

NOTES.— The type description of *Sphaeria pulicaris* includes reference to a substratum 'in rimis corticis *Sambuci*'. No type specimen exists at UPS; this species needs to be neotypified. The concept of the species *Gibberella pulicaris* is well established particularly as the teleomorph of *Fusarium sambucinum* (Booth, 1971, 1973; Nirenberg, 1995). A large body of literature is associated with this name because of its importance in the production of mycotoxins. Conservation of the anamorph name against the older and often confused *F. roseum* Link was proposed by Gams *et al.* (1997).

***Gibberella nemorosa*** (Sacc.) Wollenw., Z. Parasitenk. (Berlin) 3: 489. 1931.

≡ *Botryosphaeria nemorosa* Sacc., Michelia 1: 42. 1877.  
 ≡ *Lisea nemorosa* (Sacc.) Sacc., Michelia 1: 43. 1877.

Ascomata solitary to aggregated in groups of 2–5, on a sparse pseudoparenchymatous stroma, superficial, subglobose, 125–240 µm diam, becoming cupulate on drying, appearing black, microscopically dark purple, KOH+ black with purple pigments dissolving, fleshy, rugose. Ascomatal wall 12–18 µm thick, of one region of globose cells forming a *textura angularis*, cells 8–15 µm diam, walls slightly thickened to about 1.5 µm. Apical paraphyses visible as deliquescing strands. Asci narrowly clavate, 52–90 × 8–12 µm, apex simple. Ascospores ellipsoid, 12–16 × 4.5–7.5 µm, 1-septate, hyaline, smooth-walled.

HABITAT.— On dead twigs and stems of *Clematis* and *Cytisus*.

DISTRIBUTION.— Italy.

TYPE.— ITALY. Montello, on dead twigs of *Cytisus nigricans*, Oct. 1876 (PAD, holotype); Montello (Treviso), on dead stems of *Clematis vitalba*, Aug. 1902, P.A. Saccardo, D. Saccardo, Mycotheca italica no. 1305 (BPI, authentic, unbound).

ILLUSTRATIONS.— Wollenweber (1930, No. 821).

NOTE.— The holotype specimen at PAD of *Botryosphaeria nemorosa* has only a few remaining ascomata of a fungus resembling the original description. A later specimen identified as *Lisea nemorosa* by P.A. Saccardo was issued as Mycotheca Italica no. 1305. This specimen at BPI agrees with the original description; however, the specimen of that number at NY has larger, 3-septate ascospores of a species of *Gibberella* suggesting that Mycotheca Italica no. 1305 was a mixed collection and may have been the source of misunderstanding about this genus. Weese (1919), Petrak (1923) and later Müller & von Arx (1962) considered *Lisea* Sacc. to be a synonym of *Gibberella*. They noted that *Lisea nemorosa* occasionally has three-septate as well as one-septate ascospores

but in all other respects is typical of the genus *Gibberella*. In the holotype specimen of *Lisea nemorosa*, only one-septate ascospores were observed; it is possible that these ascomata are immature.

**HAEMATONECTRIA** Samuels & Nirenberg, *gen. nov.*

Type: *Haematonectria haematococca* (Berk. & Broome) Samuels & Nirenberg.

Ascomata non stromatica, solitaria vel gregaria, superficialia, globosa vel pyriformia, flava vel rubra, KOH+ parum fuscata, grosse verrucata, verrucae sursum acutatae e cellulis angularibus, crassitunicatis constantes, 15–30 µm diam. Asci clavati, apice simplici. Ascosporeae ellipsoideae, saepe utrinque leviter truncatae, fusco-luteae, striatae vel spinulosae.

Ascomata non-stromatic or with a basal stroma, solitary to gregarious, superficial, globose to pyriform, yellow to red, KOH+ slightly darkening, collapsing laterally when dry; coarsely warted, warts formed of angular cells, 15–30 µm diam, walls thickened; apex acute, of clavate hyphal elements. Asci clavate, apex simple, rarely with a ring, ascospores biseriate above, uniseriate below. Ascospores ellipsoid, often with ends slightly truncate, translucent yellow-brown, striate or spinulose. Anamorph *Fusarium* sect. *Martiella* or unknown. Saprobic and pathogenic on woody and herbaceous substrata.

NOTES.— *Haematonectria* corresponds to the *Nectria haematococca*-group defined by Samuels (1976a) based on both teleomorph and anamorph characteristics. The *Fusarium* anamorphs of species of *Haematonectria* are common soil inhabitants, often causing root diseases of cultivated plants, unlike species of *Nectria sensu stricto* that occur as weak parasites of trees and shrubs and are not commonly isolated from soil. *Haematonectria haematococca* is not congeneric with *Nectria sensu stricto* as defined by Rossman (1989) either on morphological or molecular grounds. The results of the analysis of sequence data presented by both Guadet *et al.* (1989) and O'Donnell (1993) as well as differing mycotoxin profiles (Marasas *et al.*, 1984) indicate that *H. haematococca* is distinct from *Nectria sensu stricto*. Just as there is little similarity between species of *Haematonectria* and species of *Nectria sensu stricto*, there is little similarity between *Haematonectria* and other teleomorphs that have *Fusarium* anamorphs, viz. *Albonectria*, *Cosmospora*, and *Gibberella*. Based on rDNA sequences, Guadet *et al.* (1989) and O'Donnell (1993) have clearly demonstrated genetic differences between *Albonectria*, *Gibberella*, and *Haematonectria*. The accumulated data support the recognition of a separate genus for '*Nectria*' *haematococca* and its relatives.

Spatafora & Blackwell (1994) used 18S rDNA sequences to show that '*N.*' *haematococca* and *Neocosmospora vasinfecta*, the type of *Neocosmospora*, form a sister group to *Nectria cinnabarina*. O'Donnell (1996), who based his conclusion on the results of Spatafora & Blackwell (1994) as well as his own data, concluded that the correct genus for '*N.*' *haematococca* and members of *Fusarium* sect. *Martiella* is *Neocosmospora*, a genus characterized by orange-brown to red, rarely white, ascospores and non-septate, hyaline to yellow-brown, striate to tuberculate ascospores (see herein). The anamorph of *Neocosmospora vasinfecta* is *Acremonium*-like having unbranched conidiophores from which non-septate conidia are produced. This fungus is a common soil fungus in warmer regions. O'Donnell (1996) argued that *Neocosmospora vasinfecta* is a microconidial *Fusarium* that has lost its ability to produce macroconidia and septate ascospores. While there is no doubt about the close relationship between '*Nectria*' *haematococca* and *Neocosmospora vasinfecta*, there are numerous, conspicuous phenotypic differences that mitigate against combining '*Nectria*' *haematococca* and related species with *Neocosmospora*, including characters of both teleomorph and anamorph. In view of the fact that *N. haematococca* cannot be retained in *Nectria* and, given these differences from *Neocosmospora vasinfecta*, we propose the new genus *Haematonectria* for '*Nectria*' *haematococca* and its close relatives.

*Haematonectria* is a genus that may eventually accommodate many species, both sexual and asexual (O'Donnell, 1996; Hering, 1997). Within the morphological species regarded as *H. haematococca*, several intersterile groups are found in agricultural settings (Van Etten & Kistler, 1988), while Samuels (1976a) found intersterile groups in tropical forests. There are also self-fertile populations that are referable to *H. haematococca*. RAPD analysis has been used to characterize mating populations I and VI within *F. solani* f. sp. *cucurbitae* (Crowhurst *et al.*, 1991) and for many other isolates (Hering, 1997), yet there has been no effort to account for the teleomorph in morphological or anatomical terms. Among the many collections of *H. haematococca* collected in tropical forests, intersterile, heterothallic populations have been found, but it is not known whether they conform to any of the mating populations that have been defined from agricultural systems. There is ample genetic and phytopathological evidence for a multiplicity of species in the *H. haematococca*/*F. solani* complex. Within this complex, K. O'Donnell (pers. comm.) has found about fifty biological species, as defined by rDNA sequences. *Haematonectria haematococca* may exemplify a fungus that has been undergoing fairly rapid speciation in re-

sponse to agricultural activities of humans. O'Donnell's molecularly defined groups will serve as a basis for the search for phenetic characters that may facilitate the recognition of the fusaria and their *Haematonectria* teleomorphs.

Species of *Haematonectria* occur on a variety of hosts both as pathogens and saprobes. While *H. haematococca* has a cosmopolitan distribution, its teleomorph is more common in the tropics, where it is found on woody and herbaceous substrata. The anamorph has been known as *Fusarium solani*, a soil fungus that is recorded on about 85 hosts in the United States (Farr *et al.*, 1989), although it is herein listed as *Fusarium* sp. (see below). At present only the three most common and best known species are placed in this genus, namely, *H. haematococca*/*Fusarium* sp., *H. ipomoeae*/*Fusarium striatum* and *H. illudens*/*F. illudens* (New Zealand) as well as two species having disarticulating ascospores.

***Haematonectria haematococca* (Berk. & Broome) Samuels & Nirenberg, *comb. nov.* — Plate 29, e–g.**

≡ *Nectria haematococca* Berk. & Broome, J. Linn. Soc. Bot. 14: 116. 1873.

≡ *Cucurbitaria haematococca* (Berk. & Broome) O. Kuntze, Rev. Gen. Pl. 3(2): 461. 1898.

≡ *Hypomyces haematococcus* (Berk. & Broome) Wollenw., Angew. Bot. 8: 191. 1926.

= *Nectria episphearioides* Penz. & Sacc., Malpighia 11: 511. 1897.

= *Nectria bogoriensis* C. Bernard, Bull. Dép. Agric. Indes Néerl. 11: 45. 1907.

= *Nectria calonecricola* Henn., Hedwigia 48: 105. 1909.

= *Nectria luteococcinea* Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 118: 299. 1909.

[= *Nectria confluens* Seaver, in Seaver & Chardón, Sci. Surv. Porto Rico & Virgin Islands 8: 44. 1926, non Petch, 1920].

= *Nectria cinnabarina* var. *jaraguensis* Höhn., Denkschr. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 83: 18. 1927.

Anamorph: *Fusarium* sp.

Ascomata solitary to densely gregarious, superficial, not obviously stromatic but difficult to remove from the substratum, globose to broadly pyriform, (225–) 275–325 µm diam, red, with red to yellowish warts, KOH+ dark red, yellow in lactic acid, non-papillate or with ascomatal apex acute, collapsing laterally or not at all, coarsely warted, warts 50–70 µm high. Cells at ascomatal surface and warts circular to angular in outline, (15–)20–25(–30) µm diam, walls 2–3(–4) µm thick. Ascomatal wall 65–95 µm thick, inclusive of warts, of two regions: outer region 50–80 µm thick including warts, of circular to angular cells, 10–30 µm diam with 2–2.5 µm thick walls; inner region 15–20 µm thick, of flattened, thin-walled cells. Asci broadly cylindrical to clavate, 60–90 × 10–17 µm, apex simple or with a ring, 8-spored, ascospores obliquely biserial. Ascospores

ellipsoid, (9–)13–16(–18) × (4–)6–8(–9) μm, 1-septate, hyaline, becoming yellow-brown, finely striate.

ANAMORPH: Conidiophores typically sparse but sometimes abundant, tending to form in poorly developed sporodochia. Conidiophores 40–80 μm long, delicate, becoming verticillately branched, each branch terminating in 1–5 phialides. Phialides somewhat swollen in the middle, 10–24 μm long × 4 μm wide. Conidia sub-cylindrical, slightly curved with the tip cell slightly hooked, basal cell somewhat pedicellate, 5–7-septate, vacuolate. Macroconidia 1–9-septate, 15–80 × 4–7.5 μm; microconidia 0–1-septate, 6–24 × 2.5–5 μm, forming in abundance from long, little-branched, monophialidic conidiophores.

HABITAT.— On bark.

DISTRIBUTION.— Pantropical.

TYPE.— SRI LANKA (Ceylon). Central Prov., on bark, no. 1104, 1868 (K, lectotype, designated by Samuels, 1976a).

ILLUSTRATIONS.— Doi (1973b, Fig. 5, as *N. haematococca*); Penzig & Saccardo (1904, Pl. 29, Fig. 2, as *N. episphaeroides*); Samuels (1976a, Figs. 23A, 24, as *N. haematococca*); Samuels & Brayford (1994, Figs. 24–29, as *N. haematococca*); Samuels *et al.* (1990, Fig. 15, as *N. haematococca*); Wollenweber (1930: no. 830–832, as *Hypomyces haematococcus*).

SPECIMEN ILLUSTRATED.— FRANCE. Pyrénées Atlantiques: Ile de Sauveterres, on *Buxus sempervirens*, 29 Nov 1992, F. Candoussau 256 pp, G.J. Samuels 92-140, *H. cf. haematococca* (BPI).

NOTES.— *Haematonectria haematococca* is more narrowly defined than in previous studies to include only tropical collections that occur on woody substrata, are heterothallic, and have relatively small ascospores. Although the anamorph has been known as *Fusarium solani* (Mart.) Sacc. (Booth, 1971) or *Fusarium eumartii* Carpenter (Gerlach & Nirenberg, 1982), it has most recently been found to be different from either of these species based on studies of their respective type specimens (H.I. Nirenberg, pers. comm.).

***Haematonectria illudens*** (Berk.) Samuels & Nirenberg, *comb. nov.* — Plate 29, d.

≡ *Nectria illudens* Berk., in Hooker, Botany of the Antarctic Voyage. II. Flora of New Zealand 7: 203. 1855.

Anamorph: *Fusarium illudens* C. Booth, The Genus *Fusarium* p. 53. 1971.

Ascomata solitary to gregarious, non-stromatic or seated on an obscure basal stroma, superficial or with the base slightly immersed, globose and non-papillate to broadly obpyriform, with a short, acute papilla, (345–)400–600(–700) × (280)357–584(–700) μm diam, yellow-orange to red, dark red when dry, KOH+ dark red, coarsely warted, warts concolorous or lighter than the ascomatal wall. Cells at ascomatal surface circular to angular, 20–40 μm diam, with 1.5–2.5 μm

thick walls. Ascomatal wall 50–160 μm thick, of two regions: outer region 30–140 μm thick including warts, cells of warts angular with lumina 10–20 μm diam, and 1.5–3.5 μm thick, pigmented walls, cells becoming progressively more ellipsoid toward the interior; inner region *ca* 15 μm thick, cells flattened, walls 1 μm thick, pigmented at the exterior, thinner, non-pigmented toward the centrum. Asci broadly cylindrical to clavate, (100–)120–160(–180) × 12–17 μm, apex simple, ascospores obliquely biserial. Ascospores broadly ellipsoid to broadly fusiform, (17–)22–28(–33) × (10–)8.5–11.5(–15) μm, 1-septate, yellow-brown, finely striate.

ANAMORPH redescribed by Gerlach & Nirenberg (1982) and Samuels & Brayford (1994): Microconidia infrequent and few in number, ellipsoid, (5.5–)6–8.5(–9.5) × 2–2.5(–3.5) μm. Macroconidia mainly 3–5-septate, 34–63 × 6–7.5 μm. Heterothallic.

HABITAT.— On bark of dicotyledonous trees.

DISTRIBUTION.— New Zealand, anamorph reported from Africa (Booth, 1971).

HOLOTYPE.— NEW ZEALAND. North Island: Bay of Islands, on bark, J.D. Hooker (not examined).

Additional specimens examined listed in Samuels & Brayford (1994).

ILLUSTRATIONS.— Booth (1971, Fig. 9, as *Fusarium illudens*); Samuels & Brayford (1994, Figs. 36–42, as *N. illudens*).

SPECIMEN ILLUSTRATED.— NEW ZEALAND. Gisborne. Urewera National Park, Lake Waikaremoana, Ngamoko Track, on base of living *Beilschmiedia tawa*, G.J. Samuels 82-98 (BPI 802461, PDD 44267).

***Haematonectria ipomoeae*** (Halst.) Samuels & Nirenberg, *comb. nov.*

≡ *Nectria ipomoeae* Halst., New Jersey Agric. Coll. Exp. Sta. Annual Rep. 12: 281. 1891.

≡ *Hypomyces ipomoeae* (Halst.) Wollenweber, Phytopathology 3: 34. 1913.

Anamorph: *Fusarium striatum* Sherb., Cornell Univ. Agric. Exp. Sta. Mem. 6: 255. 1915.

Ascomata solitary to gregarious, seated directly on host tissue, sometimes clustered around small cankers, non-stromatic, broadly pyriform with an acute apex, *ca* 300 μm diam, red-orange with lighter-colored warts. Asci 60–70 × 8–10 μm, apex simple. Ascospores broadly ellipsoid, (10.5–)11.5–13(–14) × (4–)4.5–5.5(–6) μm, 1-septate, finely striate.

ANAMORPH described by Nirenberg & Brielmaier-Liebetanz (1996): Macroconidia 5-septate, 49–64 × 4.8–5.9 μm; microconidia 0-septate, 9.8–14.5 × 4.5–5 μm.

HABITAT.— Pathogenic on *Cucurbita ficifolia*, *Passiflora edulis*, *Solanum melongena*, and *S. tuberosum* (Nirenberg & Brielmaier-Liebetanz, 1996).

DISTRIBUTION.— Europe, United States (New Jersey).

**HOLOTYPE.**— UNITED STATES. New Jersey, Mickelton, on *Solanum melongena*, 8 July 1891, B.D. Halsted (BPI 552416).

**ILLUSTRATIONS.**— Nirenberg & Brielmaier-Liebetanz (1996, Figs. 1–10, as *Nectria ipomoeae*), Wollenweber (1916: no. 56; 1930: no. 823, 825, as *Hypomyces ipomoeae*, 1025, as *F. javanicum*).

**NOTES.**— The description given above is based solely on the holotype collection. Nirenberg & Brielmaier-Liebetanz (1996) described pathogenicity of *Haematonectria ipomoeae* to *Passiflora edulis* and discussed the use of the name *Fusarium striatum* for the anamorph. The species is self-fertile.

**Haematonectria monilifera** (Berk. & Broome) Samuels & Rossman, *comb. nov.*

≡ *Nectria monilifera* Berk. & Broome, J. Linn. Soc. Bot. 14: 114. 1873.

≡ *Neoskofitzia monilifera* (Berk. & Broome) Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl. 121, Abt. 1: 367. 1912.

≡ *Nectriella monilifera* (Berk. & Broome) Sacc., Michelia 1: 279. 1878.

Anamorph: None known.

Ascomata solitary to gregarious, superficial, often immersed at the base, with a conspicuously shining ostiolar area, globose to ovoid, 320–520 µm high × 300–450 µm diam, orange to red, becoming darker red in KOH, warted. Ascromatal wall 40–50 µm thick, of two regions: outer region 15–35 µm thick, of thick-walled, pigmented cells. Asci narrowly clavate to cylindrical, 52–140 × 3.5–4.5 µm, ascospores uniseriate. Ascospores ellipsoid to cylindrical, 5.5–7.5 × 3–4 µm, 1-septate, disarticulating early into part-ascospores, part-ascospores subglobose, 3–3.5 µm diam, hyaline, becoming yellow-brown, smooth to spinulose.

**HABITAT.**— On 'laterite' soil.

**DISTRIBUTION.**— Indonesia (Java, specimen at FH, not examined), Sri Lanka.

**HOLOTYPE.**— SRI LANKA (Ceylon). Peradeniya, on soil, 1870, Berkeley 1105 (K).

**ILLUSTRATION.**— Weese (1924, Tab. 8, Figs. 7–12, as *Neoskofitzia 'moliniifera'*).

**NOTES.**— Although Petch (1920) suggested that *Haematonectria monilifera* (as *Neoskofitzia monilifera*) is a synonym of *H. termitum* (as *N. termitum*), the two species differ in thickness of the ascromatal wall, ascus size, ascospore ornamentation and habitat. Weese (1924) provided excellent illustrations of both species including sections of the ascromatal wall.

**Haematonectria termitum** (Höhn.) Samuels & Rossman, *comb. nov.*

≡ *Neoskofitzia termitum* Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 117: 998. 1908.

Anamorph: None known.

Ascomata superficial, caespitose in groups of up to 12, densely gregarious, effused over the substratum, ovoid, 170–270 µm diam (Weese, 1924), non-papillate, red, becoming darker in KOH, yellow in lactic acid, slightly warted, not collapsing. Ascromatal wall 50–60 µm thick, of two regions: outer region continuous with the stroma, of ellipsoid, elongate cells, 15–50 µm diam, with about 3.5 µm thick walls. Ascromatal apex of a palisade of clavate hyphal elements that arise from the wall below and merge with periphyses. Asci clavate, 35–52 × 4–8 µm, disintegrating early, apex simple. Ascospores 1-septate, disarticulating into sixteen part-ascospores, part-ascospores broadly ellipsoid, 3–4(–4.5) × 3–3.5 µm, translucent yellow-brown, becoming densely spinulose.

**HABITAT.**— On old termite nest.

**DISTRIBUTION.**— Indonesia (Java).

**TYPE.**— INDONESIA. Java: Buitenzorg, in a termite nest, 1907, Höhnel (BPI 630983, lectotype, designated herein); same data except 1908, Rehm: Ascomycetes no. 1818 (BPI 630984, paratype, specimen overmature).

**ILLUSTRATION.**— Weese (1924, Tab. 8, Figs. 1–6, as *Neoskofitzia termitum*).

**NOTES.**— Petrak erred in noting '*n. gen. et spec.*' on the BPI packet of von Höhnel's type specimen of *Haematonectria termitum*.

**LANATONECTRIA** Samuels & Rossman, *gen. nov.*

Type: *Lanatonectria flocculenta* (Henn. & E. Nyman) Samuels & Rossman (≡ *Nectriella flocculenta* Henn. & E. Nyman).

Stroma pseudoparenchymatosum. Ascomata superficialia, subglobosa vel late obpyriformia, rubra, KOH+ phaeorubra, non papillata vel papilla minuta praedita; pilis hyphalibus hyalinis vel luteis, levibus vel spinulosis, uncinatis vel rectis, septatis, tenuitunicatis obiecta, interdum tomentosa; paries ascromatis extus e cellulis conspicue angularibus, 10–15 µm diam, compositus. Asci clavati vel fusiformes, apice simplici vel annulo praediti. Ascosporeae ellipsoideae vel fusiformes, ad medium 1-septatae, hyalinae vel raro ochroleucae, striatae.

Stroma continuous with the ascromatal base, pseudoparenchymatous or of highly compacted, somewhat thick-walled hyphae. Ascomata superficial on a minute basal stroma, on an erumpent, previously conidial stroma, or at the base of a synnema, subglobose to broadly obpyriform, not collapsing when dry; red, KOH+ dark red, yellow in lactic acid, non-papillate or with a minute