

Full Paper

New taxa and a key to *Pertusaria* species (Pertusariaceae, lichenised Ascomycota) in Thailand

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Abstract: Four corticolous *Pertusaria* taxa from Thailand are described as new, viz. *P. flavodigitata* Jariang., *P. khuntanensis* Jariang., *P. pertusella* Müll. Arg. var. *sorediata* Jariang. and *P. phukaensis* Jariang. A key of *Pertusaria* in Thailand is presented.

Keywords: *Pertusaria*, Pertusariaceae, Thailand

INTRODUCTION

Since 2000, revisional study of the lichen genus *Pertusaria* (Pertusariaceae) in Thailand has resulted in 103 taxa, of which 73 are new to Thailand and 34 are new taxa [1-3]. Additional four taxa are here described as new.

MATERIALS AND METHODS

Many specimens were collected during an extensive survey of *Pertusaria* in Thailand. The morphology and anatomy of the specimens were studied with an Olympus SZ3 stereomicroscope and an Olympus CH-2 compound microscope. Chemical analysis was carried out by both thin layer chromatography [4, 5] and high performance liquid chromatography [6, 7].

NEW TAXA

***Pertusaria flavodigitata* Jariang. sp. nov.**

Similis *Pertusaria parmatica* Archer & Elix *sed acidum sticticum continens vice acidum salazanicum, Apothecia ignota*

Type: Thailand, Tak province, Mueang district, Mae Taw subdistrict, Lansang National Park, between Tak province and Mae Sod district, along the road to Musoe Dam and Musoe Lhueang Agricultural Station, on the trail to Pha Daeng Unit, on bark of Fagaceae, 980 m, primary evergreen, seasonal hardwood forest, Jariangprasert 3829, 20 November 2002; holotype: QBG.

Etymology: From the Latin *flavus* = yellow and *digitatus* = finger-like; referring to the colour of the thallus under ultraviolet light and the appearance of the isidia.

Morphology and anatomy: Thallus grayish-green, corticolous, surface shiny, slightly wrinkled, isidiate, soredia absent. Isidia concolorous with the thallus, crowded, cylindrical to branched, 0.1 mm diameter, 0.1-0.6 mm long. Apothecia and pycnidia not seen.

Chemistry: K-, C-, KC-, Pd-, UV+ bright yellow; lichexanthone (major-minor), \pm atranorin (minor), stictic acid (major), gracilliformin (minor), constictic acid (minor), cryptostictic acid (trace) and peristictic acid (trace).

Ecology: This species is corticolous on trees of Fagaceae and Theaceae in seasonal evergreen, hardwood forest.

Notes: *Pertusaria flavodigitata* (Figure 1A) is characterised by the isidiate thallus which fluorescence bright yellow under ultraviolet light. It is distinguished from the chemically similar, fertile Australian species, *P. isidiosa* Archer by the lack of both apothecia and 2'-*O*-methylperlatolic acid [8]. This new species resembles the isidiate, *P. parmatica* Archer & Elix from Papua New Guinea, but differs chemically. Both species give a bright yellow fluorescence under ultraviolet light, but *P. parmatica* contains salazinic acid rather than stictic acid.

Additional specimens examined (Paratypes)—Thailand: Phitsanuloke province, Phuhin Rongkla National Park, close to a water tank, next to Poo Paeng Ma guest house, behind a check point, on a tree trunk, 1,110 m, Jariangprasert 5599, 3 March 2004 (QBG); **Loei province,** Nahaew district, Nahaew National Park, on the way to check point 2, 1,408 m, on bark of Theaceae, in seasonal evergreen, hardwood forest, Jariangprasert 5386, 7 March 2004 (RAMK).

***Pertusaria khuntanensis* Jariang. sp. nov.**

Similis Pertusaria paramoana Jariang. sed acidum 4-*O*-demethylplanaicum et acidum 2'-*O*-methylanziaicum continente differt

Type: Thailand, Lampang-Chiangmai provinces, Khun Tan National Park, 99° 14' E, 18° 25' N, 600 m, deciduous dipterocarp forest, on a tree trunk, Wolseley & Boonpragob 3223, 11 Jan 1993; holotype: BM.

Etymology: From the Latin *ensis*, place of the origin and *Khun Tan* National Park.

Morphology and anatomy: Thallus grey-green to brown-green, corticolous, surface rough, subtuberculate, isidia and soredia absent. Apothecia verruciform, conspicuous, apothecia solitary, rounded confluent apothecia flattened-hemispherical, 1-4 apothecia per verrucum and contorted, constricted at the base, 0.5-1.6 mm. diameter. Ostioles black, conspicuous, protruding, solitary, sometimes fused and sunken in central concave apothecia, 1-6 per apothecia. Asci amyloid with distinctive ocular chambers, hymenium non-amyloid. Ascospores (2)-3-(4) per ascus, ellipsoid, smooth, 44-54 μ m wide, 100-156 μ m long, striated thick-wall, 10-14 μ m.

Chemistry: K+ y, C+ rose red (transient), KC+ rose red, Pd-, UV+ reddish-orange; 4,5-dichlorolichexanthone (minor), 4-*O*-demethylplanaic acid (major), 2'-*O*-methylanziaic acid (minor).

Additional specimens examined (Paratypes)—**Thailand: Lampang province**, Mueang Bahn district, Jae Sawn National park, on mountain ridge, opposite a waterfall, primary, evergreen, seasonal, hardwood forest, on bark of Fagaceae, 900 m, Jariangprasert 3223.1, 6 November 2002 (QBG).; **Chiang Mai province**, Chiang Dao district, Doi Chiang Dao National Park, 680 m, on bark of *Shorea obtusa* Wall. ex Bl. (Dipterocarpaceae), Jariangprasert 4180, 3 December 2002 (QBG).

Notes: *Pertusaria khuntanensis* (Figure 1B) is characterised by (2)-3-(4) smooth ascospores per ascus and the presence of 4,5-dichlorolichexanthone, 4-*O*-demethylplanaic acid and 2'-*O*-methylanziaic acid. 4-*O*-Demethylplanaic acid has not previously been reported in *Pertusaria*. It was reported in *Lecidea lithophila* (Ach.) Ach. and *L. plana* (Lahm in Körb.) Nyl. [9]. *Pertusaria khuntanensis* Jariang. and *P. phusoidaoensis* Jariang. [3] contain 2'-*O*-methylanziaic acid but *P. phusoidaoensis* lacks 4-*O*-demethylplanaic acid. The subtuberculate thallus surface and contorted, centrally sunken apothecia resemble those of *P. parameeana* Jariang. and *P. phusoidaoensis* Jariang. However, they differ chemically; *P. parameeana* Jariang. contains 4,5-dichlorolichexanthone and 2-*O*-methylperlatolic acid [2].

***Pertusaria pertusella* Müll. Arg. var. *sorediata* Jariang. sp. nov.**

a var. *pertusella* sed *sorediata*

Type: Thailand, Tak province, Mueang district, Mae Taw subdistrict, Lansang National Park, between Tak province and Mae Sod district, on the way to Musoe Dam and Musoe Lhueang Agricultural Station, on a tree bark, 980 m, on mountain ridge adjacent to deciduous hardwood and bamboo forest of Phadaeng Sanctuary Unit, Jariangprasert 3760, 20 November 2002; holotype: QBG.

Etymology: The varietal name is derived from the presence of soredia.

Morphology and anatomy: Thallus grayish-green, corticolous, surface cracked and verrucose, sorediate, lacking isidia. Soralia conspicuous, concolorous with the thallus, scattered, hemispherical, 0.2-0.6 mm diameter. Apothecia verruciform, conspicuous, hemispherical, not constricted at the base, solitary, 0.3-0.7 mm diameter. Ostioles black, conspicuous, surrounded with grey translucent tissue or cortex. Ascospores 2 per ascus, fusiform, smooth, 140-168 µm long, 32-40 µm wide.

Chemistry: 2,4-dichlorolichexanthone (major), 2,5-dichlorolichexanthone (major), 2,4,5-trichlorolichexanthone (minor), 2-chlorolichexanthone (major), stictic acid (minor).

Additional specimens examined—Thailand: **Tak province**, Mueang district, Mae Taw subdistrict, Lansang National Park, between Tak province and Mae Sod district, on the way to Musoe Dam and Musoe Lhueang Agricultural Station, on a tree bark, 980 m., on mountain ridge to Phadaeng Sanctuary Unit, Jariangprasert 3831, 3840, 20 November 2002 (RAMK, topotype); **Phetchaburi province**, Kaengkrachan National Park, Kao Pa Noen Tung, at milepost 80, left-hand side before reaching the palace, 1,000 m, on a tree bark in moist montane evergreen forest, Jariangprasert 2533, 12 June 2002 (QBG).

Notes: *Pertusaria pertusella* var. *sorediata* (Figure 1C) is characterised by having 2 smooth ascospores per ascus and the presence of 2,4-dichlorolichexanthone, 2,5-dichlorolichexanthone, 2,4,5-trichlorolichexanthone, 2-chlorolichexanthone and stictic acid. Both the chemistry and the

ascospores of the new variety resemble *P. pertusella* var. *pertusella* from Indian and Nepal, which has no soralia [8, 10]. The chemistry is identical to that of *P. lansangensis* Jariang. & Archer which was found at the same locality, but is differentiated by the smooth ascospores walls, rough in *P. lansangensis* [11]. Mature asci were rarely found. The ascospores are distinguished by the smooth walls and their acute, rather than round, ends as found in most *Pertusaria* species.

***Pertusaria phukaensis* Jariang. sp. nov.**

Pertusaria hirtella Singh & Sinha *similis*, a qua ascis bisporis et acido norstictico deficienti differt

Type: Thailand, Nan province, Pua district, Phuka National Park, around the head office, on Sterculiaceae tree bark, 1,300 m, Jariangprasert 5512.1, 23 March 2004; holotype: QBG.

Etymology: From the Latin *ensis*, place of origin and *Phuka* National Park.

Morphology and anatomy: Thallus grey-green, corticolous, surface slightly roughened, shining, containing tiny crystals, isidia and soredia absent. Apothecia verruciform, conspicuous, concolorous with the thallus, irregularly hemispherical, not constricted at base, solitary or sometimes 2-3 confluent, 0.5-1.0 mm diameter. Ostioles large, black, conspicuous, surrounded by grey tissue, level with the apothecia surface, 1-4 per apothecium. Hymenium densely interspersed with numerous oil droplets. Ascospores (2-)3-4(-5-6) per ascus, ellipsoid, ascospores smooth, 88-104 μm long, 32-40 μm wide.

Chemistry: atranorin (major).

Notes: *Pertusaria phukaensis* (Figure 1D) is characterised by having large, black ostioles, verruciform apothecia with 3-4 smooth ascospores per ascus, and the presence of atranorin as the only lichen compound detected. *Pertusaria* taxa containing only atranorin are uncommon. This compound usually occurs with orcinol *p*-depsides, e.g. perlatolic acid in *P. granulata* (Ach.) Müll. Arg. [12], with both confluent acid and perlatolic acid in *P. indica* Srivastawa & Awasthi [13], and with confluent acid in *P. gorokorana* Elix & Archer [14]. At present this new species is known only from the type specimen.

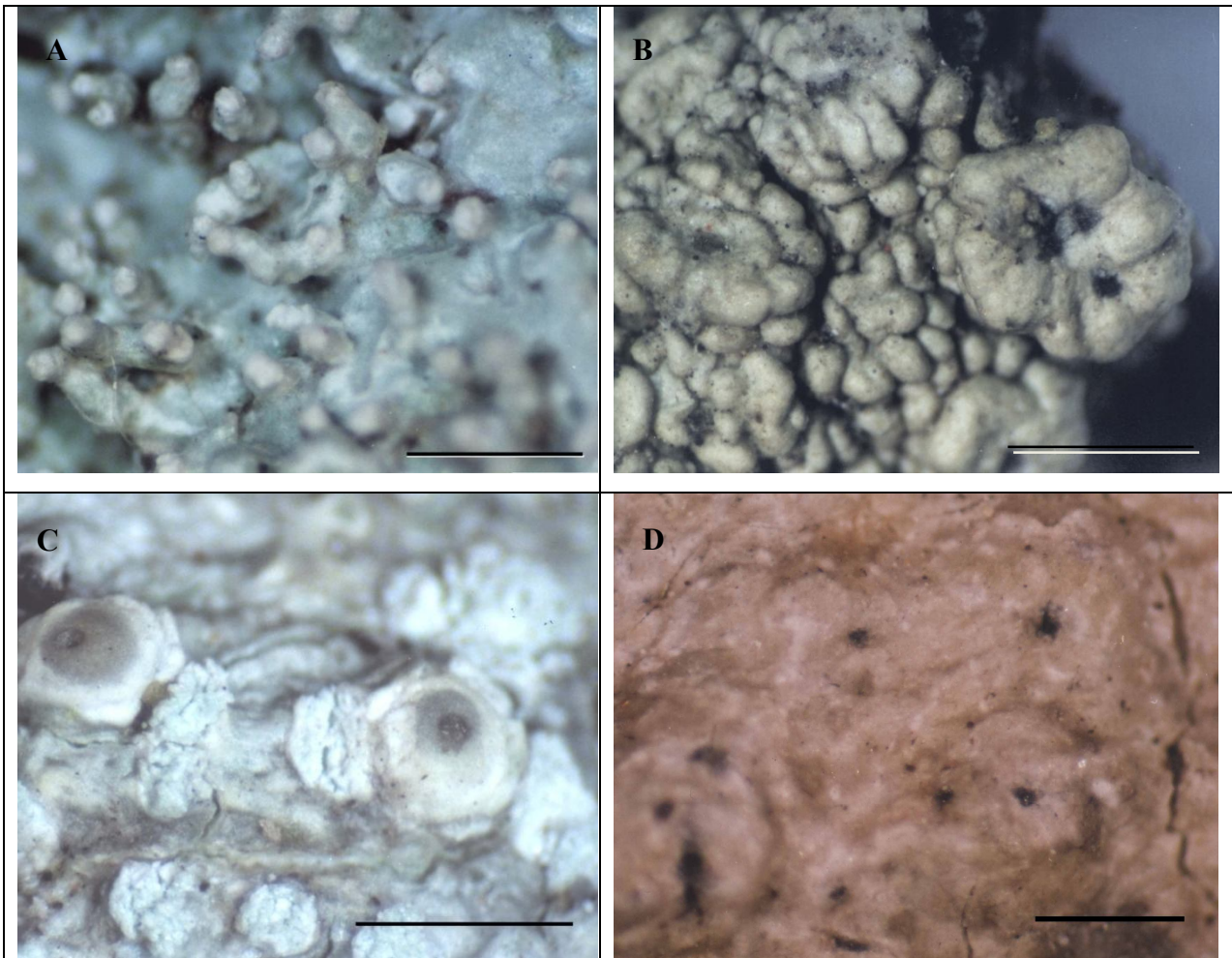


Figure 1. (A) *Pertusaria flavodigitata* Jariang. (holotype in QBG); (B) *P. khuntanensis* Jariang. (holotype in BM); (C) *P. pertusella* Müll. Arg. var. *soreciata* Jariang. (holotype in QBG); (D) *P. phukaensis* Jariang. (holotype in QBG). Scale bar = 1.0 mm

KEY TO TAXA OF *PERTUSARIA* IN THAILAND

- 1. Apothecia absent, thallus isidiate or sorediate2
 - 2. Thallus isidiateGROUP A
 - 2. Thallus sorediateGROUP B
- 1. Apothecia present, thallus rarely isidiate or sorediate3
 - 3. Apothecia disciformGROUP C
 - 3. Apothecia verruciform4
 - 4. Ascospore walls roughGROUP D
 - 4. Ascospore walls smooth5
 - 5. Ascospores 2-3 (rarely 4) per ascusGROUP E
 - 5. Ascospores 4 or 8 per ascus6
 - 6. Ascospores 4 per ascusGROUP F
 - 6. Ascospores 8 per ascus7

7. Ascospores uniseriateGROUP G
 7. Ascospores irregularly biseriateGROUP H

Group A: thalli isidiate

1. Thallus UV+ xanthonenes present.....2
 2. Thallus UV+ yellow, lichexanthone and stictic acid present.....*P. flavodigitata* Jariang.
 2. Thallus UV+ orange, 4,5-dichlorolichexanthone present3
 3. 2'-*O*-Methylperlatolic acid present*P. pilosula* Archer & Elix
 3. 2'-*O*-Methylperlatolic acid absent4
 4. Skyrin and methyl barbatate present*P. montpittensis* Archer
 4. Skyrin and methyl barbatate absent.....*P. angabangensis* Archer & Elix
 1. Thallus UV-, xanthonenes absent5
 5. Stictic acid present6
 6. 2'-*O*-Methylperlatolic acid present*P. pilosula* Archer & Elix var. *abditiva* Jariang.
 6. 2'-*O*-Methylperlatolic acid absent7
 7. Hypostictic acid present*P. hypostictica* Jariang.
 7. Hypostictic acid absent*P. muricata* David
 5. Stictic acid absent8
 8. Isidia K+ red, norstictic acid present*P. ramulifera* Magn.
 8. Isidia K-, norstictic acid absent9
 9. Thallus Pd+ orange, protocetraric acid present*P. umbricola* Archer & Elix
 9. Thallus Pd+ yellow, psoromic acid present*P. wauensis* Elix & Archer

Group B: thalli sorediate

1. Thallus UV-, xanthonenes absent2
 2. Lichen chemical substances absent*P. albescens* (Huds.) Choisy & Wern.
 2. Lichen substances present3
 3. Soralia KC+ red purple, picrolichenic acid present*P. amara* (Ach.) Nyl.
 3. Soralia KC-, picrolichenic acid absent4
 4. Thallus Pd+ yellow, psoromic acid present*P. psoromica* Archer & Elix
 4. Thallus Pd-, psoromic acid absent5
 5. Soralia K+purple, hypothamnolic acid present*P. bengalensis* Vain.
 5. Soralia K-, 2'-*O*-methylperlatolic acid present*P. uttaraditensis* Jariang.
 1. Thallus UV+ yellow or orange, xanthonenes present6
 6. Thallus UV+ yellow, lichexanthone present7
 7. Soralia K+ yellow, β -orcinol depsides present8
 8. Haemathamnolic acid present*P. moreliensis* Lesd.
 8. Thamnolic acid present*P. scaberula* Archer
 7. Soralia K-, confluentia acid present*P. confluentica* Jariang.
 6. Thallus UV+ orange, di-and trichloroxanthonenes present with stictic acid....*P. puffina* Archer & Elix

Group C: apothecia disciform

1. Thallus UV-, lichexanthone absent2
 2. Thallus without lichen secondary metabolites3

- 3. Apothecia fertile, fatty acids present*P. ophthalmiza* (Nyl.) Nyl.
- 3. Apothecia rarely fertile, fatty acids absent*P. albescens* (Huds.) Choisy & Wern.
- 2. Thallus with lichen secondary metabolites4
- 4. Thallus K⁺ red, norstictic acid present5
- 5. Thallus corticolous, ascospores 2 per ascus*P. asiana* Vain.
- 5. Thallus saxicolous, ascospores unknown*P. erubescens* (Hook. f. & Tayl.) Nyl.
- 4. Thallus K⁻ or K⁺ yellow, norstictic acid absent6
- 6. Thallus C⁺ rose-pink, lecanoric acid present*P. velata* (Turner) Nyl.
- 6. Thallus C⁻, lecanoric acid absent7
- 7. Thallus KC⁻, picrolichenic acid absent, thamnolic acid present.....*P. scutellifera* Archer & Elix
- 7. Thallus KC⁺ purple, picrolichenic acid present, thamnolic acid absent.....*P. patellifera* Archer
- 1. Thallus UV⁺ yellow, lichexanthone present8
- 8. Lichexanthone only present*P. asterella* Aptroot
- 8. Lichexanthone and other compounds present9
- 9. Thallus K⁺ purple, hypothamnolic acid present*P. tropica* Vain.
- 9. Thallus K⁻ or K⁺ yellow, hypothamnolic acid absent10
- 10. Thallus KC⁺ purple, picrolichenic acid present with derivatives.....11
- 11. Thamnolic acid present*P. subventosa* Malme
- 11. Thamnolic acid absent*P. clarkeana* Archer
- 10. Thallus KC⁻, picrolichenic acid absent12
- 12. Thallus K⁻, Pd⁻, squamatic acid present *P. xantholeuca* Müll. Arg.
- 12. Thallus K⁺ yellow, Pd⁺ orange, squamatic acid absent13
- 13. Haemathamnolic acid present.....*P. commutata* Müll. Arg.
- 13. Thamnolic acid present*P. miscella* Archer

Group D: ascospore walls rough

- 1. Thallus not isidiate or sorediate2
- 2. Thallus UV⁺ yellow, lichexanthone present.....*P. tetrathalamia* (Fee) Nyl. var. *plicatula* Müll. Arg.
- 2. Thallus UV⁻ or UV⁺ orange, lichexanthone absent3
- 3. Thallus UV⁻, xanthonenes absent4
- 4. Thallus K⁺ red, norstictic acid present with barbatic and divaricatic acids*P. allothwaitesii* Jariang. & Archer
- 4. Thallus K⁺ yellow, stictic acid present*P. cicatricosa* Müll. Arg. var. *deficiens* Archer & Streimann
- 3. Thallus UV⁺orange, xanthonenes present5
- 5. Orcinol *para*-depsides present6
- 6. Thallus K⁻, stictic acid absent*P. litchicola* Jariang. & Archer
- 6. Thallus K⁺ yellow, stictic acid present.....*P. pallida* Archer & Elix
- 5. Orcinol *para*-depsides absent7
- 7. Protocetraric acid present, stictic acid absent.....*P. thwaitesii* Müll. Arg.
- 7. Protocetraric acid absent, stictic acid present8
- 8. 2,4-Dichloro-,2,5-dichloro and 2,4,5-trichloroxanthonenes present...*P. cicatricosa* Müll. Arg.

- 8. 4,5-Dichlorolichexanthone present9
- 9. Apothecia forming irregular lumps, ostioles black, ascospores dominantly cylindrical, 88-158 x 34-56 μm *P. tetrathalamia* (Fée) Nyl.
- 9. Apothecia solitary, hemispherical, ostioles hyaline, ascospores dominantly ellipsoid, 74-152 x 26-56 μm *P. macounii* (Lamb) Dibben
- 1. Thallus isidiate or sorediate10
- 10. Thallus isidiate11
- 11. 2'-*O*- methylperlatolic acid absent*P. takensis* Jariang. & Archer
- 11. 2'-*O*- methylperlatolic acid present.....*P. microstoma* Müll. Arg. var. *isidiata* Jariang.
- 10. Thallus sorediate*P. lansangensis* Jariang. & Archer

Group E: ascospore walls smooth, 2-3 rarely 4 per ascus

- 1. Thallus isidiate or sorediate.....2
- 2. Thallus isidiate*P. allomicrostoma* Jariang.
- 2. Thallus sorediate*P. pertusella* Müll. Arg. var. *sorediata* Jariang.
- 1. Thallus not isidiate or sorediate3
- 3. Thallus without lichen chemical substances*P. subnegans* Vain.
- 3. Thallus with lichen chemical substances.....4
- 4. Thallus UV-, xanthonenes absent5
- 5. Thallus K⁺ red, norstictic acid present*P. glomerata* (Ach.) Schaer.
- 5. Thallus K⁻ or K⁺ yellow, norstictic acid absent6
- 6. Thallus K⁺ yellow, stictic acid present7
- 7. Planaic acid present8
- 8. 2'-*O*-Methylperlatolic acid present (with 2-*O*-methylperlatolic acid, planaic acid, methyl 2-*O*-methylperlatolate and methylplanaiate).....*P. subcopelandii* Jariang.
- 8. Methyl 2'-*O*-methylstenosporate present (with 2-*O*-methylperlatolic acid, planaic acid, methyl 2-*O*-methylperlatolate and methyl planaiate).....*P. methylstenosporica* Jariang.
- 7. Planaic acid absent*P. ramuensis* Archer & Elix
- 6. Thallus K⁻, stictic acid absent9
- 9. Confluent acid present*P. orientalis* Jariang.
- 9. Confluent acid absent, 2'-*O*-methylstenosporic acid present with 2'-*O*-methylperlatolic acid, planaic acid, methyl 2-*O*-methylperlatolate and methylplanaiate...*P. archeri* Jariang.
- 4. Thallus UV⁺ yellow or orange, xanthonenes present.....10
- 10. Thallus UV⁺ yellow, lichexanthone present (with confluent and stictic acids)
.....*P. inthanonensis* Jariang.
- 10. Thallus UV⁺ orange, lichexanthone absent.....11
- 11. Thallus KC⁺rose-red, 2'-*O*-methylaniziaic acid present.....12
- 12. 4-*O*-demethylplanaic acid present*P. khuntanensis* Jariang.
- 12. 4-*O*- demethylplanaic acid absent*P. phusoidaoensis* Jariang.
- 11. Thallus K⁺ or K⁻, 2'-*O*-methylaniziaic acid absent13
- 13. Thallus K⁺ red or K⁻, stictic acid absent14
- 14. Thallus K⁺ red, norstictic acid present (with 4,5-dichloroliche xanthone).....

-*P. neoknightiana* Jariang.
14. Thallus K-, norstictic acid absent15
15. Orcinol *para*-depsides absent16
16. Dichloro- and trichloroxanthenes present*P. xanthonaria* Archer & Elix
16. Dichlorolichexanthone only present*P. irregularis* Müll. Arg.
15. Orcinol *para*-depsides present17
17. 2-*O*-Methylperlatolic acid present18
18. Thallus corticolous*P. parameeana* Jariang.
18. Thallus saxicolous*P. nahaeoensis* Jariang. & Archer
17. 2-*O*-Methylperlatolic acid absent19
19. 2,2'-Di-*O*-methylstenosporic acid present with 2'-*O*-methyl stenosporic acid*P. subplanaica* Archer & Elix var. *tetraspora* Jariang & Archer
19. 2,2'-Di-*O*-methylstenosporic acid and 2'-*O*-methylstenosporic acid absent planaic acid present.....*P. siamensis* Jariang.
13. Thallus K+ yellow, stictic acid present20
20. Orcinol *para*-depsides present21
21. Confluentic acid present*P. cinchonae* Müll. Arg.
21. Confluentic acid absent22
22. 2'-*O*-Methylperlatolic acid present (with \pm 2-chlorolichexanthone, planaic and 2-*O*-methylperlatolic acids, methyl 2'-*O*-methylperlatolate and methylplanaiate).....*P. novaguineae* Archer & Elix
22. 2-*O*-Methylperlatolic acid present (with 4,5-dichlorolichexanthone).....
..... *P. loeiensis* Jariang.
20. Orcinol *para*-depsides absent.....23
23. 4,5-Dichlorolichexanthone present.....24
24. Ostioles fused*P. pustulata* (Ach.) Duby
24. Ostioles rarely fused*P. pertusa* (Weigel) Tuck.
23. 2,4-Dichloro-, 2,5-dichloro- and 2,4,5,-trichlorolichexanthone present.....25
25. Ostioles hyaline, ascospores 2, rarely 3 per ascus.....*P. pertusella* Müll. Arg.
25. Ostioles black, ascospores 3-4, rarely 2 per ascus.....*P. ceylonica* Müll. Arg.

Group F: ascospore walls smooth, 4 per ascus

1. Thallus UV+ yellow, lichexanthone present.....2
2. 2,2'-Di-*O*-methylstenosporic acid present... *P. alboaspera* Archer & Elix var. *tetraspora* Jariang.
2. 2'-*O*-methylstenosporic acid, 2'-*O*-methyl divaricatic acid, and 2'-*O*-methylperlatolic acid present....
.....*P. elixii* Jariang.
1. Thallus UV- or UV+ orange, lichexanthone absent.....3
3. Thallus UV-, xanthenes absent4
4. Thallus K-, stictic acid absent, atranorin present.....*P. phukaensis* Jariang.
4. Thallus K+ yellow, stictic acid present*P. radiata* Oshio
3. Thallus UV+ orange, xanthenes present5
5. Orcinol *para*-depsides absent.....6

- 6. Stictic acid present*P. leioplaca* Sch.
- 6. Stictic acid absent7
 - 7. Thiophaninic acid present*P. endochroma* Müll. Arg.
 - 7. Thiophaninic acid absent.....*P. nebulosa* Archer
- 5. Orcinol *para*-depsides present8
 - 8. Stictic acid absent*P. kansriae* Jariang.
 - 8. Stictic acid present9
 - 9. Planaic acid present*P. bonariensis* Malme
 - 9. Planaic acid absent10
 - 10. Ostioles black; 2-*O*-methylperlatolic acid present with 2-chlorolichexanthone, 2-*O*-methylisohyperlatolic, 2-*O*-methylhyperlatolic and 2-*O*-methylsuperlatolic acids.....
.....*P. follmanniana* Archer & Elix
 - 10. Ostioles hyaline; 2-*O*-methylperlatolic acid absent; 4,5-dichlorolichexanthone present with 2'-*O*-methylstenosporic, 2'-*O*-methyldivaricatic and 2'-*O*-methylperlatolic acids
.....*P. thailandica* Jariang.

Group G: ascospores 8 per ascus, uniseriate

- 1. Thallus UV-, K- or K+, xanthenes absent.....2
 - 2. Thallus K- ; 2-*O*-methylperlatolic acid present *P. mattogrossensis* Malme
 - 2. Thallus K+ yellow, stictic acid present.....3
 - 3. 2-*O*-Methylsuperlatolic acid present with superlatolic and isohyperlatolic acids.....
.....*P. krabiensis* Jariang.
 - 3. 2'-*O*-Methylperlatolic acid present*P. phulhuangensis* Jariang.
- 1. Thallus UV+ yellow or orange, xanthenes present4
 - 4. Thallus UV+ yellow, lichexanthone present*P. leucostigma* Müll. Arg.
 - 4. Thallus UV+ orange, lichexanthone absent5
 - 5. Ostioles yellow; thiophaninic acid and 2-*O*-methylperlatolic acid present.....*P. xylophyes* Archer
 - 5. Ostioles black; thiophaninic acid absent; 4,5-dichlorolichexanthone, 2,2'-di-*O*-methylstenosporic, 2'-*O*-methylperlatolic, 2'-*O*-methylstenosporic, planaic and 2,2'-di-*O*-methyldivaricatic acids present*P. subplanaica* Archer & Elix

Group H: ascospores 8 per ascus, irregularly uniseriate-biseriate

- 1. Thallus lacking lichen chemical substances*P. subrigida* Müll. Arg.
- 1. Thallus containing lichen chemical substances.....2
 - 2. Thallus UV-, xanthenes absent3
 - 3. Thallus K+ red, norstictic acid present*P. norstictica* Archer
 - 3. Thallus K- or K+ yellow, norstictic acid absent, stictic and 2,2'-di-*O*-methylstenosporic acids present*P. alboaspera* Archer & Elix var. *disflavens* Jariang.
 - 2. Thallus UV+ yellow or orange, xanthenes present4
 - 4. Thallus UV+ yellow, lichexanthone present5
 - 5. Orcinol *para*-depsides absent*P. phaeostoma* Müll. Arg.
 - 5. Orcinol *para*-depsides present6
 - 6. Thallus K-, stictic acid absent7

| | | |
|--|---|-----------|
| 7. Protocetraric acid present | <i>P. nanensis</i> Jariang. & Archer | |
| 7. 2'- <i>O</i> -Methylstenosporic acid present.... | <i>P. alboaspera</i> Archer & Elix var. <i>deficiens</i> Jariang. | |
| 6. Thallus K ⁺ yellow, stictic acid present | | 8 |
| 8. 2,2'-Di- <i>O</i> -methylstenosporic acid present..... | <i>P. alboaspera</i> Archer & Elix | |
| 8. 2'- <i>O</i> -Methylstenosporic acid present..... | <i>P. platycarpa</i> Jariang. | |
| 4. Thallus UV ⁺ orange, lichexanthone absent | | 9 |
| 9. Thiophaninic acid present | | 10 |
| 10. Stictic acid absent | | 11 |
| 11. Thallus saxicolous..... | <i>P. petrophytes</i> Knight | |
| 11. Thallus corticolous..... | <i>P. thiophaninica</i> Archer | |
| 10. Stictic acid present | | 12 |
| 12. Orcinol <i>para</i> -depsides present | | 13 |
| 13. 2,2'-Di- <i>O</i> -methylstenosporic, planaic and isoplacodiolic acids present..... | <i>P. omkoiensis</i> Jariang. & Archer | |
| 13. Perlatolic and hyperlatolic acids present | <i>P. hylocola</i> Jariang. & Archer | |
| 12. Orcinol <i>para</i> -depsides absent..... | | 14 |
| 14. Depsides present (4- <i>O</i> -methylisocryptochlorophaeic acid) | <i>P. paradoxica</i> Archer & Elix | |
| 14. Depsides absent..... | | 15 |
| 15. Hypostictic acid absent | <i>P. texana</i> Müll. Arg. | |
| 15. Hypostictic acid present | <i>P. leioplacella</i> Nyl. | |
| 9. Thiophaninic acid absent | | 16 |
| 16. 4,5-Dichlorolichexanthone absent | | 17 |
| 17. Stictic acid absent | | 18 |
| 18. Divaricatic acid, 2-chlorolichexanthone, methyl 2,2'-di- <i>O</i> -methyl divaricatate and methyl 2- <i>O</i> -methyldivaricatate present..... | <i>P. orarensis</i> Archer & Elix | |
| 18. Arthothelin, 6- <i>O</i> -methylarthothelin, di- and trichlorinated norlichexanthones present | <i>P. howeana</i> Archer & Elix | |
| 17. Stictic acid present..... | | 19 |
| 19. Di- and trichloro xanthenes present | <i>P. lordhowensis</i> Archer & Elix | |
| 19. 2-Chlorolichexanthone present..... | <i>P. limbata</i> Vain. | |
| 16. 4,5-Dichlorolichexanthone present | | 20 |
| 20. Stictic acid absent | | 21 |
| 21. Orcinol <i>para</i> -depsides absent | <i>P. mundula</i> Müll. Arg. | |
| 21. Orcinol <i>para</i> -depsides present..... | | 22 |
| 22. 2,2'-Di- <i>O</i> -methylstenosporic acid present..... | <i>P. bokluensis</i> Jariang. | |
| 22. 2'- <i>O</i> -Methylperlatolic acid present..... | <i>P. gibberosa</i> Müll. Arg. | |
| 20. Stictic acid present | | 23 |
| 23. Ostioles black..... | <i>P. sommerfeltii</i> Flk. | |
| 23. Ostioles not black | | 24 |
| 24. Orcinol <i>para</i> -depsides absent | | 25 |

25. Ostioles protruding, ascospores 72-92 x 32-40 μm ***P. leiocarpella*** Müll. Arg.
25. Ostioles surrounded with hyaline tissue, ascospores 90-114 x 28-36 μm ...
.....***P. stenostoma*** Vain.
24. Orcinol *para*-depsides present**26**
26. 2,2'-Di-*O*-methylstenosporic acid present with 2,2'-di-*O*-methyldivaricatic, 2'-*O*-methylstenosporic, planaic acids and 2'-*O*-methylstenosporate.....
.....***P. subplanaica*** Archer & Elix var. ***stictica*** Jariang.
26. 2,2'-Di-*O*-methylstenosporic acid present; 2,2'-di-*O*-methyldivaricatic, methyl 2'-*O*-methylstenosporic, planaic acids and methyl 2'-*O*-methylstenosporate absent.....***P. kansriae*** Jariang. var. ***stictica*** Jariang.

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