	A	Lop Buri	3441	ht	NA	Chiang Mai

^{1/} KUFC = Kasetsart University Fungal Collection^{2/} sp = soil plate method, dp = dilution plate method, alc = alcohol treatment, ht = heat treatment^{3/} A = agricultural soil, NA = nonagricultural soil, F = forest soil

Table 9 (Continued)

KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location	KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location
<i>Talaromyces flavus</i>				3554	ht	A	Suphan Buri
3442	ht	NA	Chiang Mai	3555	ht	F	Trat
3445	ht	A	Nonthaburi	3556	ht	F	Nong Khai
3446	ht	F	Mae Hong Son	3557	alc	NA	Nakhon Ratchasima
3455	ht	NA	Ratchaburi	3558	alc	A	Kanchanaburi
3456	sp	A	Chathaburi	3559	ht	A	Kanchanaburi
3457	sp	A	Chathaburi	3570	sp	A	Chonburi
3458	ht	NA	Chiang Mai	3571	ht	F	Sakon Nakhon
3459	ht	F	Chiang Mai	3576	sp	NA	Phang Nga
3466	alc	NA	Chiang Mai	3585	alc	NA	Chiang Mai
3467	alc	NA	Saraburi	3586	ht	NA	Nakhon Ratchasima
3473	sp	NA	Ang Thong	3587	ht	A	Lop Buri
3474	alc	A	Lop Buri	3588	ht	A	Phra Nakhon Si Ayutthaya
3477	alc	NA	Nakhon Ratchasima	3600	ht	NA	Uthai Thani
3478	alc	NA	Chiang Mai	3601	alc	NA	Nakhon Ratchasima
3479	alc	F	Pitsanulok	3603	ht	NA	Surat Thani
3480	alc	F	Trat	3604	ht	NA	Sing Buri
3481	alc	NA	Tak	3605	ht	NA	Sing Buri
3482	alc	NA	Nakhon Si Thammarat	3614	ht	F	Mae Hong Son
3485	sp	A	Nakhon Ratchasima	3617	ht	F	Mae Hong Son
3492	alc	A	Lop Buri	3618	ht	F	Trat
3502	ht	A	Chiang Rai	3619	ht	A	Chanthaburi
3503	ht	NA	Phang Nga	3627	sp	NA	Phang Nga
3507	alc	NA	Phatthalung	3628	alc	F	Chiang Mai
3508	alc	NA	Ang Thong	3639	alc	NA	Roi Et
3509	sp	A	Chon Buri	3640	ht	NA	Roi Et
3510	alc	A	Lop Buri	3646	ht	NA	Si Sa Ket
3516	ht	NA	Khon Kaen	3647	ht	NA	Udon Ratchathani
3517	ht	NA	Khon Kaen	3651	sp	NA	Phang Nga
3521	ht	F	Trat	3652	ht	A	Chiang Rai
3530	ht	F	Chiang Rai	3659	sp	F	Loei
3533	sp	NA	Sing Buri	3660	alc	NA	Trang
3536	alc	A	Lop Buri	3661	ht	A	Chiang Rai
3537	ht	A	Chiang Rai	3662	ht	F	Mae Hong Son
3538	ht	F	Trat	3663	ht	F	Mae Hong Son
3539	alc	NA	Bangkok	3664	ht	F	Sakon Nakhon
3542	alc	NA	Bangkok	3665	alc	NA	Chiang Mai
3543	ht	F	Chiang Mai	3666	ht	A	Nakhon Pathom
3544	alc	NA	Buri Rum	3667	ht	A	Chon Buri
3549	alc	NA	Krabi	3668	ht	F	Trat
3550	ht	NA	Sing Buri	3669	ht	NA	Chiang Rai

^{1/} KUFC = Kasetsart University Fungal Collection^{2/} sp = soil plate method, dp = dilution plate method, alc = alcohol treatment, ht = heat treatment^{3/} A = agricultural soil, NA = nonagricultural soil, F = forest soil

Table 9 (Continued)

KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location	KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location
<i>Talaromyces flavus</i>				3452	ht	F	Trat
3670	ht	F	Sakon Nakhon	3453	ht	NA	Phatthalung
3671	ht	F	Sakon Nakhon	3454	ht	A	Chiang Rai
3672	ht	F	Sakon Nakhon	3460	sp	A	Chiang Mai
<i>Talaromyces luteus</i>				3461	alc	A	Lop Buri
3331	ht	F	Mae Hong Son	3462	alc	A	Lop Buri
3364	ht	F	Mae Hong Son	3463	ht	F	Chiang Mai
<i>Talaromyces macrosporus</i>				3465	alc	A	Chonburi
3339	ht	A	Chiang Rai	3467	alc	A	Chonburi
3342	ht	F	Sakon Nakhon	3469	ht	A	Chiang Rai
3343	ht	F	Sakon Nakhon	3470	ht	A	Chiang Rai
3345	ht	F	Khon Kaen	3476	alc	NA	Chiang Mai
3346	ht	NA	Chiang Mai	3483	ht	NA	Sing Buri
3347	ht	NA	Chiang Mai	3484	ht	A	Suphan Buri
3348	alc	F	Nong Khai	3485	ht	F	Trat
3349	alc	NA	Chiang Mai	3486	ht	F	Trat
3356	alc	A	Nakhon Pathom	3494	alc	NA	Ratchaburi
3363	sp	F	Chiang Mai	3497	alc	NA	Ratchaburi
3365	alc	F	Mae Hong Son	3498	ht	NA	Nakhon Ratchasima
3367	ht	A	Chon Buri	3499	ht	NA	Nakhon Si Thammarat
3371	ht	NA	Nakhon Si Thammarat	3500	ht	NA	Nakhon Si Thammarat
3373	alc	NA	Phang Nga	3501	sp	NA	Phangnga
3374	alc	NA	Krabi	3504	alc	F	Chiang Mai
3377	sp	NA	Krabi	3505	ht	NA	Chiang Mai
3384	alc	NA	Krabi	3506	ht	A	Nakhon Ratchasima
3385	alc	NA	Surat Thani	3511	ht	F	Chiang Mai
3386	alc	NA	Surat Thani	3512	ht	F	Chiang Mai
3387	alc	A	Ang Thong	3513	alc	A	Suphan Buri
3396	alc	NA	Phatthalung	3518	ht	NA	Buri Ram
3397	alc	NA	Bangkok	3520	ht	NA	Buri Ram
3398	alc	NA	Bangkok	3522	ht	NA	Kalasin
3437	sp	NA	Uthai Thani	3523	ht	A	Lumpang
3438	alc	A	Lop Buri	3524	ht	A	Lumpang
3439	ht	A	Chiang Rai	3525	ht	F	Trat
3440	ht	NA	Kalasin	3526	ht	F	Trat
3443	alc	NA	Si Sa Ket	3527	sp	NA	Phang Nga
3444	alc	NA	Nakhon Ratchasima	3528	alc	F	Chiang Mai
3448	sp	NA	Saraburi	3529	alc	A	Nakhon Ratchasima
3450	alc	A	Suphan Buri	3531	ht	NA	Sakon Nakhon
3451	ht	A	Suphan Buri	3532	ht	F	Pitsanulok

^{1/} KUFC = Kasetsart University Fungal Collection^{2/} sp = soil plate method, dp = dilution plate method, alc = alcohol treatment, ht = heat treatment^{3/} A = agricultural soil, NA = nonagricultural soil, F = forest soil

Table 9 (Continued)

KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location	KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location
<i>Talaromyces macrosporus</i>				<i>Talaromyces macrosporus</i>			
3534	ht	NA	Sakon Nakhon	3624	alc	NA	Chiang Mai
3535	sp	NA	Phang Nga	3625	sp	NA	Chiang Mai
3540	sp	NA	Roi Et	3626	alc	NA	Buri Rum
3541	sp	NA	Rayong	3629	ht	F	Loei
3545	alc	NA	Chiang Mai	3630	ht	A	Chiang Rai
3546	ht	F	Mae Hong Son	3631	ht	A	Chiang Rai
3547	ht	F	Mae Hong Son	3632	ht	A	Nonthaburi
3548	ht	F	Loei	3638	sp	NA	Chiang Mai
3552	alc	NA	Chiang Mai	3642	sp	F	Trat
3563	alc	A	Ayutthaya	3643	alc	A	Lop Buri
3564	alc	A	Ayutthaya	3644	ht	A	Chiang Rai
3566	alc	F	Chiang Mai	3645	alc	F	Mae Hong Son
3567	alc	NA	Chiang Mai	3653	alc	F	Mae Hong Son
3568	ht	F	Mae Hong Son	3654	ht	NA	Krabi
3569	ht	NA	Chiang Mai	3655	ht	NA	Si Sa Ket
3570	ht	F	Mae Hong Son	<i>Talaromyces rotundus</i>			
3572	ht	NA	Kalasin	3359	alc	NA	Chiang Mai
3573	ht	NA	Chiang Mai	3379	ht	NA	Sing Buri
3574	alc	NA	Chiang Mai	3410	ht	A	Suphan Buri
3575	alc	A	Ubol Ratchathani	3447	ht	F	Trat
3577	alc	A	Ang Thong	3475	alc	NA	Bangkok
3578	sp	NA	Chonburi	3609	alc	F	Mae Hong Son
3579	alc	A	Lop Buri	3620	ht	F	Mae Hong Son
3581	ht	A	Chiang Rai	<i>Talaromyces stipitatus</i>			
3582	ht	A	Chiang Rai	3357	ht	F	Sakon Nakhon
3583	alc	F	Nong Khai	3422	sp	NA	Krabi
3584	alc	NA	Trang	3449	alc	NA	Chiang Mai
3589	sp	NA	Trang	3464	ht	F	Mae Hong Son
3591	alc	A	Lop Buri	3472	ht	NA	Nakhon Ratchasima
3597	alc	NA	Roi Et	3487	ht	NA	Bangkok
3599	alc	NA	Buri Rum	3514	ht	NA	Nakhon Si Thammarat
3602	alc	A	Ubol Ratchathani	3515	alc	A	Bangkok
3606	alc	A	Nonthaburi	3551	ht	NA	Chiang Mai
3607	alc	F	Nong Khai	3553	ht	NA	Chiang Mai
3608	sp	NA	Sing Buri	3560	ht	NA	Bangkok
3610	alc	A	Lop Buri	3561	ht	A	Chiang Rai
3612	ht	A	Chiang Rai	3594	ht	A	Chon Buri
3613	ht	A	Chiang Rai	3636	ht	F	Sakon Nakhon
3623	alc	A	Chiang Mai	3641	ht	NA	Bangkok

^{1/} KUFC = Kasetsart University Fungal Collection^{2/} sp = soil plate method, dp = dilution plate method, alc = alcohol treatment, ht = heat treatment^{3/} A = agricultural soil, NA = nonagricultural soil, F = forest soil

Table 9 (Continued)

KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location	KUFC ^{1/}	Isolation method ^{2/}	Source ^{3/}	Location
<i>Talaromyces stipitatus</i>				3488	ht	NA	Chiang Mai
3648	sp	NA	Phangnga	3489	ht	NA	Uthai Thani
3658	alc	NA	Chiang Mai	3490	alc	A	Chon Buri
<i>Talaromyces trachyspermus</i>				3634	ht	NA	Chon Buri
3352	ht	NA	Bangkok	3615	alc	NA	Bangkok
3353	ht	NA	Bangkok	3616	sp	NA	Krabi
3355	ht	NA	Chiang Mai	3622	sp	NA	Chiang Mai
3372	sp	NA	Phangnga	3634	alc	A	Chiang Rai
3380	sp	NA	Phangnga	3637	alc	A	Bangkok
3421	sp	F	Mae Hong Son	3650	ht	NA	Sing Buri
3423	alc	NA	Chiang Mai	3656	ht	A	Suphan Buri
3425	ht	F	Loei	<i>Talaromyces sp. 1</i>			
3428	ht	F	Sakon Nakhon	3399	alc	A	Trat
3495	ht	NA	Saraburi		ht	NA	Chiang Mai
3596	alc	NA	Chiang Mai	<i>Talaromyces sp. 2</i>			
3621	alc	NA	Bangkok	3383	ht	F	Trat
3635	alc	NA	Buri Rum				
3649	alc	NA	Chiang Mai				
3657	alc	F	Chiang Rai				
<i>Talaromyces wortmannii</i>							
3333	ht	F	Mae Hong Son				
3354	ht	NA	Krabi				

^{1/} KUFC = Kasetsart University Fungal Collection

^{2/} sp = soil plate method, dp = dilution plate method, alc = alcohol treatment, ht = heat treatment

^{3/} A = agricultural soil, NA = nonagricultural soil, F = forest soil

2. Morphological study of *Talaromyces* spp.

1. *Talaromyces austrocalifornicus* Yaguchi et Udagawa (Figures 6-10)

Strains examined: KUFC 3351 forest soil, Mae Hong Son; KUFC 3401

nonagricultural soil, Chiang Mai

Reference: Yaguchi *et al.*, 1993b

Stat. Anam. *Penicillium austrocalifornicum* Yaguchi et Udagawa

Colonies on CZA growing slowly, reaching a diameter of 10-12 mm within 7 days at 25°C, umbonate, slightly sulcate, consisting of a thin basal felt, Light Yellow or Pure Yellow (R 14); producing developing ascomata on the felt; conidiogenesis sparse, inconspicuous; exudates small, yellow; reverse Sienna (R 8) or Bay (R 6) (Figures 6 A, a). Colonies on CZA at 28°C, attaining a diameter of 15 mm and 20-22 mm within 7 and 14 days respectively, velvety to funicubse, slightly sulcate, consisting of a compact basal felt, producing immature ascomata on the agar surface, Pure Yellow (R 14); reverse Straw at the margin (R 46), Scarlet (R 5) at the centre (Figures 7-8 A, a).

Colonies on CYA growing restrictedly, reaching a diameter of 8-10 mm within 7 days at 25°C, umbonate, floccose, consisting of a compact basal felt, Sulphur Yellow (R 15) to Pure Yellow (R 14); producing young ascomata in a layer on the felt, conidiogenesis limited, exudates absent; reverse Umber (R 9) to Chestnut (R 40) (Figures 6 B, b). Colonies on CYA at 28°C, reaching 17 and 20 mm in diameter within 7 and 14 days respectively, funiculose, consisting of a thick basal felt, Pure Yellow (R 14); producing abundant ascomata over the entire surface; exudates absent; reverse Salmon (R 41) to Umber (R 8) (Figures 7-8 B, b).

Colonies on MEA growing moderately, attaining a diameter of 20 mm within 7 days at 25°C, plane, more or less funiculose, with central area raised up to 34 mm deep floccose, consisting of a compact mycelial felt, Pure Yellow (Rayner 14); producing young ascomata intermixed with yellow mycelial hyphae; conidiogenesis inconspicuous and sparse; margins entire; exudates as pale yellow drops, abundantly

produced in central area; odor musty; reverse Cinnamon (R 62) or Sepia (R 63) (Figures 6 C, c). Colonies on MEA at 28°C, reaching 22 mm and 35-37 mm in diameter within 7 and 14 days respectively, plane, fasciculate, consisting of a compact basal felt, Pure Yellow (R 14); developing abundant ascomata which form a continuous layer over the entire surface; conidiogenesis absent; reverse Amber (R 47) to Umber (R 9) (Figures 7-8 C, c).

Colonies on CMA growing moderately, attaining a diameter of 20 mm within 7 days at 25°C; plane, consisting of a very thin mycelial felt, vegetative mycelium submerged and forming sparse growth of aerial hyphae, Light Yellow or Pure Yellow (R 14); ascomata moderately produced on the agar surface; conidiogenesis sparse; exudates scattered, as small clear drops; reverse uncolored (Figures 6 D, d). Colonies on CMA at 28°C, reaching 22 mm and 35-40 mm in diameter within 7 and 14 days respectively, fasciculate, consisting of a thin basal felt, with surface appearing granular due to the production of abundant ascomata, Pure Yellow (R 14); conidiogenesis absent; reverse Straw (R 46) (Figures 7-8 D, d).

Colonies on OMA growing moderately, attaining a diameter of 22-24 mm within 7 days at 25°C, plane, consisting of a thin mycelial felt where abundant yellow ascomata developed, showing an increased yellowish coloration, Light Yellow or Pure Yellow (R 14); conidiogenesis inconspicuous and sparse; exudates absent; reverse uncolored (Figures 6 E, e). Colonies on OMA at 28°C, reaching 25 mm and 40-45 mm in diameter within 7 and 14 days respectively, fasciculate, colonies characters and colored as on CMA; reverse Straw (R 46) to Luteous (R 12) (Figures 7-8 E, e).

Colonies on G25N agar growing extremely slowly within 7 days at 25°C and 28°C (Figures 6-7 F, f), attaining a diameter of 9-12 mm within 14 days at 28°C, consisting of a compact mycelial felt, producing abundant penicilli over the entire surface, Pale Greenish Grey (R 123); ascomata absent; exudates small, Pale Orange (R 7); margins entire; reverse uncolored (Figures 8 F, f).

At 37°C, growth is extremely restricted.

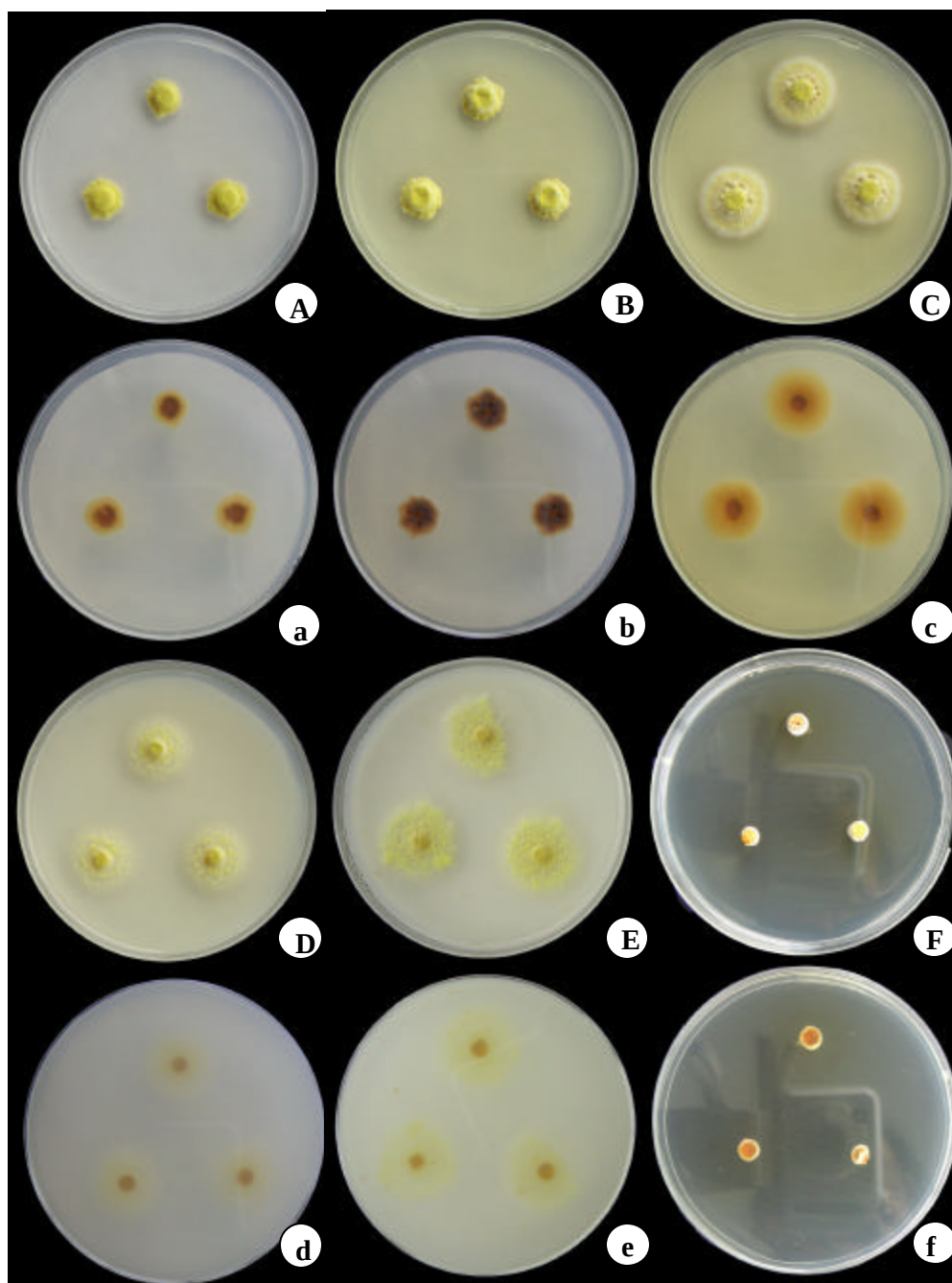


Figure 6 *Talaromyces austrocalifornicus* KUFC 3401. Obverse and reverse views of colonies on different media, incubated for 7 days at 25°C; CZA (A, a), CYA (B, b), MEA (C, c), CMA (D, d), OMA (E, e), G25N (F, f)

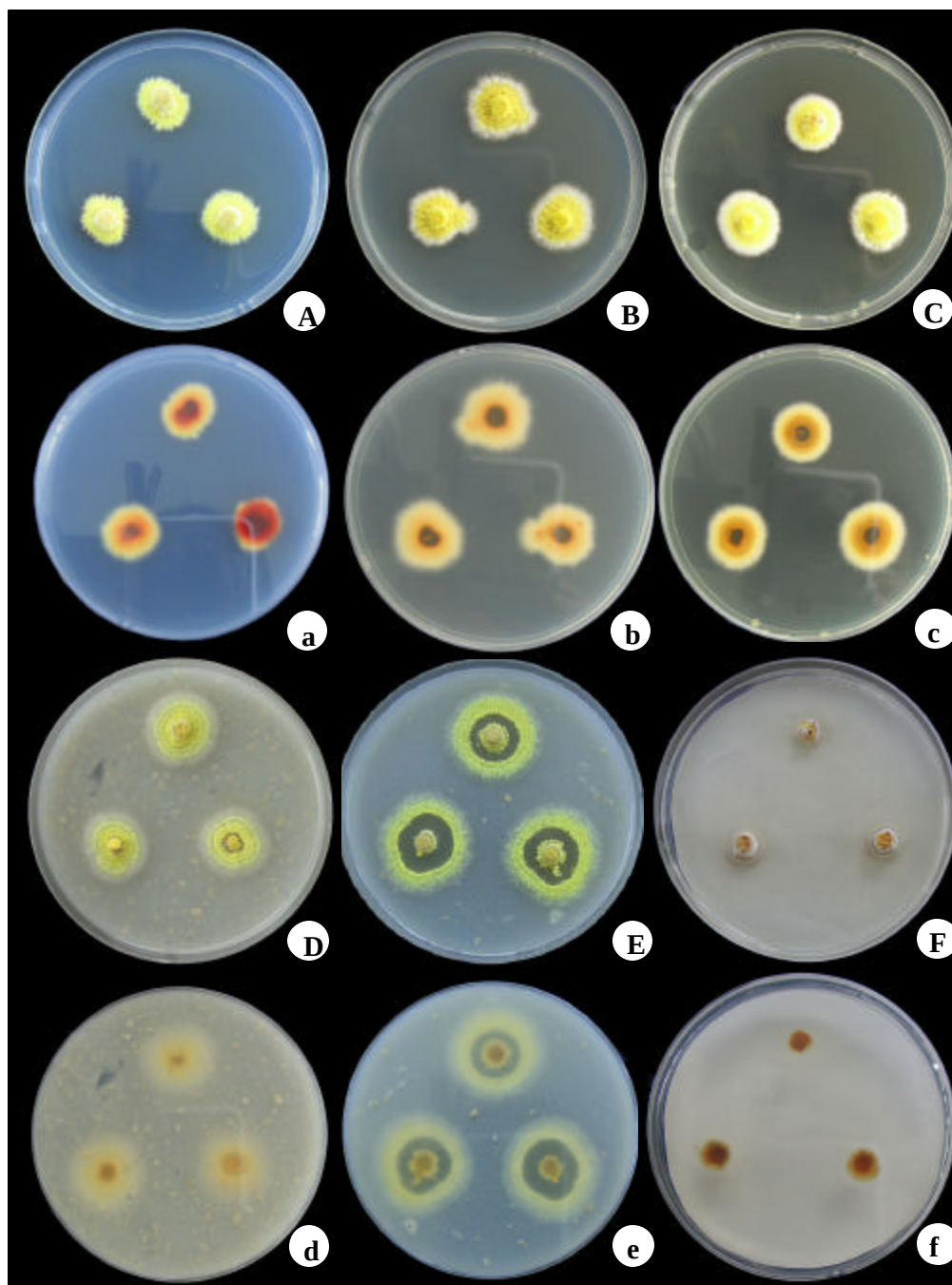


Figure 7 *Talaromyces austrocalifornicus* KUFC 3401. Obverse and reverse views of colonies on different media, incubated for 7 days at 28°C; CZA (A, a), CYA (B, b), MEA (C, c), CMA (D, d), OMA (E, e), G25N (F, f)

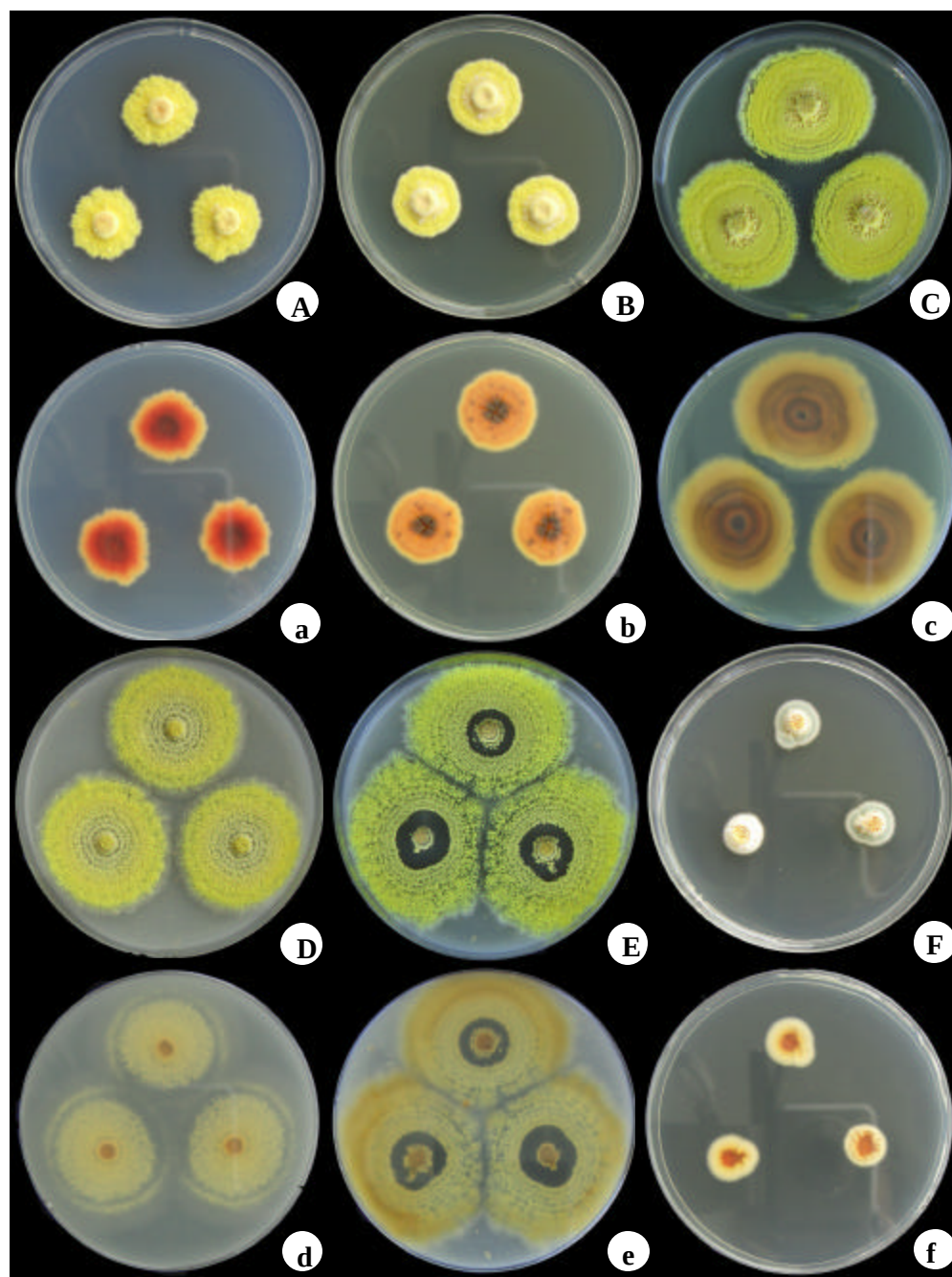


Figure 8 *Talaromyces austrocalifornicus* KUFC 3401. Obverse and reverse views of colonies on different media, incubated for 14 days at 28°C; CZA (A, a), CYA (B, b), MEA (C, c), CMA (D, d), OMA (E, e), G25N (F, f)

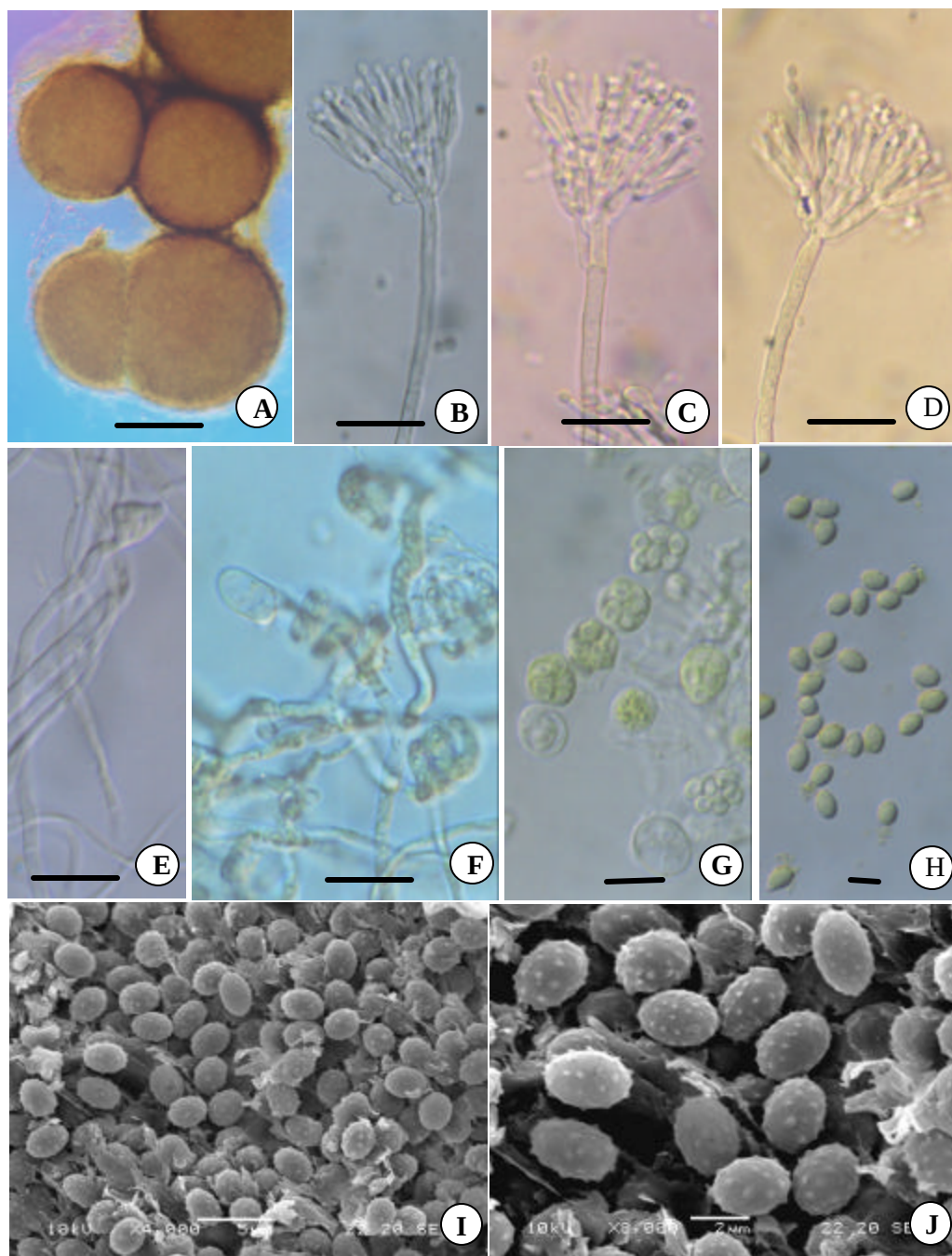


Figure 9 *Talaromyces austrocalifornicus* KUFC 3401

A. ascomata; B-D. penicilli; E-F. ascomatal initials; G-H. asci and ascospores; I-J. ascospores (SEM)

(Bars: A = 100 μm ; B-G = 10 μm ; H = 3 μm ; I = 5 μm ; J = 2 μm)

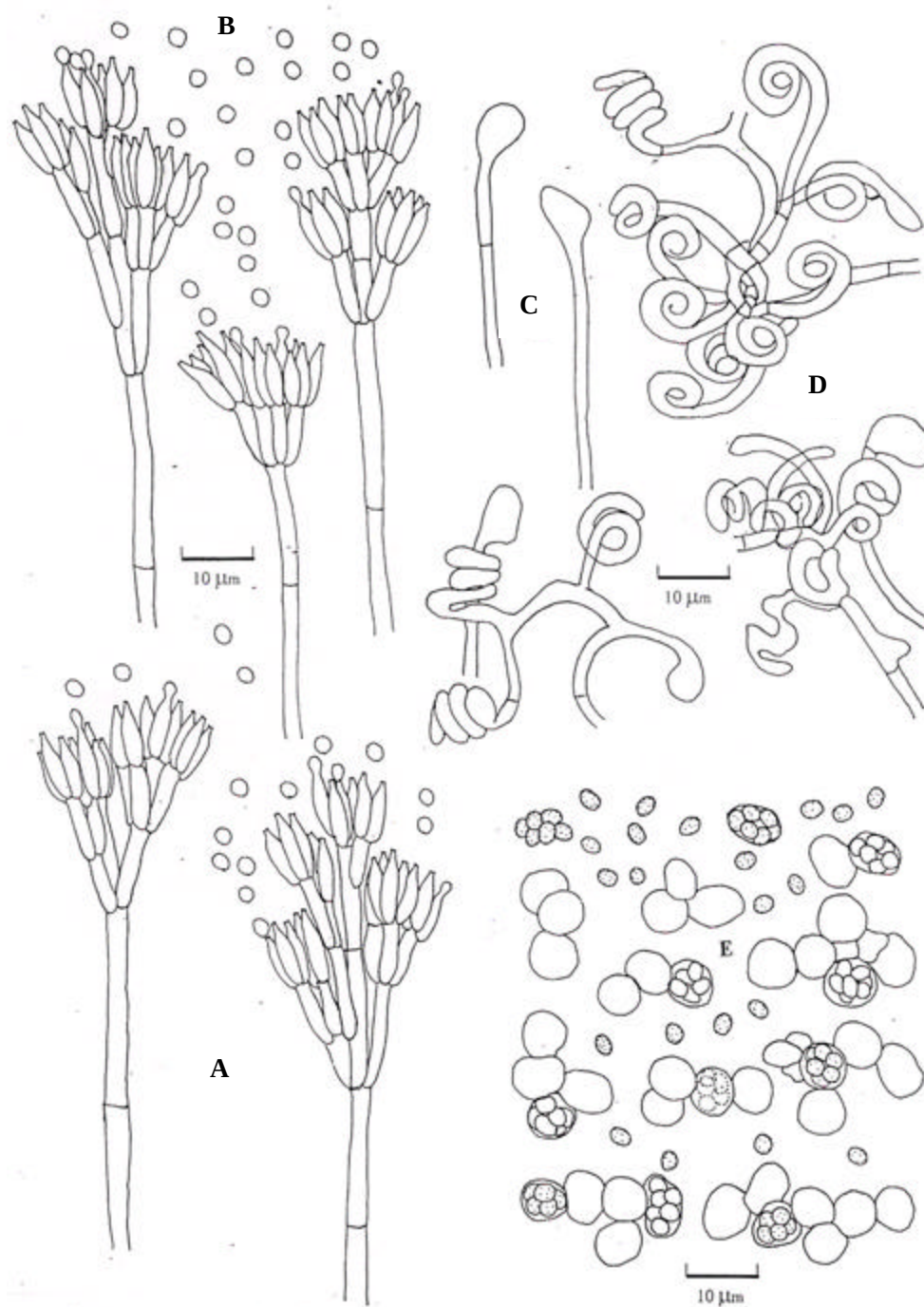


Figure 10 *Talaromyces austrocalifornicus* KUFC 3401

Camera lucida drawings of A. Penicilli; B. conidia; C. ascogonia;
D. ascomatal initials; E. asci and ascospores

Ascomata discrete or confluent, non-ostiolate, soft, ripening within 14 to 21 days (Figures 8 A-E), globose to subglobose, (150-) 200-300 (-400) μm in diameter, ascomatal wall composed of a loose network of branched, septate, radiate, yellow, interwoven hyphae (Figure 9 A). Ascomatal initials pattern comprising the formation of long-stipitate ascogonium which swollen at apex and soon enveloped in incurved or twisted branches of aerial hypha (antheridia) (Figures 9 E-F, 10 C-D). Asci borne in chains, 8-spored, globose to ovoidal, 6-7.5 x 4.5-5.5 μm , evanescent (Figures 9 G, 10 E). Ascospores pale yellow, broadly ellipsoidal, small, 2.2-3.3 x 2.2-2.5 μm , finely spinulose with sparse spines (Figures 9 H-J, 10 E).

Conidiophores arising from the basal mycelium or aerial hyphae; stipes hyaline, smooth, 75-100(-120) x 2.7-3(-3.5) μm . Penicilli typically biverticillate, sometime terverticillate or quaterverticillate; rami 10-25 μm long. Metulae mostly appressed verticils of 4-6, 8-10 x 2-3 μm . Phialides acerose, 4-6 in the verticil, (9-) 10-12 x 2-3 μm (Figures 9 B-D, 10 A). Conidia hyaline, subglobose to globose, 2-3 μm , smooth-walled (Figures 9 B-D, 10 B).

Talaromyces austrocalifornicus was first reported as new species from soil at the University of Southern California, Los Angeles, California, U.S.A. (Yaguchi *et al.*, 1993b). It is related to *T. convolutes* which has been reported as new species from soil in Nepal in the same year (Udagawa, 1993). The growth rate on common media, colony morphology, well-developing penicilli, ascospores size and morphology and especially ascomatal initial pattern are in similar. They seemed to be the same species. However, both species differ in ascomata size and conidiophore length. *T. austrocalifornicus* belonged to the section *Talaromyces*, series *Lutei* in its growth-rate on MEA, colony morphology, ascomata size and color and well-developing penicilli. Suzuki *et al.*, (1999) have reported the isolation of (-)- mitorubrinol and (-)- mitorubrinic acid from yellow pigment on ascomata of this species.

2. *Talaromyces bacillisporus* C.R. Benjamin (Figures 11-13)

Strains examined: KUFC 3350 nonagricultural soil, Kasetsart Univ., Bangkok; KUFC 3417 forest soil, Mok Fa water fall, Chiang Mai; KUFC 3580 forest soil, Mae Hong Son

Reference: Stolk and Samson, 1972

Stat. Anam. *Geosmithia swiftii* Pitt (1979)

Penicillium bacillisporum Swift (1932)

Colonies on CZA growing moderately, attaining a diameter of 20 mm within 7 days at 25°C, plane, velvety, slightly radiate furrow, consisting of a compact basal felt, Creamish to Straw (R 46); ascomata absent; conidiogenesis profuse; exudates and soluble pigment absent; reverse Dark Mouse Grey (R 119), but Straw (R 46) at the margin (Figures 11 A, a).

Colonies on CYA growing rapidly, attaining a diameter of 40 mm within 7 days at 25°C, velvety, zonate, sulcate, consisting of a compact basal felt, producing numerous young ascomata on the mycelium felt, Creamish to Pale Sulphur Yellow (R 15); conidiogenesis sparse and inconspicuous; exudates absent; reverse Orange (R 7), Umber (R 9) to Hazel (R 88) (Figures 11 B, b).

Colonies on MEA growing rapidly, attaining a diameter of 40-43 mm within 7 days at 25°C, plane, velvety, consisting of a thin mycelial felt, producing abundant conidiogenesis over the entire surface, Pale Mouse Grey (R 117); ascomata absent; margins entire and lower; exudates absent; reverse Dark Green (R 21) at centre but margins uncolor (Figures 11 C, c).

Colonies on CMA growing moderately, attaining a diameter of 35 mm within 7 days at 25°C, plane, consisting of a compact tough Saffron (R 10) mycelial felt, showing Salmon (R 41) to Saffron (R 10) shade, occasionally furrowed in radial pattern, white to Pale Luteous (R 11) sectors occur, ascomata absent; exudates absent; reverse Orange (R 7), Umber (R 9) to Hazel (R 88) (Figure 11 D, d).

Colonies on OMA growing rather rapidly, attaining a diameter of 45 mm within 7 days at 25°C, plane, consisting of a compact mycelial felt in which abundant developing ascomata, covered by a floccose to funiculose aerial mycelium bearing penicilli, showing creamish to Pale Luteous (R 11) color; conidiogenesis abundant; exudates absent; reverse Dark Green (R 21) to Dark Bluish Green (R 24) (Figures 11 E, e).

Colonies on G25N agar growing slowly; attaining a diameter of 15 mm within 7 days at 25°C, producing abundant penicilli, Glaucus Blue Green (R 94); ascomata absent; exudates absent; reverse Straw (R 46) (Figures 11 F, f).

Colonies on all media at 37°C, 7 days, growing rapidly, attaining a diameter of 20-45 mm, commonly similar in appearance to colonies on CYA, plane, furrow, consisting of a compact basal felt, Vinaceous Buff (R 86) to Hazel (R 88); ascomata absent; conidiogenesis abundant; reverse Sienna (R 8) to Umber (R 9).

Ascomata creamish to pale yellow, usually globose, 50-200 μm in diameter, discrete or confluent, ripening within 2 weeks. Covering consisting of a thin network of loosely interwoven hyphae, surrounded by a weft of radiating, white to creamish (Figure 12 A). Ascomatal initials developing directly from vegetative hyphae, consisting of swollen, somewhat twisted hyphal elements, which become irregularly septate and produce coiling branches thus developing a compact mass of ascogenous hyphae (Figures 12 D, 13 C). Asci 8-spored, globose to ovoidal, 12-14 x 9.5-13 μm (Figures 12 E, 13 D). Ascospores globose, 4.5-5.2 μm in diameter, thick-walled, spinulose with spines up to 0.5 μm in length (Figures 12 F-H, 13 E).

Conidiophores arising from aerial hyphae, short, 25-75 x 1.5-2.5 μm , Penicilli typically monoverticillate or occasionally biverticillate. Phialides smooth, consisting of a cylindrical base, tapering abruptly to a short conidium-bearing tip, about 2 to 6 in the verticil (Figures 12B-C, 13A). Conidia hyaline, cylindrical, 3.5 x 1.5-2 μm , smooth-walled (Figures 12 B-C, 13 B).

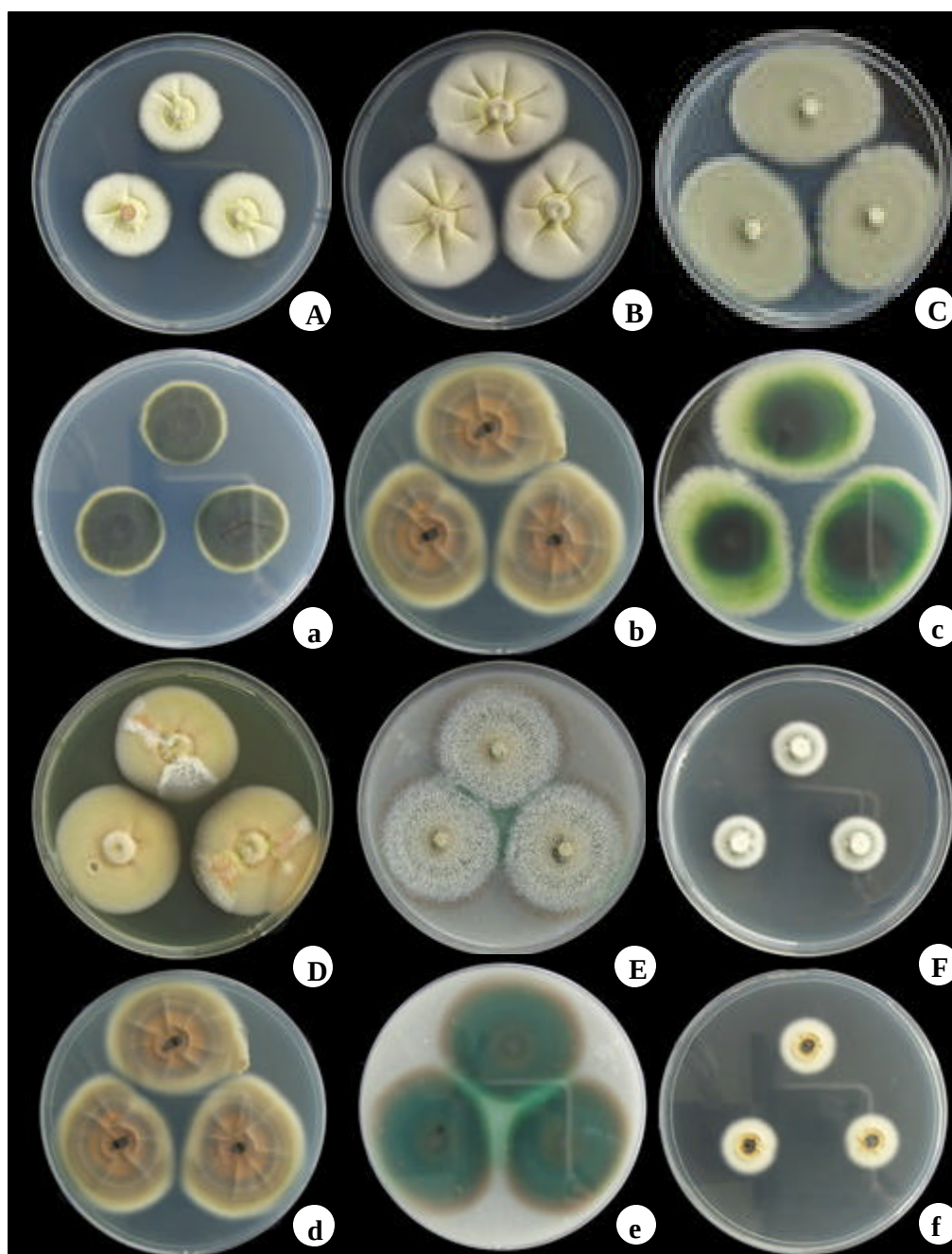


Figure 11 *Talaromyces bacillisporus* KUFC 3350. Obverse and reverse views of colonies on different media, incubated for 7 days at 25°C; CZA (A, a), CYA (B, b), MEA (C, c), CMA (D, d), OMA (E, e), G25N (F, f)

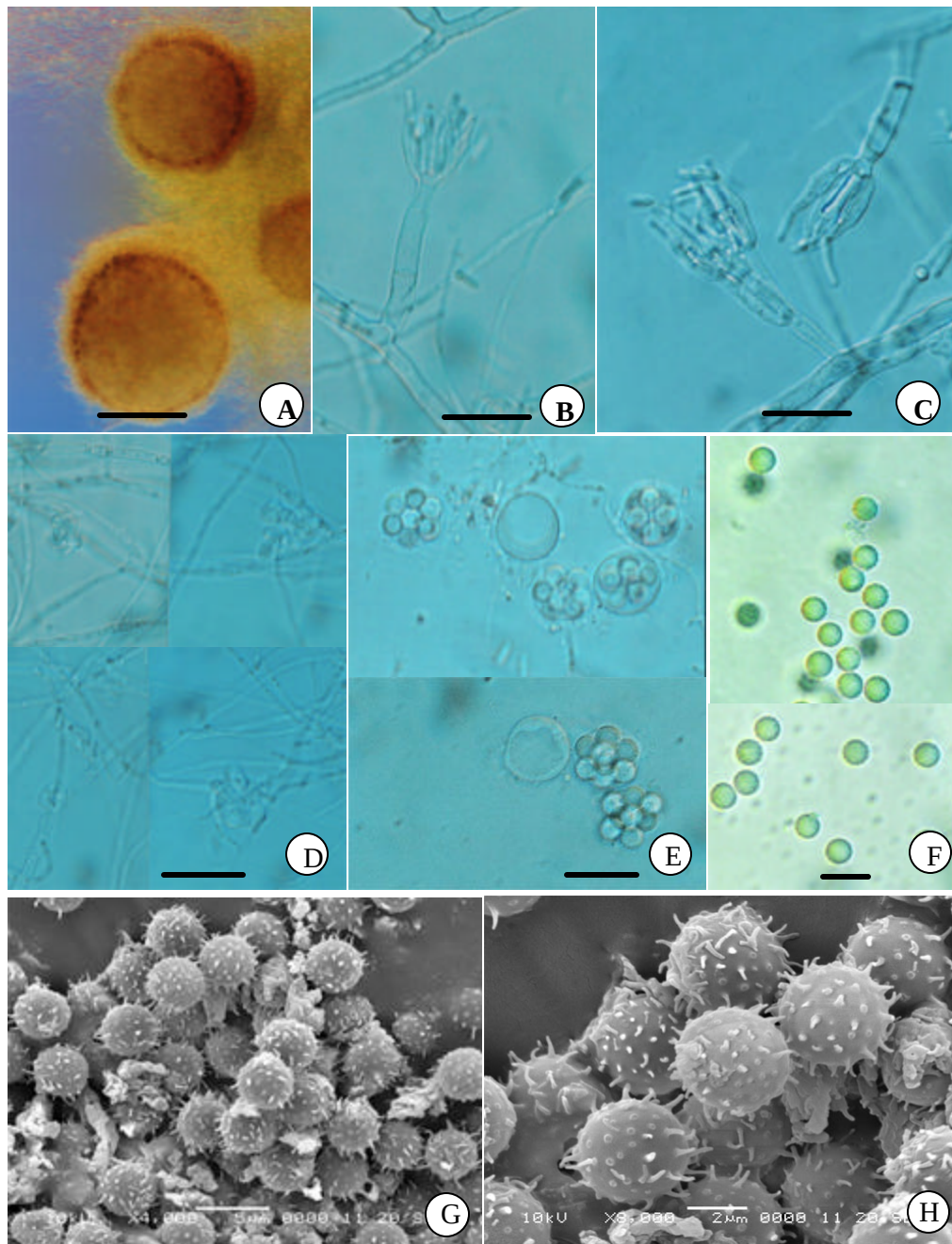


Figure 12 *Talaromyces bacillisporus* KUFC 3350

A. ascomata; B-C. penicilli and conidia; D. ascomatal initials; E-F. asci and ascospores; G-H. ascospores (SEM)

(Bars: A = 100 μm; B-E = 10 μm; F-G = 5 μm; H = 2 μm)

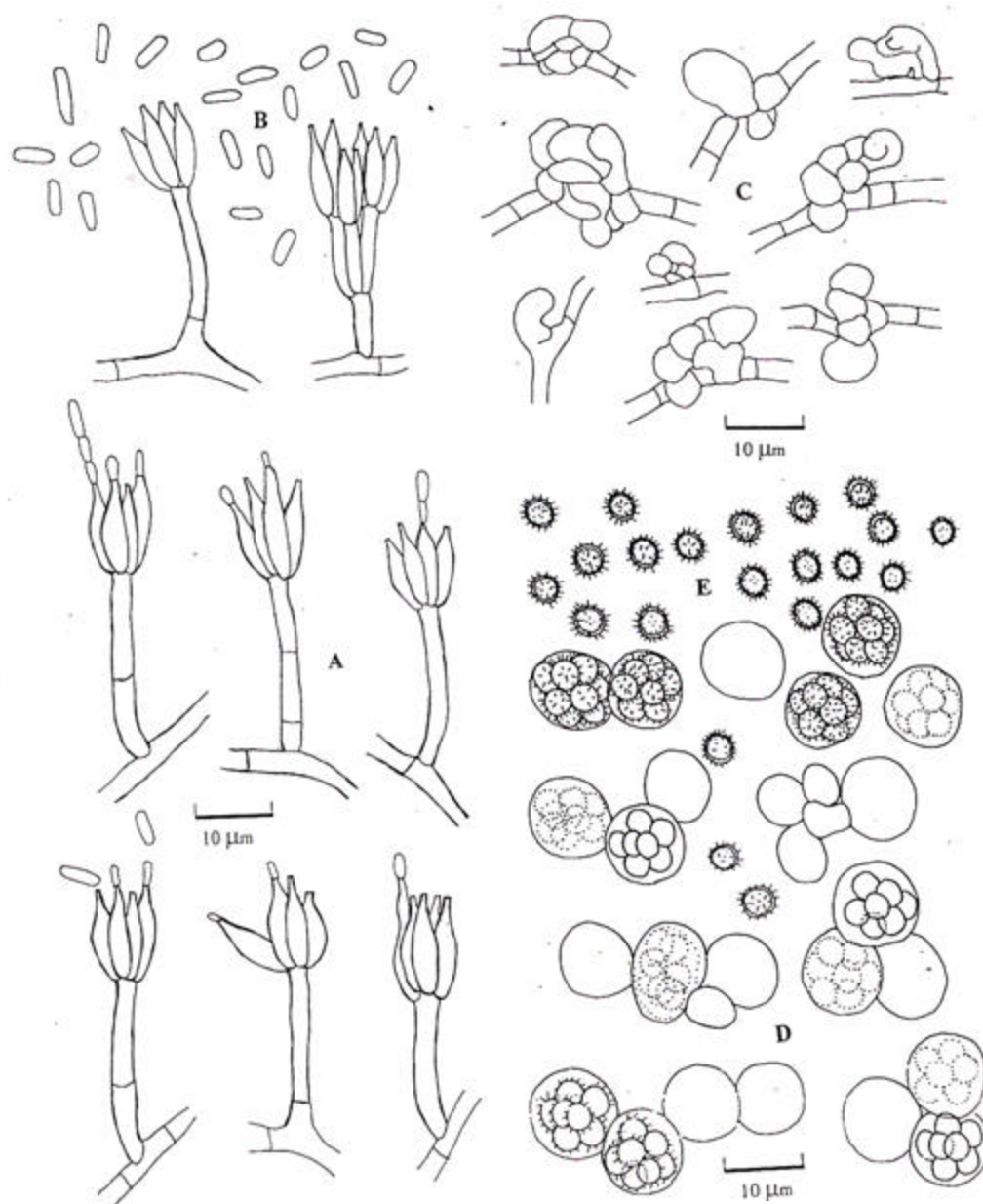


Figure 13 *Talaromyces bacillisporus* KUFC 3350

Camera lucida drawings of A. penicilli; B. conidia; C. ascomatal initials; D. asci and ascospores

Talaromyces bacillisporus can easily be distinguished from other species by the green color shade of colony reverse, conspicuous globose and spinulose ascospores. This species has been regarded as a very rare species, however it reported from soils and pasteurized fruit juice from many countries (Stolk and Samson, 1972; Pitt and Hocking, 1997; Asan, 2004). In Thailand, *T. bacillisporus* was isolated from agricultural, forest soils, termite mounds and rat dung (Manoch *et al.*, 2004, Jeamjitt, 2007). Yamazaki and Okuyama (1980) reported oxaphenalenone dimers and xanthone carboxylic acid from *T. bacillisporus* as bacillosporins A-C and pinselin and found that bacillosporins A can exhibit antibacterial activity against *Bacillus subtilis* and *Sarcina lutea*. In addition, Ishii *et al.*, (1995) was also reported talarotoxin from this fungus. This compound showed cytotoxic activity which inhibited the proliferation of both mouse myeloma X63.Ag8.6.5.3 cells and BALB/3T3 mouse fibroblasts. In this study, two new compounds, bacillisporins D and E have been isolated from *T. bacillisporus* (KUFC 3350).

3. *Talaromyces flavus* (Klöcker) Stolk & Samson (Figures 14-19)

Strains examined KUFC 3332 nonagricultural soil, Bangkok; KUFC 3334 forest soil, Mae Hong Son; KUFC 3335 nonagricultural soil, Krabi; KUFC 3340 agricultural soil, Lop Buri; KUFC 3344 agricultural soil, Chiang Rai; KUFC 3360 nonagricultural soil, Bangkok; KUFC 3363 agricultural soil, Chon Buri; KUFC 3381 agricultural soil, Kasetsart Univ., Bangkok; KUFC 3395 agricultural soil, Suphan Buri; KUFC 3397 agricultural soil, Nonthaburi; KUFC 3400 agricultural soil, Chiang Mai; KUFC 3408 agricultural soil, Nakhon Ratchasima; KUFC 3420 nonagricultural soil, Rayong; KUFC 3455 nonagricultural soil, Ratchaburi; KUFC 3485 agricultural soil, Nakhon Ratchasima; KUFC 3446 agricultural soil, Chiang Mai; KUFC 3473 nonagricultural soil, Krabi; KUFC 3501 agricultural soil, Chiang Mai; KUFC 3510 agricultural soil, Chiang Mai; KUFC 3523 agricultural soil, Kanchanaburi; KUFC 3525 agricultural soil, Nonthaburi; KUFC 3528 agricultural soil, Chon Buri; KUFC 3530 agricultural soil, Chanthaburi; KUFC 3549 nonagricultural soil, Buri Rum; KUFC 3550 forest soil, Sakon Nakhon; KUFC 3554 agricultural soil, Suphan Buri; KUFC 3556 forest soil, Trat

References: Stolk and Samson, 1972; Pitt, 1979a; Domsch *et al.*, 1993a, b

Stat. Anam. *Penicillium vermiculatum* Dangeard

Morphological characteristics of *T. flavus* isolate KUFC 3530: colonies on CZA growing slowly, attaining a diameter of 25-28 mm in 7 days at 25°C, plane, more or less funiculose, consisting of a thick basal felt with Pure Yellow (R 14) aerial mycelium, producing numerous developing ascomata on the felt, Light Yellow or Pure Yellow (R 14); conidiogenesis sparse, inconspicuous; exudates small, pale orange; reverse Red (R 2) but white at the margin (Figures 14 A, a). Colonies on CZA at 28°C, reaching a diameter of 40 mm within 7 days, plane, funiculose, consisting of a thick basal felt, producing abundant immature ascomata, Pure Yellow (R 14); conidiogenesis sparse, inconspicuous; exudates small, pale orange; reverse Saffron (R 10) to Apricot (R 42) (Figures 15 A, a).

Colonies on CYA spreading broadly, reaching 55 mm diameter within 7 days at 25°C, velvety, plane, zonate, consisting of a thin basal felt, producing developing ascomata in a layer on the felt; conidiogenesis sparse, Sulphur Yellow (R 15) to Pure Yellow (R 14); exudates pale orange at the centre; reverse ranging from Luteous (R 12), Ochreous (R 44) to Scarlet (R 5) (Figures 14 B, b). Colonie on CYA at 28°C, attaining a diameter 60 mm within 7 days, velvety later becoming more fasciculate, zonate, producing limited ascomata in the central area, Pale Sulphur Yellow (R 15); conidiogenesis lacking; exudated scattered; reverse ranging Straw (R 46), Scarlet (R 5) to Rust (R 39) (Figures 15 B, b).

Colonies on MEA growing rapidly, attaining a diameter 70 mm within 7 days at 25°C, thin, funiculose, producing numerous young ascomata over the entire surface, usually forming a conspicuous thick layer, showing Sulphur Yellow (R 15) to Pure Yellow (R 14), but some strains, such as KUFC 3332, KUFC 3344 growing moderately, 40-45 mm within 14 days and produced paler yellow shades; conidial sparse and intermixed with aerial hyphae; exudates limited; reverse conspicuous brown shading, ranging from Peach (R 4) to Umber (R 9) (Figures 14 C, c). Colonies on MEA at 28°C, reaching 50-55 mm diameter within 7 days, funiculose, producing abundant ascomata on the agar surface, showing an increased yellowish coloration; conidiogenesis moderate; exudates absent; reverse Peach (R 4) to Flesh (R 37) (Figures 15 C, c).

Colonies on CMA growing rapidly, attaining a diameter 40-50 mm within 7 days at 25°C, plane, funiculose, consisting of a thin basal felt, producing limited ascomata on the felt, loosely covered by somewhat funiculose hyphae, White to Yellowish White; conidiogenesis moderate; exudates absent; reverse uncolored (Figures 14 D, d). Colonies on CMA at 28°C, reaching 50-55 cm in diameter within 7 days, plane, funiculose, producing abundant ascomata on the agar surface, Light Yellow or Pure Yellow (R 14); conidiogenesis moderate; exudates absent; reverse Straw (R 14) (Figures 15 D, d).

Colonies on OMA spreading broadly, reaching 45-50 cm diameter within 7 days at 25°C, velvety to more or less funiculose, consisting of a compact funiculose basal felt, ascomata slowly developing on the felt, White; conidiogenesis limited; margins spread broadly and submerged; exudates absent; reverse uncolored (Figures 14 E, e). Colonies on OMA spreading broadly, reaching 50–55 cm diameter within 7 days at 25°C, velvety to more or less funiculose, consisting of a thin basal felt, ascomata slowly developing on the felt, Sulphur Yellow (R 15); conidiogenesis lacking; margins spread broadly and submerged; exudates absent; reverse uncolored (Figures 15 E, e).

Colonies on G25N agar growing slowly; attaining a diameter of 20 mm within 7 days at 25°C, mycelium and conidiogenesis sparse; abundant developing ascomata on the entire surface, Sulphur Yellow (R 15) to Pure Yellow (R 14); conidiogenesis limited; exudates absent; reverse Pale Yellow (Figures 14-15 F, f).

Microscopic characteristics of *T. flavus* (KUFC 3530) were examined under light and scanning electron microscopes. Ascomata sulphur yellow to yellow, usually globose, 200-450 µm in diameter, discrete or confluent, ripening within 10 to 14 days. Covering consisting of thin interwoven hyphal networks, surrounded by loose wefts of yellow, slightly twisted, predominantly radiating hyphae. Ascomatal initials consisting of club-shaped ascogonia, around with thin antheridia coil tightly several times. After fertilization, the ascogonia become septate (Figures 18 A-B). The primordium becomes enveloped in closely wound delicate hyphae, which develop into the covering and develop to ascogenous cell. Asci broadly ellipsoidal to subglobose, 6-7 x 4.5-5.5 µm (Figures 18 A-B). Ascospores ellipsoidal, 2.5-3 x 1.5-2 µm, in some strains slightly larger, up to 3.7 x 2.2 µm, very delicately spinulose, with the spines usually irregularly disposed on the surface (Figures 18 A-B, 19 A-D).

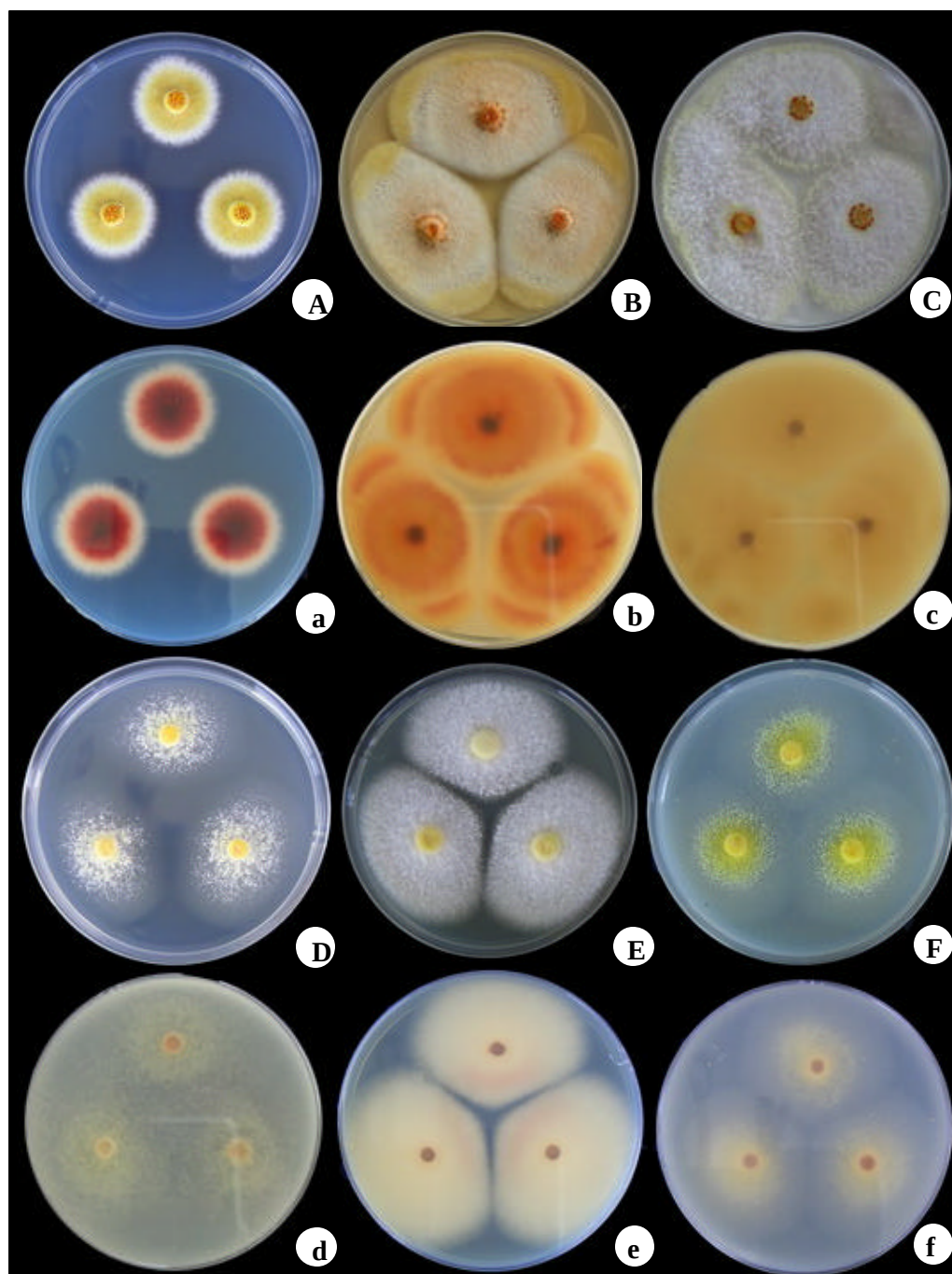


Figure 14 *Talaromyces flavus* KUFC 3530. Obverse and reverse views of colonies on different media, incubated for 7 days at 25°C; CZA (A, a), CYA (B, b), MEA (C, c), CMA (D, d), OMA (E, e), G25N (F, f)

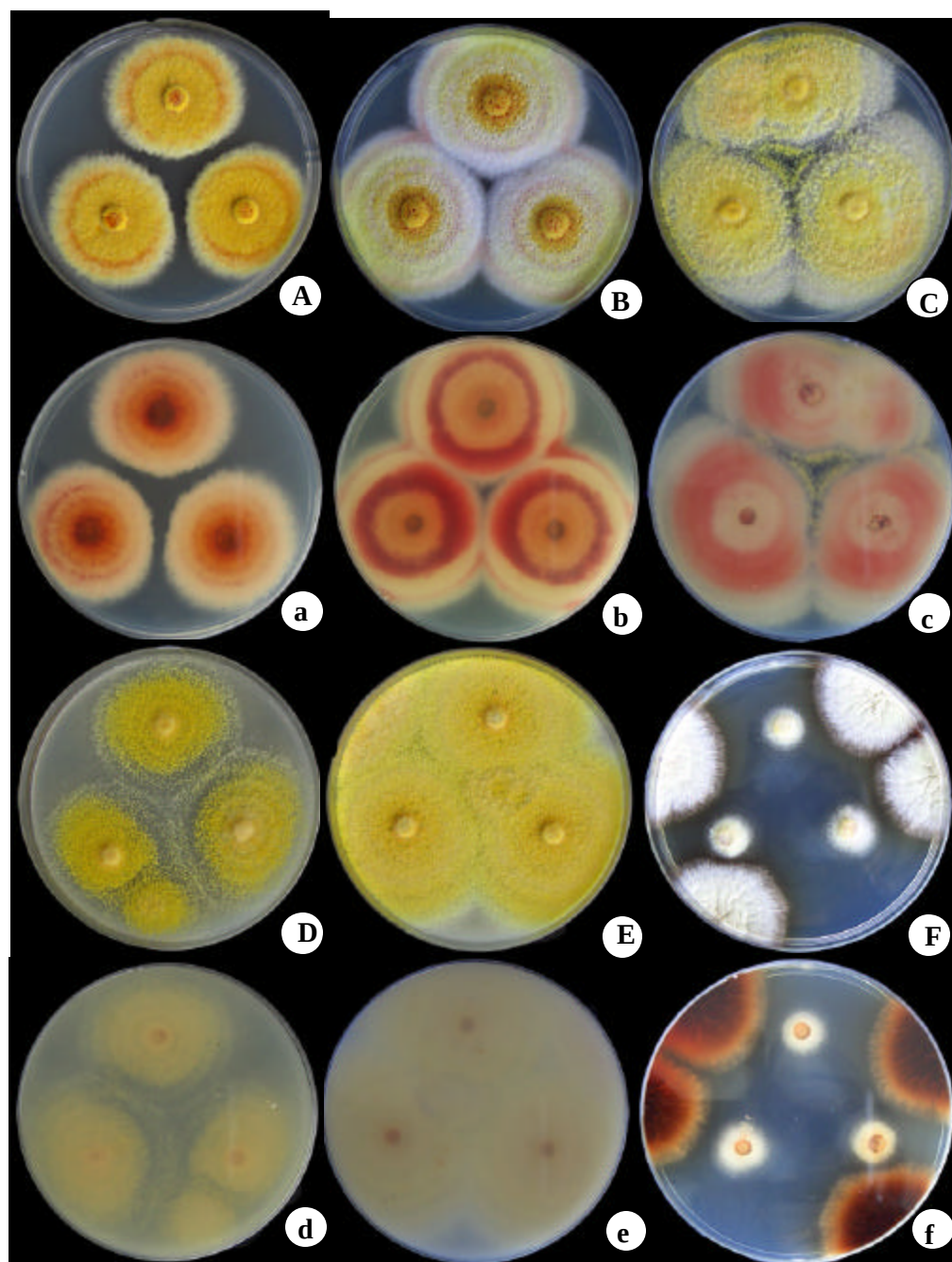


Figure 15 *Talaromyces flavus* KUFC 3530. Obverse and reverse views of colonies on different media, incubated for 7 days at 28°C; CZA (A, a), CYA (B, b), MEA (C, c), CMA (D, d), OMA (E, e), G25N (F, f)

Conidiophores arising from the aerial mycelium, 20-70 x 2-2.5 μm , yellow-green, smooth-walled. Penicilli typically biverticillate, rarely monoverticillate and terverticillate (Figures 17 A-E, 18 A-B). Metulae in small verticils of 2 to 4, yellow-green, 10-12 x 2-2.5 μm . Phialides 2 to 6 in the verticil, 8-10 x 2-3 μm , typically lanceolate. Conidia pale greenish, subglobose to ellipsoidal 2.7-3.5 x 2-2.7 μm , smooth-walled (Figures 17 A-D, 18 A-B).

Two varieties of this fungus were recorded, in differs of colony appearance and size of ascospore including *T. flavus* var. *flavus* (ascospore size, 2.2-3.5 x 3-5 μm) and *T. flavus* var. *macrosporus* (ascospore size, 3.5-5.2 x 5-6.5 (-7) μm) (Stolk and Samson, 1972). On the basis of differences in secondary metabolites production. Frisvad *et al.*, (1990) raised the variety to species status. In this study, both of species were isolated from all soil samples and have been reported from many substrates in Thailand in previous report. In addition, *T. macrosporus* have been recorded as a cause of pasteurised orange juice and food (Pitt and Hocking, 1997).

Stolk and Samson (1972) stated that *Talaromyces flavus* is an extremely variable species. Different strains may vary in colour, in the amount of red pigment produced, in the number of penicilli and in size of ascospores. We also found the variation among different *T. flavus* isolates (Figure 16). Differences in the shape, size and ornamentation of ascospores were also noted.

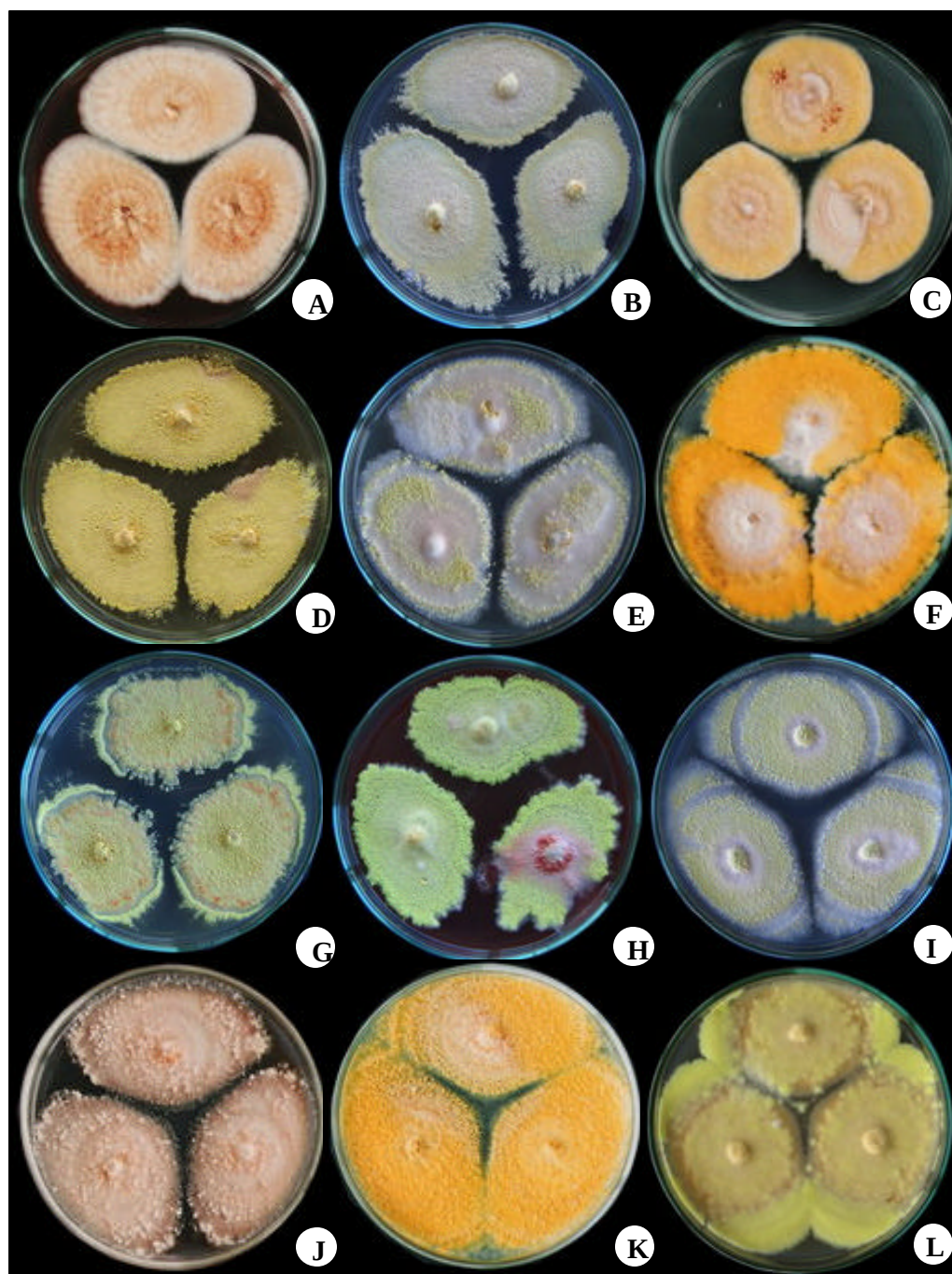


Figure 16 Variations of colony pattern of *T. flavus* on MEA at 28°C for 14 days

- | | | | |
|---------------|---------------|---------------|--------------|
| A. KUFC 3332, | B. KUFC 3335, | C. KUFC 3408, | D. KUFC 3344 |
| E. KUFC 3556, | F. KUFC 3340, | G. KUFC 3455, | H. KUFC 3420 |
| I. KUFC 3360, | J. KUFC 3510, | K. KUFC 3549, | L. KUFC 3554 |

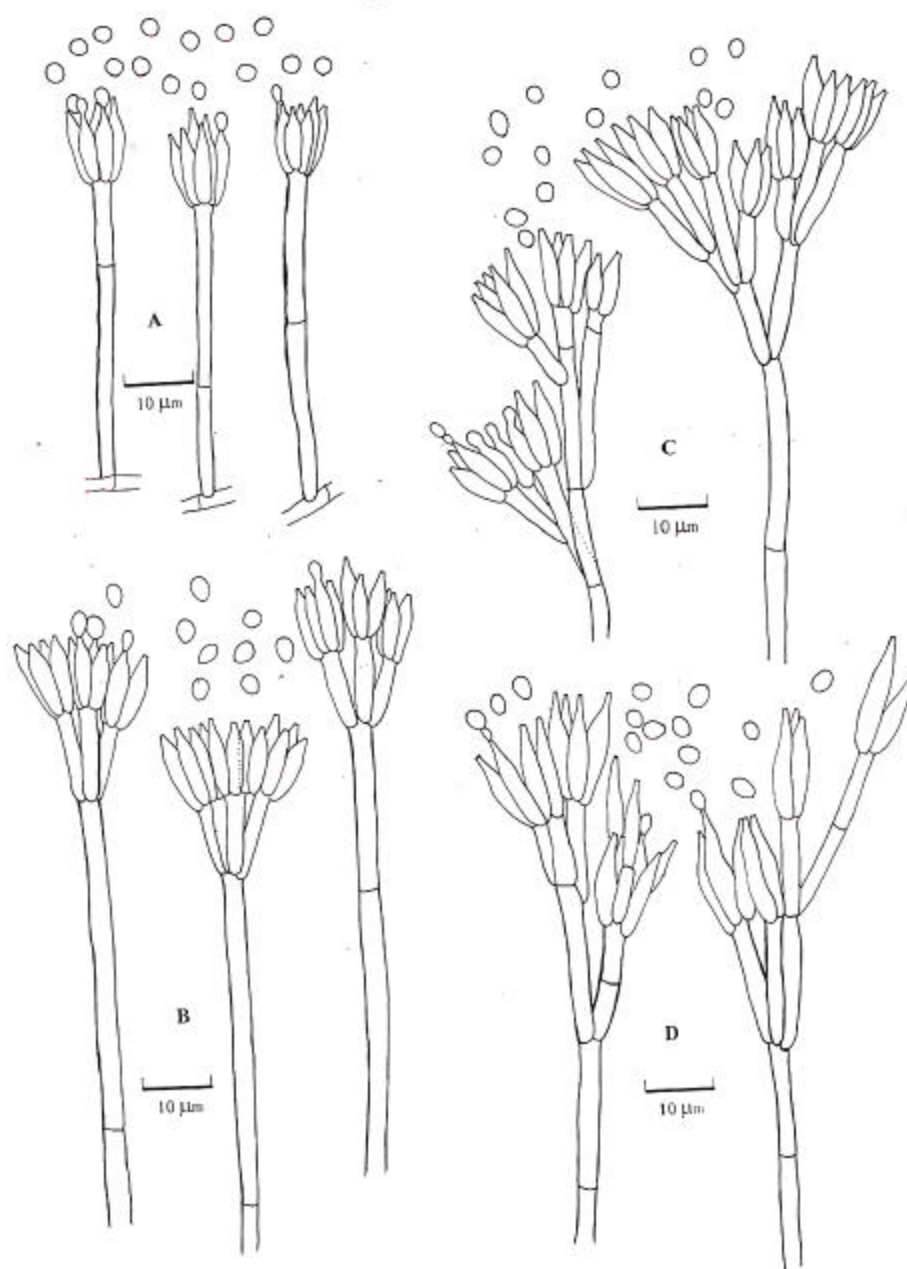


Figure 17 Variations of penicili of *Talaromyces flavus*

A. KUFC 3334

B. KUFC 3340

C. KUFC 3501

D. KUFC 3506

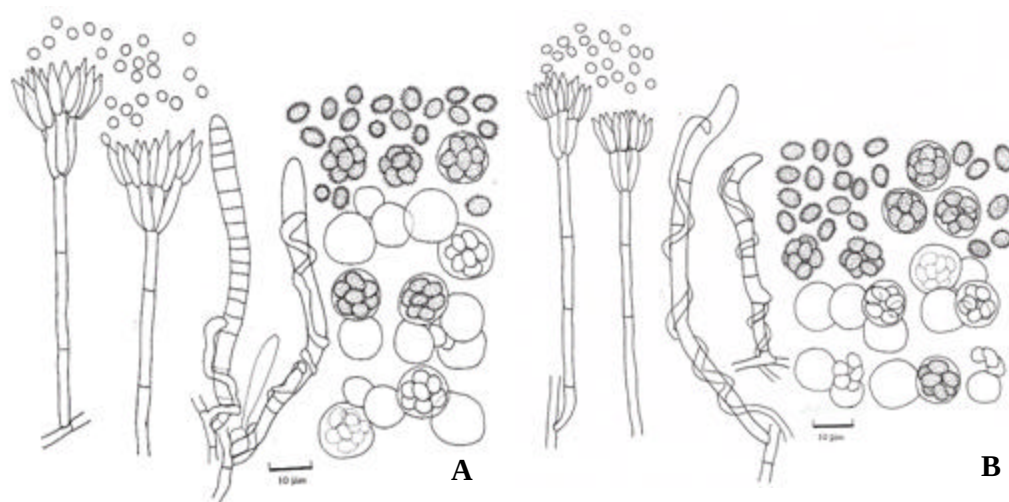


Figure 18 Camera lucida drawings of *Talaromyces flavus* showing penicilli, conidia, ascomatal initials, asci and ascospores
A. KUFC 3523 B. KUFC 3528

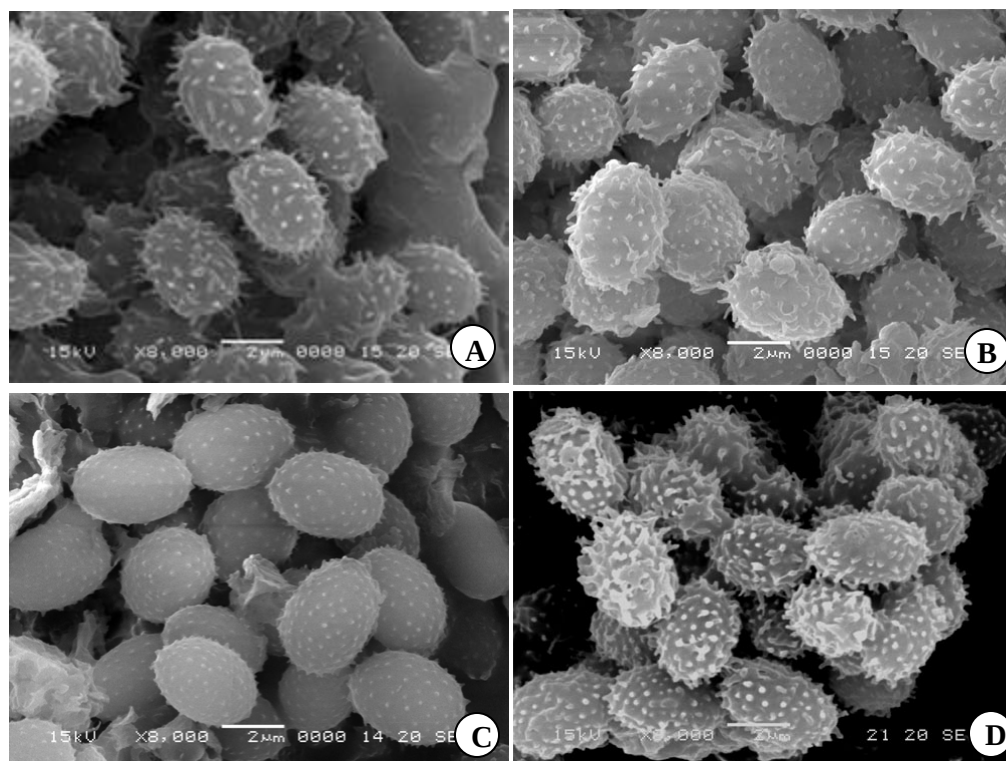


Figure 19 SEM photomicrographs showing variations in shape, size and ornamentation of ascospores among different isolates of *T. favus*
A. KUFC 3523; B. KUFC 3528; C. KUFC 3530; D. KUFC 3340

4. *Talaromyces helicus* C.R. Benjamin var. *major* Stolk & Samson

(Figures 20-22)

Strains: KUFC 3593, KUFC 3598 agricultural soil, Chanthaburi

Reference: Stolk and Samson, 1972

Stat. Anam. *Penicillium helicum* Raper & Fennell

Colonies on CZA growing slowly, attaining a diameter of 15 mm within 7 days at 25°C, plane, consisting of a very thin basal mycelial felt, Straw (R 46); ascomata and conidiogenesis absent; exudates absent; reverse uncolored to Pale Luteous (R 11) (Figures 20 A, a).

Colonies on CYA growing rather rapidly, attaining a diameter of 22-24 mm within 7 days at 25°C, velvety, floccose at the central area, consisting of a compact basal felt, producing only white mycelium; ascomata and conidiogenesis lacking; exudates absent; reverse Straw (R 46) to Pale Luteous (R 11) (Figures 20 B, b).

Colonies on MEA spreading broadly, reaching a diameter of 65-70 mm within 7 days at 25°C, plane, more or less funiculose, consisting of a compact mycelial felt, producing abundant ascomata over the entire surface, Sulphur Yellow (R. 15) to Pure Yellow (R 14); conidiogenesis inconspicuous and sparse, margins entire; exudates abundant at central area, as pale yellow drops; reverse Luteous (R 11) (Figures 20 C, c).

Colonies on CMA growing rapidly, attaining a diameter of 50 mm within 7 days at 25°C, plane, thin, consisting of a spreading, submerged vegetative mycelium, with limited development of funiculose aerial hyphae, producing yellow ascomata in central area, Straw (R 46) or Pure Yellow (R 14); conidiogenesis inconspicuous and sparse; margins entire; exudates absent; reverse uncolored (Figures 20 D, d).

Colonies on OMA growing rapidly, attaining a diameter of 60-70 mm within 7 days at 25°C, plane, consisting of a thin mycelial felt in which abundant

developing ascomata, Sulphur Yellow (R 15); conidiogenesis inconspicuous and sparse; exudates absent; reverse uncolored (Figures 20 E, e).

Colonies on G25N agar growing extremely slowly; attaining a diameter of 5-6 mm within 7 days at 25°C, producing only sparse white mycelium (Figures 20 F, f).

Ascomata discrete or often confluent, ripening within 10 to 14 days, globose to subglobose, (150-) 170-210 µm in diameter (Figure 21A), soft, surrounded by loose wefts of yellow hyphae; ascomatal wall soft, consisting of thin, branched, interwoven hyphae. Ascomatal initials consisting of club-shaped ascogonia around which thin antheridia coil tightly several times in the basal pattern, growing out to coil terminally in a conspicuous helical pattern (Figures 21 D, 22 C). Asci in chains, 8-spored, broadly subglobose to globose, 6.5-10 x 6-8 µm (Figures 21 E, 22 D). Ascospores hyaline, broadly ellipsoidal, smooth-walled, 3.3-4 x 2.3-2.6 µm (KUFC 3623), whereas ascospores size of KUFC 3628 rather bigger, 3.6-4.7 x 2.7-3 (Figures 21 F-I, 22 E-F).

Conidiophores arising from basal mycelium or as short branches from aerial hyphae, hyaline, 30-50 x 2-2.5 µm, smooth-walled. Penicilli typically biverticillate or monoverticillate. Metulae in small verticils of 2 to 4, hyaline, 10-12 x 2.5-2.7 µm. Phialides 2 to 6 in the verticil, hyaline, 10-12 (-15) x 2-3 µm (Figures 21 B-C, 22 A-B). Conidia globose to subglobose, 3-4 µm or 3.5-4.5 µm in diameter, smooth-walled (Figures 21 B-C, 22 A-B).

The main characteristic of *Talaromyces helicus* var. *major* is the production of poorly developed penicilli and smooth-walled ascospores. This fungus was reported from soil in Sweden, Switzerland, Argentina and Australia (Domsch *et al.*, 1993a, b). *Talaromyces helicus* isolated from co-contaminated sludge of the east channel, Argentina could detoxify copper and biphenyl in environmental (Ormero *et al.*, 2006).

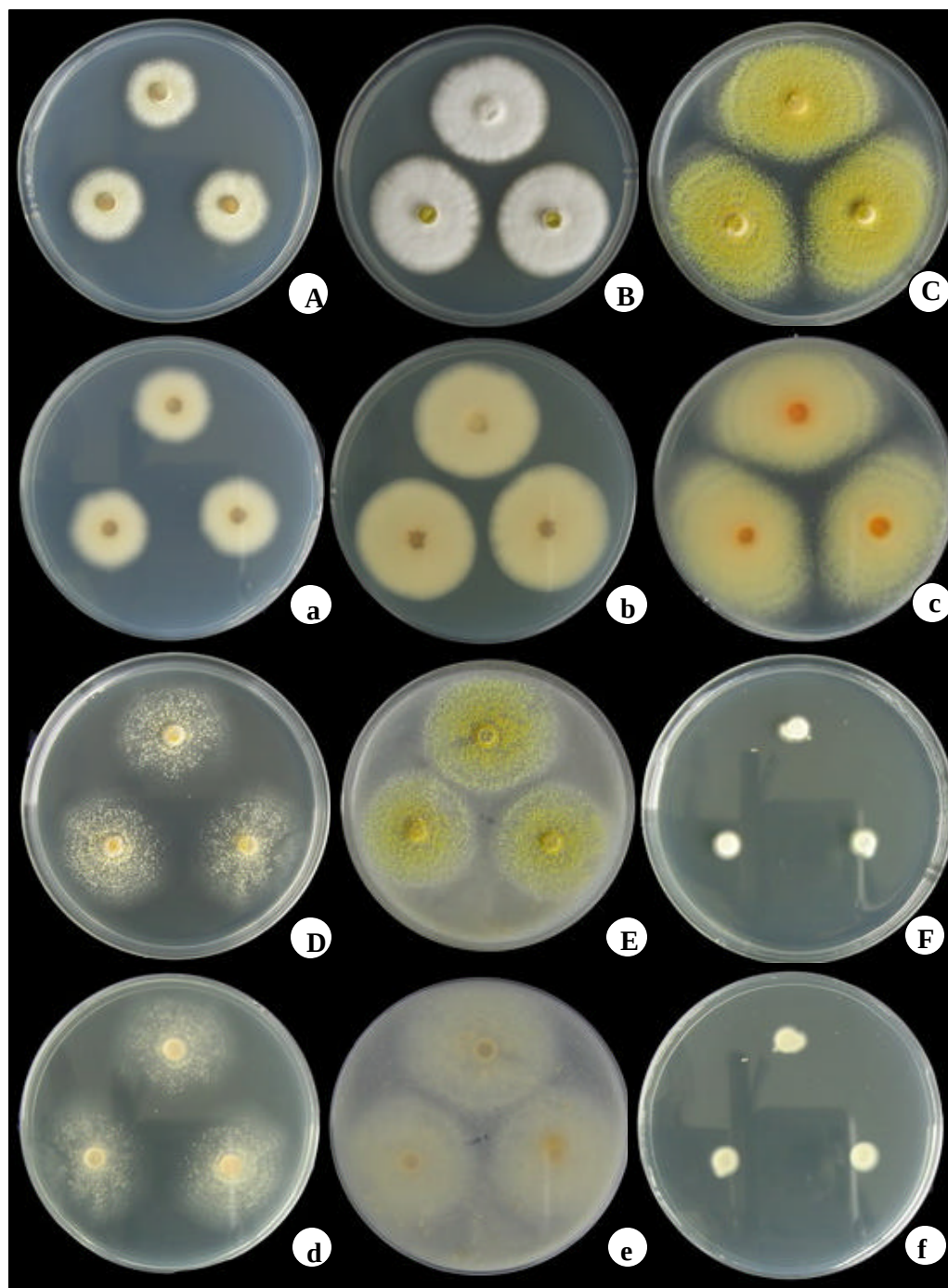


Figure 20 *Talaromyces helicus* var. *major* KUFC 3598. Obverse and reverse views of colonies on different media, incubated for 7 days at 25°C; CZA (A, a), CYA (B, b), MEA (C, c), CMA (D, d), OMA (E, e), G25N (F, f)

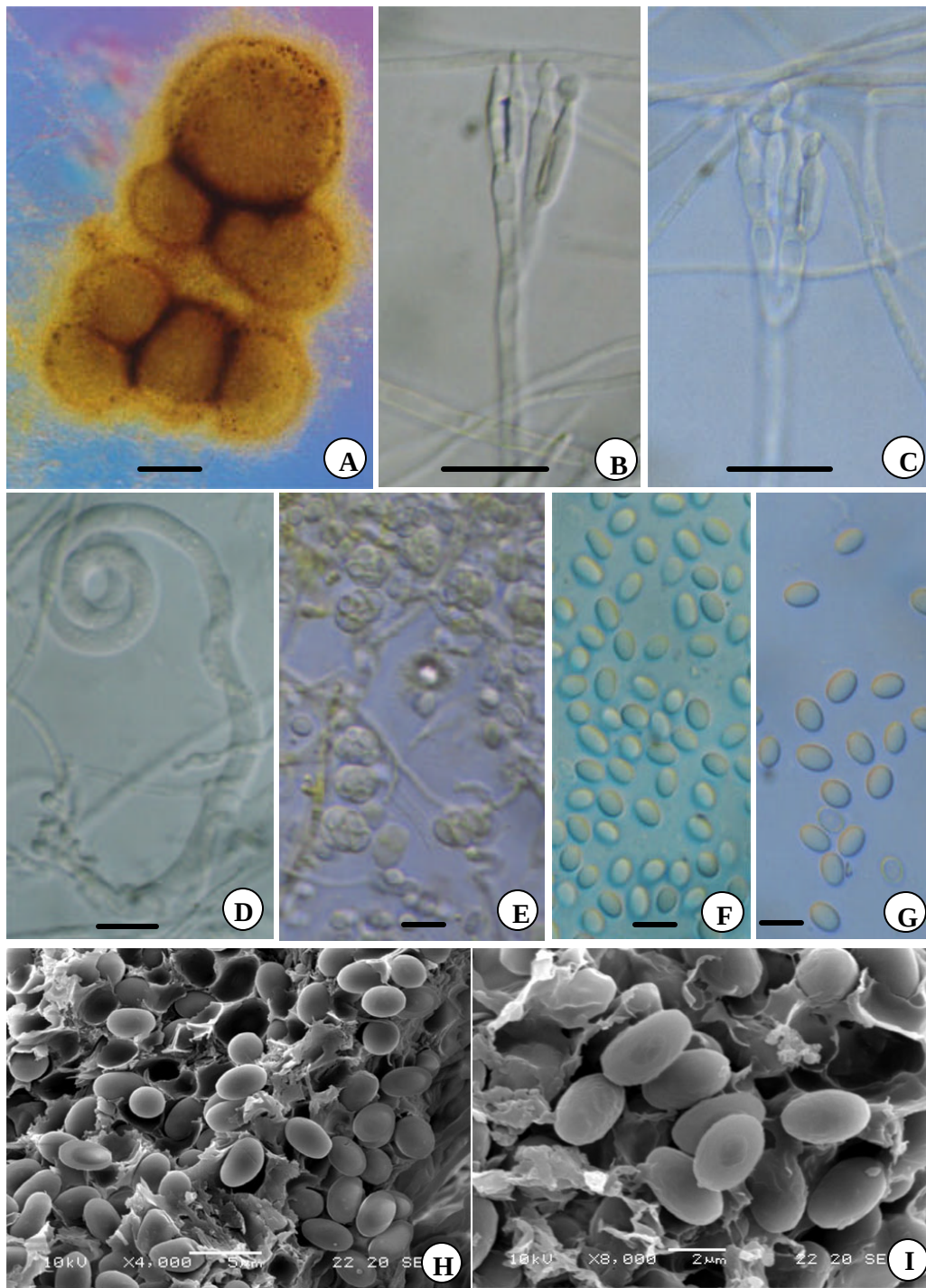


Figure 21 *Talaromyces helicus* var. *major* KUFC 3598

A. ascomata; B-C. penicilli; D. ascomatal initial; E. asci and ascospores; F. ascospores KUFC 3593; G. KUFC 3598; H-I. ascospores (SEM) (Bars: A = 100 μm; B-D = 10 μm; E-H = 5 μm; I = 2 μm)

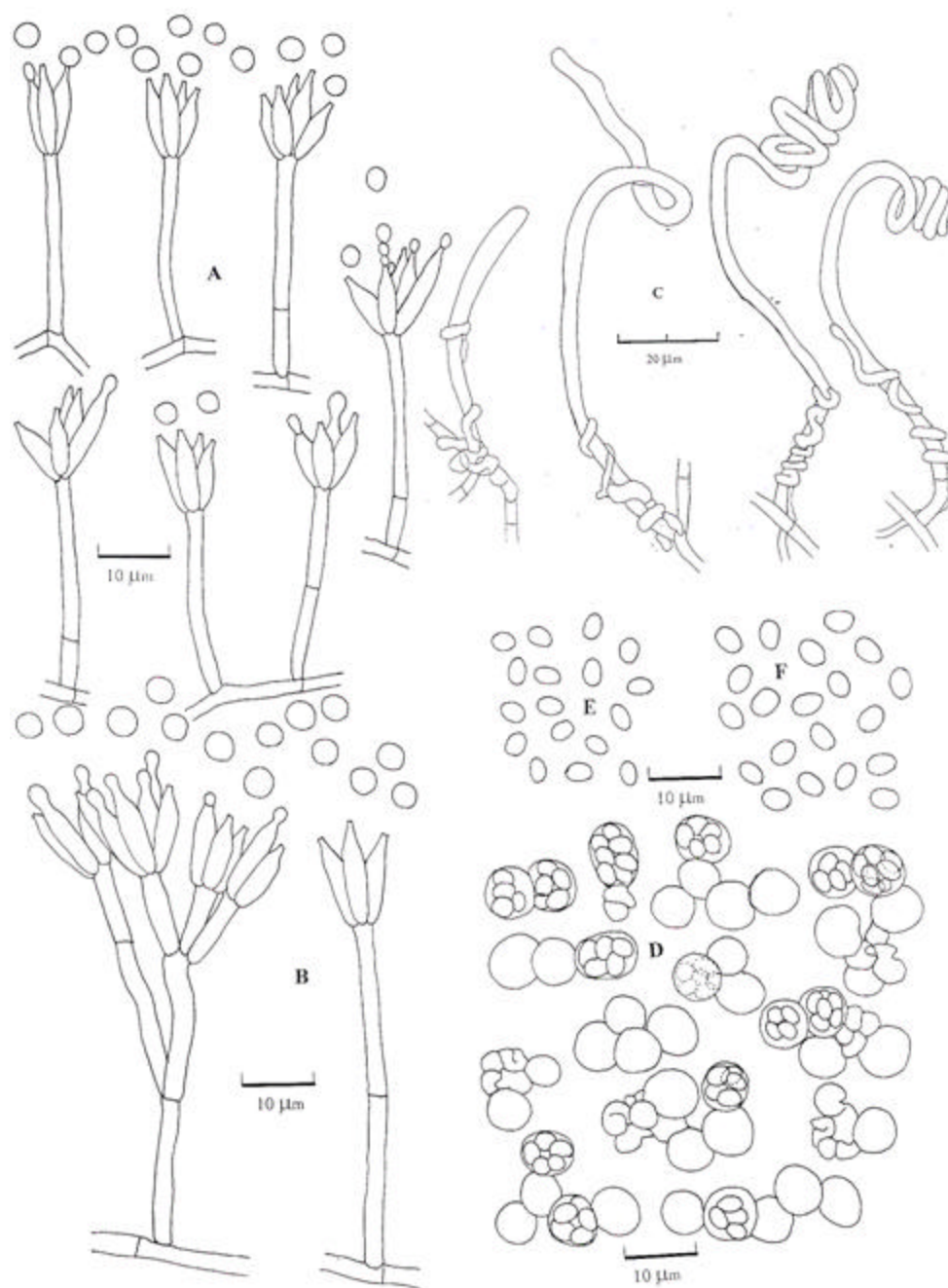


Figure 22 *Talaromyces helicus* var. *major*

Camera lucida drawings of A. penicilli KUFC 3593; B. KUFC 3598

C. ascomatal initials; D. ascus and ascospores; E. ascospores

KUFC 3593, F. KUFC 3598

5. ***Talaromyces luteus*** (Sacc.) Stolk & Samson (Figures 23-25)

Strains examined: KUFC 3331, KUFC 3364 soil at hot spring,

Mae Hong Son

References: Stolk and Samson, 1972; Pitt, 1979a

Stat. Anam. *Penicillium udagawae* Zukal

Colonies on CZA growing moderately, attaining a diameter of 20 mm within 7 days at 25°C, plane, velvety to funiculose, sulcate, consisting of a compact basal felt, producing only Pure Yellow (R 14) mycelium on the felt; conidiogenesis sparse, inconspicuous; exudates absent; reverse Pale Luteous (R 11). Colonies on CZA at 28°C, reaching a diameter of 25 mm and 40 mm within 7 and 14 days respectively, plane, velvety to fasciculate, sulcate, consisting of a compact basal felt, producing abundant young ascomata over the entire surface, Pure Yellow (R 14); conidiogenesis sparse, inconspicuous; exudates absent; reverse Straw (R 46) (Figures 23 A, a).

Colonies on CYA growing moderately, attaining a diameter of 20-22 mm within 7 days at 25°C, floccose to funicubse, slightly sulcate, commonly umbonate at the central area, consisting of a compact basal felt, producing developing ascomata in a layer on the felt, Pure Yellow (R 14); conidiogenesis sparse and inconspicuous; exudates absent; reverse Cinnamon (R 62). Colonies on CYA at 28°C, reaching a diameter of 25 mm and 45 within 7 and 14 days respectively, funicubse, slightly zonate, consisting of a compact basal felt, producing young ascomata in the central area, Pure Yellow (R 14) to Orange (R 7); conidiogenesis sparse and inconspicuous; exudates absent; reverse Pale Luteous (R 11) to Orange (R 7) (Figures 23 B, b).

Colonies on MEA growing moderately, attaining a diameter of 20-22 mm within 7 days at 25°C, plane, velvety, more or less funiculose, producing abundant ascomata over the entire surface; conidiogenesis limited, Pure Yellow (R 14); margins broad, entire; exudates scattered, as small clear drops; reverse Straw (R 46). Colonies on MEA at 28°C, reaching a diameter of 25 mm and 40 within 7 and 14 days respectively, plane, consisting of a thick interwoven basal felt, in which numerous

ascomata are embedded near the agar surface, Luteous (R12) to Orange (R 7) in the central area, surrounded by a thin, submerged margin; conidiogenesis sparse and inconspicuous; exudates clear to orange drops; reverse Pale Luteous (R 11) (Figures 23 C, c).

Colonies on CMA growing slowly, attaining a diameter of 17-18 mm within 7 days at 25°C, plane, consisting of a thin mycelial felt, plane, producing moderately ascomata on the agar surface, Pure Yellow (R 14); conidiogenesis limited; exudates absent; reverse uncolored. Colonies on CMA at 28°C, reaching a diameter of 20 mm and 35 mm within 7 and 14 days respectively, colony as mentioned above, but ascomata are more abundantly overgrown by aerial mycelium, Pure Yellow (R 14); conidiogenesis absent; exudates absent; reverse uncolored.

Colonies on OMA growing slowly, attaining a diameter of 15-18 mm within 7 days at 25°C, plane, consisting of a thin mycelial felt in which abundant yellow ascomata soon develop intermix with conidiogenesis, showing an increased yellowish coloration, Pure Yellow (R 14); conidiogenesis limited; exudates absent; reverse uncolored. Colonies on OMA at 28°C, reaching a diameter of 20 mm and 35 mm within 7 and 14 days respectively, vegetative mycelium submerged or forming a sparse growth of aerial hyphae, producing abundant ascomata near the agar surface, Pure Yellow (R 14); conidiogenesis limited; exudates absent; reverse uncolored.

Colonies on G25N agar growing extremely slowly; attaining a diameter of 10 mm within 14 days at 28°C, producing only sparse aerial growth.

At 37°C, growth is extremely restricted.

Ascomata yellow to orange, subglobose or globose, about 200-300 µm in diameter, usually confluent, occasionally discrete, ripening within 2 weeks. Covering consisting of thin networks of loosely interwoven hyphae (Figure 24 A). Ascomatal initials start with the terminal or intercalary swelling and branching of hyphae, occasionally forming a small plexus of swollen cells, from which long, single, coiling

aseptate hyphae develop, producing several loose coils in a helical pattern (Figures 24 E, 25 C). Asci 8-spored, broadly ellipsoidal to subglobose, $7.3\text{--}11 \times 6\text{--}9 \mu\text{m}$ (Figures 24 F, 25 D). Ascospores ellipsoidal, $4\text{--}4.7 \times 2.7\text{--}3.3 \mu\text{m}$, ornamented with 3 to 5 regularly transverse, nearly parallel ridges, $1\text{--}1.5 \mu\text{m}$ wide (Figures 24 G-I, 25 D).

Conidiophores arising both from submerged and aerial hyphae, short, $30\text{--}50 \times 3\text{--}3.5 \mu\text{m}$. Penicilli typically irregularly arranged, sometimes terverticillate or monoverticillate. Metulae in small verticils of 2 to 3, $7\text{--}10 \times 2.7\text{--}3 \mu\text{m}$. Phialides ampulliform to acerose, about 2 to 4 in the verticil (Figures 24 B-D, 25 A). Conidia hyaline, subglobose to globose, $3\text{--}5 \times 1.5\text{--}2 \mu\text{m}$, smooth-walled, borne in tangled, disordered chains (Figures 24 B-D, 25 B).

Yoshida *et al.*, (1996) isolated three new azaphilones, luteusins A, B, C, D and E from this fungus.

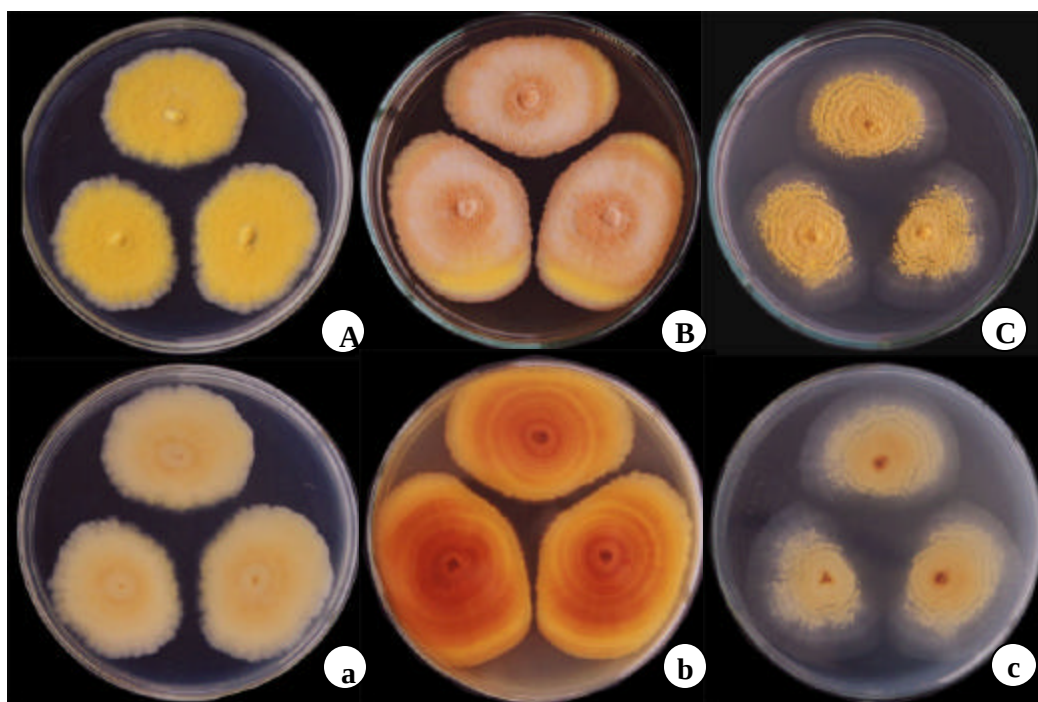


Figure 23 *Talaromyces luteus* KUFC 3364. Obverse and reverse views of colonies on different media, incubated for 7 days at 28°C ; CZA (A, a), CYA (B, b), MEA (C, c)

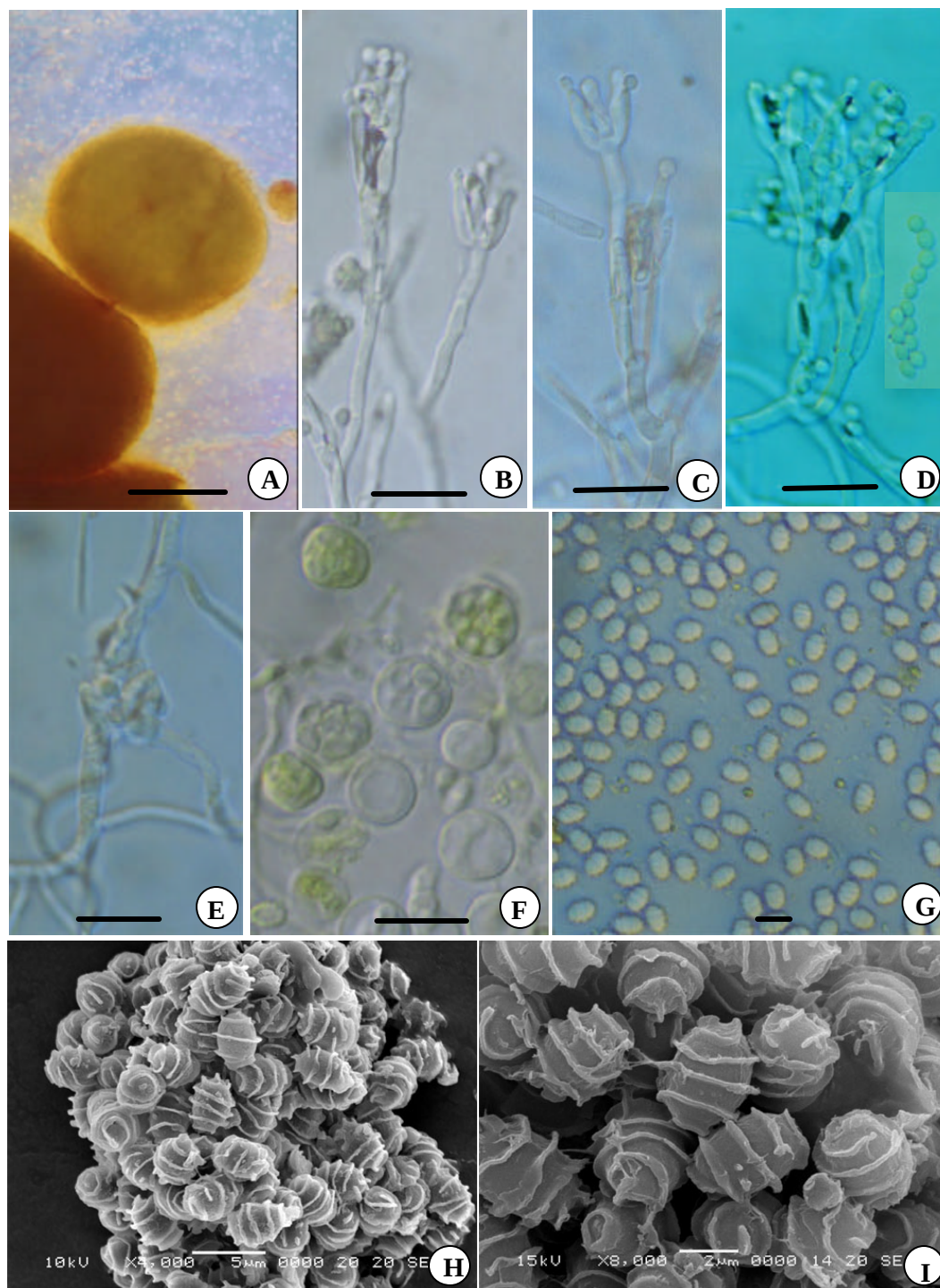


Figure 24 *Talaromyces luteus* KUFC 3364

A. ascomata; B-D. penicilli; E. ascomatal initial; F-G. asci and ascospores; H-I. ascospores (SEM)

(Bars: A = 100 μm ; B-F = 10 μm ; G-H = 5 μm ; I = 2 μm)

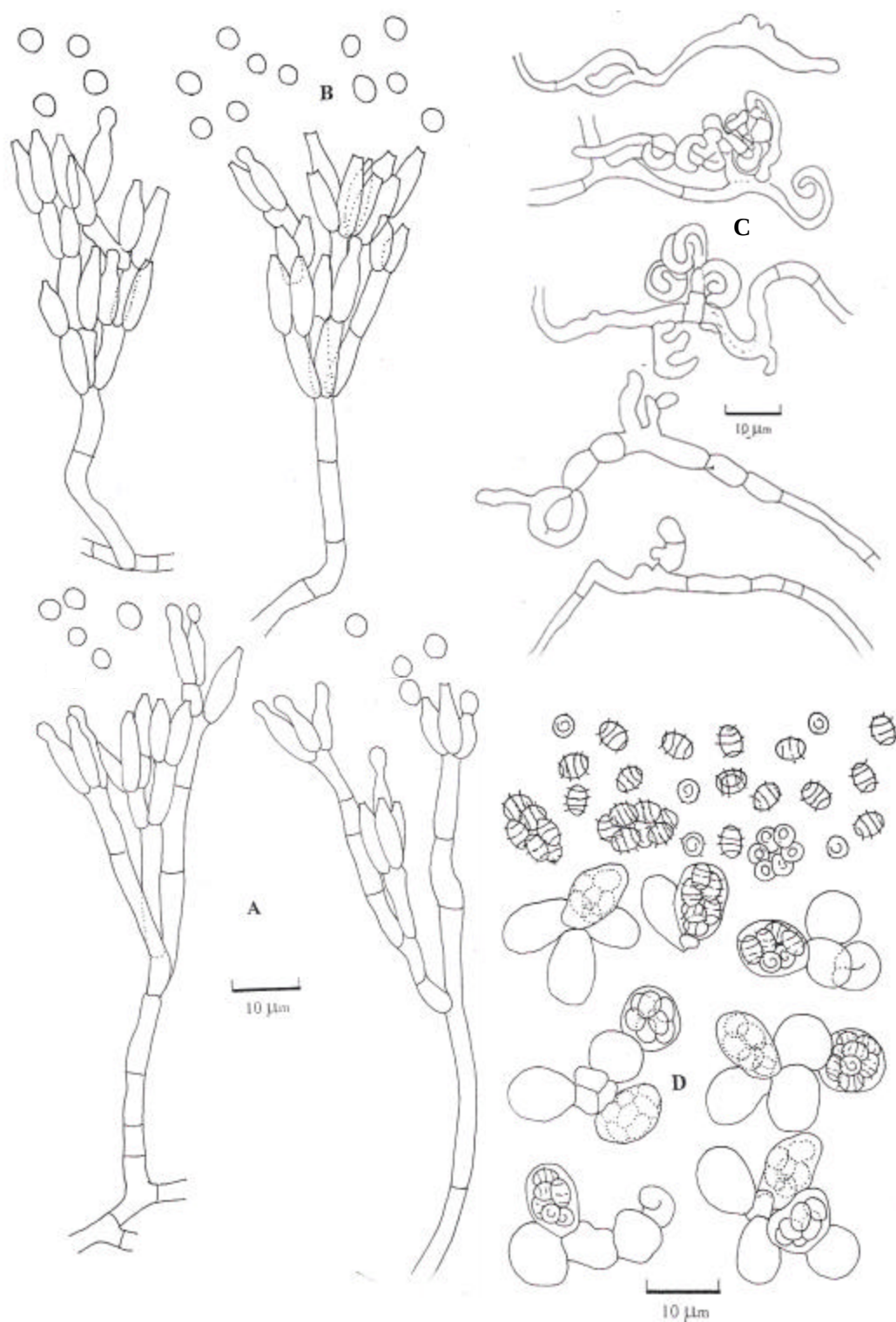


Figure 25 *Talaromyces luteus* KUFC 3364

Camera lucida drawings of A. penicilli; B. conidia;
C. ascomatal initials; D. ascus and ascospores