

Clé des *Sarcodon* Quélet ex P. Karst. Par J.A. Stalpers

Basidiome annual, fleshy to brittle, centrally or excentrically stipitate, solitary or conrescent, sometimes branching from a common base; pileus more or less round; abhymenial surface at first velutinous to felty, becoming smooth with areolately rupturing upper layer or tomentum breaking up into scales, or pileus scaly from an early stage; colour cream to yellowish, pinkish, brownish, reddish, violaceous or greenish, darkening when dry. Stipe typically solid, tapering or bulbous, sometimes rooting, tomentose, whitish or concolorous with pileus; base sometimes of different colour. Hymenial surface hydroid, covering the underside of the pileus and often decurrent on the stipe. Spines typically brown to purplish. Trama fleshy, brittle, soft to firm, typically not duplex, whitish or with pink to purple tinges. Spore-print brownish. Trama darkening in KOH. Hyphal system monomitic (in one case skeletal hyphae present). Generative hyphae hyaline to brownish, with thin to sometimes thickened walls, in the pileus and stipe typically inflated. Clamps present on all septa, rare or absent. Gloeoplerous-like hyphae typically present. Cystidia absent. Basidia clavate, with or without a basal clamp, with 4 sterigmata. Spores brownish, thin- to thick-walled, subglobose to ellipsoid, irregular in outline, with inequidistant warts, which may be conrescent and thus form a bifurcate (exsculptate) ornamentation or ridge, not amyloid. [p. 54] Substratum: terrestrial, ectomycorrhizal with angiosperms (typically Fagaceae) and gymnosperms (typically Pinaceae).

Type species: *Hydnum imbricatum* L.: Fr.

Ref.: Maas Geesteranus, 1971, 1975; Harrison, 1961; Baird, 1986a.

- 1a. Clamps present, sometimes rare, or lacking in stipe 2
- 1b. Clamps absent from all septa 15

- 2a. Spores up to 6 µm long 3
- 2b. Spores longer than 6 µm, at least on average 7

- 3a. Trama blackish blue. Hyphae of stipe lacking clamps.
Pileus convex to plane, becoming depressed, roughened to grooved, dark violet to blackish, up to 13 cm diam, margin even. Trama not duplex. Spines dark violet, up to 0.4 cm long, strongly decurrent. Stipe central to excentric, narrowed at the base. Gloeoplerous-like hyphae may be present. Basidia 35-45 x 5.5-7.5 µm. Spores coarsely warty, 5-5.5 x (3.8-)4-5 µm. Associated with gymnosperms.
S. fuscoindicus K. Harrison Ref.: Harrison, 1964; Baird, 1986a.
- 3b. Trama paler, lilac grey to pale orange. Hyphae of stipe with clamps.
Pileus plane-convex to slightly depressed, orange-brown to reddish, with darker, appressed scales (in the centre sometimes ascending) or fibers, often with purplish or violaceous tinges or even completely vinaceous violet to bluish black, up to 10(-20) cm diam, margin often becoming lobed; trama not duplex, trama whitish to pale orange, rarely pale violet. Spines concolorous to purplish, often with white tips, up to 0.5(-1) cm long, decurrent. Stipe central to excentric, often narrowed at the base, concolorous with pileus in the upper part, whitish at the base. Hyphae hyaline, thin-walled (rarely slightly thick-walled), up to 15(-30) µm wide. Gloeoplerous-like hyphae present. Spores tuberculate to coarsely warty, 4-6(-7) x 3.5-5 µm. *S. versipellis* complex 4

- 4a. (3b) Spores (5-)5.5-7 x 4.5-5.5 µm. Basidia 25-35 x (5-)6-7.5 µm.
Pileus pale orange to red or brown, up to 17 cm diam.
S. indurescens (Hall & Stuntz) Stalpers Ref.: Hall & Stuntz, 1972a; Baird, 1986a.
- 4b. Spores 4-6 x 3.5-5 µm. Basidia 25-40(-45) x 5-6(-6.5) µm 5

- 5a. (3b) Warts of spores flattened to bifurcate. [p. 55]
Pileus henna to violet-brown. Associated with gymnosperms.
S. calvatus (K. Harrison) K. Harrison Ref.: Harrison, 1964; Hall & Stuntz, 1972a; Baird,

- 1986a
- 5b. Warts of spores rounded 6
- 6a. (3b) Pileus orange-brown when fresh, becoming dark brown to purplish brown. Associated with gymnosperms.
S. versipellis (Fr.) Quélet
 Syn.: *Hydnum versipelliforme* Allescher; *H. crassum* K. Harrison
 Ref.: Harrison, 1961; Hall & Stuntz, 1972a; Maas Geesteranus, 1975; Baird, 1986a; Breitenbach & Kränzlin, 1986; Cetto, 1987.
 Note: *S. subfelleus* (K. Harrison) K. Harrison and *S. ussuriensis* Nikol. seem to be identical.
- 6b. (3b) Pileus vinaceous violet to bluish black. Associated with Pinaceae.
S. cyanellus (K. Harrison) Stalpers
 Ref.: Harrison, 1964; Baird, 1986a.
- 7a. (2) Scales absent from pileus. Spines not decurrent (except *S. excentricus*) 8
 7b. Pileus with scales. Spines decurrent 12
- 8a. Pileus with orange, brown or red tinges.
 Pileus pubescent when young, soon becoming glabrous, not zonate, up to 10(B17) cm diam; trama pale orange, not duplex. Abhymenial surface, fawn to cinnamon, spines up to 1 cm long, decurrent. Stipe central to excentric, pale brown to orange. Hyphae hyaline, thin-walled, up to 13(-15) µm wide. Basidia (25-)30-45 x 5.5-8 µm. Spores coarsely warted, (6.5-)7-8 x (5.5-)6-7.5 µm, warts flattened to bifurcate.
S. excentricus Coker & Beers in Baird
 Ref.: Baird, 1984, 1986a, 1986b.
 Note: *S. harrisonii* Baird is very similar, differing only in non decurrent and more densely aggregated spines.
- 8b. Pileus with olive, grey, violaceous or black tinges.
 Pileus not zonate, up to 7(-10) cm diam; trama pale brown, becoming green, (especially when dry), not duplex. Abhymenial surface, olive to grey or brownish, spines up to 2(-5) cm long, not decurrent. Stipe central to excentric, olive to grey. Hyphae hyaline, thin-walled, up to 13(-16) µm wide. Basidia 30-45(-50) x (6.5)-7-9(-11) µm. Spores coarsely warted, 7-9(-10) x 6.5-8(-8.5) µm, warts flattened to bifurcate. *S. thwaitesii* complex 9
- 9a. Pileus with pink to purplish tinges 10
 9b. Pileus without pink to purplish tinges [p. 56] 11
- 10a.(8b) Pileus pinkish grey when fresh, becoming cream-coloured to dark brown, pubescent when young, becoming smooth. Spines subdecurrent.
S. scabripes Peck
 Ref.: Baird, 1986a, 1986b.
- 10b.(8b) Pileus dull ochraceous, greyish or brownish, typically with drab to purplish tinges, dark olive when dry, finely tomentose. Spines not decurrent.
S. conchyliatus Maas Geest.
 Ref.: Maas Geesteranus, 1971.
- 11a.(8b) Pileus olive to grey, pubescent when young, soon becoming smooth.
S. atroviridis (Morgan) Banker
 Syn.: *Hydnum blackfordae* Peck; *Sarcodon fumosus* Banker; *H. bambusinum* Baker & Dale
 Ref.: Maas Geesteranus, 1971, 1974, 1975; Baird, 1986a, 1986b
- 11b.(8b) Pileus blackish olive when (old and) dry, velutinous to felted, becoming smooth. Associated with angiosperms.
S. thwaitesii (Berk. & Broome) Maas Geest.
 Syn.: *Sarcodon carbonarius* (G.H. Cunn.) ex Maas Geest.
 Ref.: Maas Geesteranus, 1971; McNabb 1971.

12a.(7) Spores 5B7 μm long, on average about 6 μm . Pileus whitish to orange when young. Cf. *S. indurescens* under 3.

12b. Spores at least 6 μm long, on average about 7 μm or more. Pileus without white to orange tinges when young

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13a. Scales coarse and at least in the centre erect. Spores 6.5-8(--8.5) μm wide.

Pileus plane-convex to umbilicate, yellowish brown to reddish brown, with dark brown, imbricate scales, up to 11(-15) cm diam; trama brownish, not duplex. Hymenial surface brownish, spines up to 1 cm long, decurrent. Stipe central, often with basal bulb, brownish. Hyphae hyaline, thin-walled, up to 20(-30) μm wide. Basidia (25-)30-45 x (5-)6-8 μm . Spores coarsely warted, 7-9(-10) x 6.5-8(-8.5) μm , warts flattened to bifurcate. Associated with Pinaceae.

S. imbricatus (L.: Fr.) P. Karst.

Syn.: *Hydnum badium* Pers.; *H. aspratium* Berk. ex Cooke

Ref.: Harrison, 1961; Hall & Stuntz, 1972a; Maas Geesteranus, 1971, 1975; Baird, 1986a; Breitenbach & Kränzlin, 1986; Cetto, 1987; Imazeki *et al.*, 1988 (sub *S. aspratium*); Moser & Jülich.

13b. Scales appressed or in the centre slightly ascending at the tip. Spores (5-)5.5-6(-7) μm wide.

Pileus plane-convex to umbilicate, often with purplish tinges, up to 12(-20) cm diam; trama yellowish white, becoming brown when bruised, later sometimes olivaceous, not duplex. Spines reddish to purplish with white [p. 57] tips, up to 0.8(-1.5) cm long, decurrent. Stipe central to excentric, often narrowed at the base, concolorous with pileus in the upper part, whitish at the base. Hyphae hyaline, thin-walled, up to 15(-25) μm wide. Basidia 30-40(-50) x 7-9(-10) μm . Spores coarsely warted, (6-)6.5-9(-10) x (5-)5.5-6(-7) μm , warts flattened to bifurcate. Associated with gymnosperms, rarely with angiosperms. *S. leucopus* complex

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14a.(13b) Pileus covered with many fulvous to brick-red scales. Stipe brick-red, white at the base. Associated with angiosperms.

S. praestans Maas Geest.

Ref.: Maas Geesteranus, 1974.

14b.(13b) Only the centre of the pileus with scales. Pileus purplish brown to dark brown, stipe concolorous, but much paler at the base. Associated with gymnosperms.

S. leucopus (Pers.) Maas Geest. & Nannf.

Syn.: *Hydnum curtisii* Berk.; *H. colosseum* Bres.; *H. subpallidum* Snell & Dick

Ref.: Maas Geesteranus, 1975; Baird, 1986a; Breitenbach & Kränzlin, 1986; Cetto, 1987.

Note: *S. humilis* Maas Geest. from Singapore is very close; no reliable differentiating characters could be extracted from the description.

15a.(1) Spores at least on average longer than 6.5 μm

15b. Spores at least on average smaller than 6.5 μm

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16a. Spores with low warts. Associated with Pinaceae.

Pileus plane-convex to slightly depressed, sometimes concrescent, ochraceous to yellowish brown, often with reddish brown tinge, fibrillose when young, breaking up into squarrose scales when mature. Trama not duplex, whitish to pale orange. Spines becoming purplish brown, often with white tips, up to 5 mm long, somewhat decurrent. Stipe central to excentric, felty, but becoming glabrous, concolorous with pileus, but often bluish or greenish at the base. Hyphae hyaline, thin-walled, up to 20 μm wide. Gloeoplerous-like hyphae present. Basidia 35-45 x 5.5-7.5 μm . Spores with low warts, 6.5-7.5(-8) x 4.5-6 μm .

S. fennicus (P. Karst.) P. Karst.

Ref.: Harrison, 1961; Maas Geesteranus, 1975; Baird, 1986a.

16b. Spores with coarse warts. Associated with Fagaceae.

Pileus plane-convex to slightly depressed, rarely infundibuliform, yellowish brown to

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- reddish brown to purplish or dark brown orange-brown to reddish, with darker fibers or appressed scales, which in the centre may become raised, up to 10 cm diam, margin often becoming lobed; trama not duplex, whitish to pale orange, often with pinkish or purplish hue. Spines becoming purplish brown, often with white tips, up to 6 mm long, [p. 58] decurrent. Stipe central to excentric, often narrowed at the base, felty, but becoming glabrous, pinkish brown to yellowish brown, darkening when touched, whitish at the base. Hyphae hyaline, thin-walled, up to 30 μm wide. Gloeoplerous-like hyphae present. Basidia 30-50 x 6-9(-10) μm . Spores coarsely warted, 6-7.5 x 5-6.5(-7) μm . *S. underwoodii* complex
- 17a.(16b) Pileus trama distinctly red. Scales appressed. **S. rutilus** Maas Geest.
Ref.: Maas Geesteranus, 1974. 18
- 17b.Pileus trama not red 19
- 18a.Scales appressed 20
- 18b.Scales at least in the centre erect 21
- 19a.(16b) Pileus pinkish brown, in the centre purplish brown, yellow-brown at the margin. **S. cyrneus** Maas Geest.
Ref.: Maas Geesteranus, 1975.
- 19b.(16b) Pileus dark grey-brown with rufous tinge, brownish pink at the margin. **S. caliginosus** Maas Geest.
Ref.: Maas Geesteranus, 1974.
- 20a.(16b) Spores 5-6.5 μm broad. **S. underwoodii** Banker
Syn.: *Sarcodon murrillii* Banker; *S. radicans* Banker
Ref.: Hall & Stuntz, 1972a; Maas Geesteranus, 1975; Baird, 1986a, 1986b.
- 20b.(16b) Spores 3.5-4.5 μm broad. **S. illudens** Maas Geest.
Ref.: Maas Geesteranus, 1976.
- 21a.(15) Pileus with pink, reddish or purplish tinges and/or trama in base of stipe bluish or greenish. Scales present or more rarely lacking 22
- 21b.Pileus with yellowish, orange, olive, green or brown tinges; trama in base of stipe not bluish or greenish. Scales absent (except *S. lanuginosum*) 23
- 22a.Trama becoming completely dark, violaceous leaden or black with age 24
- 22b.Trama whitish to pale brown, but a pinkish or purplish hue may be present 25
- 23a.Pileus trama blackening on exposure, ink blue in KOH.
Pileus plane-convex to slightly depressed, velutinous to felty, becoming reticulate, greyish brown to yellowish brown with purplish hue, with darker brown fibrils, bluish grey when dried, up to 6 cm diam, margin [p. 59] often becoming lobed; trama not duplex. Spines purplish brown to blackish, up to 2 mm long, decurrent. Stipe central, often narrowed at the base, felty, concolorous. Excretion granules often present when dry. Hyphae hyaline, thin-walled, up to 13 μm wide. Gloeoplerous-like hyphae absent. Basidia 20-35 x 5-7.2 μm . Spores tuberculate, 5.5-6.5 x 4.5-5.5 μm . **S. wrightii** (Berk.& M.A. Curtis) Maas Geest.
Ref.: Maas Geesteranus, 1971; Baird, 1986a. 26
- 23b.Pileus trama lilaceous to violet, blue green in KOH 27
- 24a.Associated with angiosperms (especially Fagaceae). Pileus not very dark with age (except apices of scales).
Pileus plane-convex to slightly depressed, yellowish brown with purplish hue or pinkish brown to reddish brown to purplish or dark brown orange brown to reddish, with darker

- scales, which may become raised in the centre, 2.5-12 cm diam, margin often becoming lobed; trama not duplex, whitish to pale orange, often with pinkish or purplish hue. Spines becoming purplish brown, often with white tips, up to 0.4 cm long, decurrent. Stipe central to excentric, often narrowed at the base, felty, but becoming glabrous, concolorous, sometimes greyish green to blackish green at the base. Yellowish excretion granules often present when dry. Hyphae hyaline, thin- to somewhat thick-walled, up to 25 μm 5B6.5 μm . Spores coarsely ϕ wide. Gloeoplerous-like hyphae absent. Basidia 20B35 warts, 5-7(-7.2) x (3.5-)4-5 μm . Context blue-green in KOH.
- S. joeides** (Pass.) Bat.
 Syn.: *Sarcodon roseolus* Banker; *S. commutatus* Bourdot & Galzin; *S. inopinatus* Donk
 Ref.: Maas Geesteranus, 1971, 1975; Baird, 1986a, 1986b; Breitenbach & Kränzlin, 1986.
- Note: *S. aglaosoma* Maas Geest. and *S. ianthinus* Maas Geest., both from New Guinea, are very close. Reliable criteria to distinguish these species could not be detected.
- 24b. Associated with gymnosperms (especially Pinaceae). Pileus becoming very dark with age. Pileus trama finally lead-gray coloured.
 Pileus plane-convex to slightly depressed, velutinous to felty when young, becoming glabrous, then fibrillose becoming scaly with raised tips, yellowish brown to reddish brown or olive brown, becoming dark violet grey or lead-gray to blackish blue, 4B13 cm diam, margin often becoming lobed; trama not duplex. Spines becoming purplish brown, often with white tips, up to 4 mm long, decurrent. Stipe central, often narrowed at the base, felty, but becoming glabrous, reddish, sometimes greyish green to blackish green at the base. Yellowish excretion granules often present when dry. Hyphae hyaline, thin- to somewhat thick-walled, up to 25 μm wide. Gloeoplerous-like hyphae present. Basidia 30-45 x 5-7(-8) μm . Spores with [p. 60] rather low, rounded warts, (4.5-)5-6.5 x 4-5.2(-5.8) μm . Context blue-green in KOH.
- S. fuligineoviolaceus** (Kalchbr. in Fr.) Pat.
 Syn.: *Sarcodon talpa* Maas Geest.
 Ref.: Harrison, 1964; Maas Geesteranus, 1971, 1975; Baird, 1986a.
- 25a. Trama of base whitish to brownish. Trama of pileus white to pale orange or pale brown.
 Pileus plane-convex to slightly depressed, yellowish brown to reddish brown to purplish brown, with appressed or more rarely raised scales, up to 10 cm diam, margin often becoming lobed; trama not duplex. Spines becoming purplish brown, often with white tips, up to 3(-5) mm long, decurrent. Stipe central to excentric, often narrowed at the base or bulbous, felty, but becoming glabrous, buff to reddish brown to violaceous. Hyphae hyaline, thin-walled, up to 19 μm wide. Gloeoplerous-like hyphae present. Basidia (25-)30-50 x 5-6.5(-7.5) μm . Spores warts, 4.5-6 x 3.5-5 μm . *S. modestus* complex 27
- 25b. Trama of base of stipe blue-green. Trama of pileus typically with pink to purplish hue or with purplish spots 30
- 26a. Scales present, often raised in the centre 26
 26b. Scales absent or appressed in the centre 28
- 27a. (25a) Taste peppery. Associated with gymnosperms.
S. lundellii Maas Geest. & Nannfeldt
 Ref.: Maas Geesteranus, 1975; Baird, 1986a.
- 27b. (25a) Taste mild.
S. lanuginosus K. Harrison
 Ref.: Harrison, 1961, 1964; Baird, 1986a.
- 28a. (25a) Taste bitter. Associated with gymnosperms and angiosperms.
S. modestus (Snell & Dick) Baird
 Syn.: *Hydnum subincarnatum* K. Harrison
 Ref.: Snell & Dick, 1962; Hall & Stuntz, 1972a; Baird, 1986a.
- 28b. Taste mild or absent 30

- 29a.(25a) Spores with low, rounded tubercular ornamentation. Associated with Pinaceae.
S. rimosus (K. Harrison) K. Harrison
 Ref.: Harrison, 1964; Hall & Stuntz, 1972a; Baird, 1986a.
- 29b.(25a) Spores with coarse tuberculate ornamentation. Associated with Pinaceae.
S. martioflavus (Snell & al. in Snell & Dick) Maas Geest.
 Syn.: *Sarcodon armeniacus* Maas Geest.[p. 61]
 Ref.: Snell & Dick 1962; Maas Geesteranus, 1975; Baird, 1986a; Breitenbach & Kränzlin, 1986.
- 30a.(25) Trama of base of stipe with bluish or greenish tinges 31
 30b. Trama of base of stipe greyish or with purplish hue. Cf. *S. joeides* under 24a.
- 31a. Scales appressed or absent.
 Pileus plane-convex to slightly depressed, velutinous to felty when young, becoming glabrous, with some appressed scales, yellowish brown to reddish brown or purplish brown, sometimes locally violaceous grey, up to 11 cm diam, margin often becoming lobed; trama not duplex, whitish to pale orange, often with purplish or reddish tinges. Spines becoming purplish brown, often with white tips, up to 4 mm long, decurrent. Stipe central, often narrowed at the base, felty, but becoming glabrous, concolorous, greyish green at the base. Yellowish excretion granules often present when dry. Hyphae hyaline, thin-walled, up to 20 µm wide. Gloeoplerous-like hyphae present. Basidia 25-35 x 5-7 µm. Spores with rounded warts, 5-6.5 x (3.5-)4-5 µm. Associated with gymnosperms.
S. glaucopus Maas Geest. & Nannfeldt
 Ref.: Maas Geesteranus & Nannfeldt, 1969; Maas Geesteranus, 1975; Baird, 1986a; Breitenbach & Kränzlin, 1986; Cetto, 1987.
- 31b. Scales present, in the centre upright when mature.
 Pileus plane-convex to depressed, often concrescent, velutinous to felty when young, becoming glabrous, then fibrillose becoming scaly with raised tips, pinkish brown to reddish brown, becoming purplish brown, up to 10(-14) cm diam, margin often becoming lobed; trama not duplex, at first white, becoming yellowish brown to red. Spines becoming purplish brown, often with white tips, up to 10 mm long, decurrent. Stipe central, often narrowed at the base, felty, but becoming glabrous, pink to violaceous, becoming purplish brown, greyish green to blackish green at the base. Hyphae hyaline, thin-walled, up to 30 µm wide. Gloeoplerous-like hyphae present. Basidia 35-50 x 5-9 µm. Spores coarsely warted, 5-6.5 x 3.5-4.5(-5) µm. *S. scabrosus* complex 32
- 32a.(31b) Stipe violaceous at the base. Associated with Pinaceae.
S. regalis Maas Geest.
 Ref.: Maas Geesteranus, 1975.
- 32b. Stipe not violaceous at the base 33
- 33a (31b) Scales coarse. Associated with angiosperms and gymnosperms.
S. scabrosus (Fr.) P. Karst.
 Ref.: Harrison, 1961; Maas Geesteranus, 1971, 1975; Baird, 1986a, 1986b; Breitenbach & Kränzlin, 1986; Imazeki *et al.*, 1988; Moser & Jülich. [p. 62]
- 33b.(31b) Scales with erect tips only. Associated with Fagaceae.
S. lepidus Maas Geest.
 Ref.: Maas Geesteranus, 1975.
- 34a.(21) Pileus trama blackening on exposure, ink-blue in KOH. Cf. *S. wrightii* under 23a. 35
 34b. Pileus trama not blackening, not-ink blue in KOH
- 35a. Scales present. Pileus hyphae up to 15(-19) µm wide 28
 35b. Scales absent, or only indicated in the centre when old. Pileus hyphae up to 10(-13) µm wide 36

- 36a. Skeletal hyphae present in stipe. Spores 4.5-5.5 μm long. Taste mild or none. *Hydnellum stereosarcinon* complex, cf. *Hydnellum* under 31.
- 36b. Skeletal hyphae absent. Spores 5-6.5 μm long. Taste acrid or bitter. *Hydnellum compactum* complex, cf. *Hydnellum* under 34.