Bionectria: a genus for species of the *Nectria ochroleuca* group

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Summary: *Nectria* as it is traditionally viewed is heterogeneous. Species of the *Nectria ochroleuca* group differ significantly from *Nectria sensu stricto*, particularly from the type species, *Nectria cinnabarina*, but they are similar to *Bionectria tonduzii*, the type species of *Bionectria*. To reflect natural relationships in the generic classification, *N. ochroleuca*, *N. byssicola*, *N. aureofulva*, and *N. apocyni* are transferred to *Bionectria*.

Zusammenfassung: *Nectria*, im traditionellen Sinne, ist heterogen. Arten der *Nectria ochroleuca*-Gruppe unterscheiden sich signifikant von *Nectria sensu stricto*, insbesondere von der Typenart *Nectria cinnabarina*; sie ähneln jedoch *Bionectria tonduzii*, der Typenart von *Bionectria*. Um eine Gattungsklassifikation zu erreichen, die natürlich verwandte Artengruppen zusammenfaßt, werden die Arten *N. ochroleuca*, *N. byssicola*, *N. aureofulva* und *N. apocyni* in *Bionectria* überführt.

1. Introduction

The genus *Nectria* Fries is generally used for hypocrealean fungi that have brightly colored, stromatic or non-stromatic perithecia, unitunicate asci, and one-septate ascospores. About 650 species have been described in *Nectria* (SAMUELS, 1976). Anamorphs of species classified in *Nectria* are phialidic and can be classified in more than 20 genera (SEIFERT, 1993). Many species are well-known plant pathogens, and others are toxigenic to animals and man.

In its broadest sense, *Nectria* is heterogeneous (see, e.g., ROSSMAN, 1996; SAMUELS, 1996), and two approaches have been adopted to account for this heterogeneity, viz. classification at infrageneric level or segregation of genera. SACCARDO (1883) and subsequent authors delimited subgenera based on single or few characters, such as ascospore septation or the kind of perithecium

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aggregation on the substratum. Subsequently anamorphs became more important in the recognition of subgroups in *Nectria* (WOLLENWEBER, 1931; WOLLENWEBER & REINKING, 1935; DINGLEY, 1951, 1957; BOOTH, 1959). Many authors proposed new, often monotypic, genera for nectrioid fungi based on single characters or combinations of few conspicuous characters, e.g. *Calonectria* De NOTARIS (1867); *Pseudonectria* SEAVER (1909); *Bionectria* SPEGAZZINI (1919); these newly described genera were often not accepted by later authors and the species were combined in *Nectria*. BOOTH (1959), followed by SAMUELS (1976) and ROSSMAN (1983, 1989), was the first to describe groups in *Nectria* based on rather complex combinations of characters, including anamorphs, the anatomy of the perithecial wall and stroma if formed, and ecology, in order to delimit natural or monophyletic groups of species. In many instances, previously recognized infrageneric groupings are now recognized as being generically distinct from *N. cinnabarina*. This is especially true when new and independently collected data sets confirm morphologically based hypotheses of relatedness, or when new data lead to a reevaluation of morphological features. Based on combinations of characters, *Nectria* can be split into ca. 20 genera (ROSSMAN & SAMUELS, unpublished), with *Nectria sensu stricto* being restricted to not more than ca. 30 species (ROSSMAN, 1989). The resultant taxonomy provides a system that accounts well for naturally related groups of species.

In this publication we consider the '*Nectria ochroleuca* group' (BOOTH, 1959; SAMUELS, 1976), which is centered on *Nectria ochroleuca* (Schw.) Berk., a frequently encoutered species. The perithecial teleomorph of this species is known from tropical and temperate regions. Its anamorph, *Gliocladium roseum* Bainier (SMALLEY & HANSEN, 1957; SAMUELS, 1976; DOMSCH & al., 1980) is a common cosmopolitan, soil-borne mycoparasite and saprophyte. The *N. ochroleuca* group was first proposed by BOOTH (1959) for three European species, perithecia of which are orange and form on a weakly developed stroma, and anamorphs of which were referred to *Gliocladium*. He distinguished this group from the '*Nectria cinnabarina* group,' in which he included three species that form, respectively, orange or red perithecia, on the basis of a well-developed stroma in the latter group. The *N. cinnabarina* group included the type species of *Nectria*, *N. cinnabarina* (Tode : Fr.) Fr.. ROSSMAN (1989) and SAMUELS (1976, 1988a/b, 1989, 1990) gave more emphasis to perithecial pigmentation. They distinguished on the one hand species groups with red perithecia that either change color in 3% KOH or that become deeper red in KOH but always turn yellow in 100% lactic acid, and, on the other, groups with pale-colored perithecia (whitish, yellow, orange, brownish orange) and lacking any conspicuous color change in KOH and lactic acid. Samuels expanded the *N. ochroleuca* group to ca. 20, mostly tropical species that have orange perithecia and anamorphs in *Clonostachys* Corda, *Sesquicillium* W. Gams, *Dendrodochium* Bonordon and cf. *Myrothecium*, whilst *Nectria sensu stricto* was confined to ca. 30 species that have red perithecia and anamorphs in *Tubercularia* Tode (sensu SEIFERT, 1985) and *Zythiostroma* Höhnel (ROSSMAN, 1989). The difference between species having red and orange perithecia and, particularly, the distinction between *Nectria sensu stricto* and species of the *N. ochroleuca* group was corroborated by sequence analysis of the 28 S ribosomal DNA (REHNER & SAMUELS, 1995). From this study two major clades, which were supported by high bootstrap values, are evident in *Nectria sensu lato*. The first clade, the '*Bionectria* clade,' includes two species of the *N. ochroleuca* group, additional species that have pale/non-red perithecia, and a few cleistothecial species. Representatives of the *N. cinnabarina* group and other species with red perithecia were included in the second clade, the '*Nectria* clade'.

While species of the *N. ochroleuca* group are phylogenetically and morphologically distinct from species of the *Nectria cinnabarina* group, they resemble *Bionectria tonduzii* Speg., the type and only described species in *Bionectria* Speg. (SPEGAZZINI, 1919) in life style, perithecial surface (smooth to warted, but not hairy or hyphal), perithecial wall anatomy, and ascospore ornamentation. The genus *Bionectria* therefore is available to accommodate this group of species. As a consequence, we transfer species close to *N. ochroleuca*, viz. *N. byssicola* Berk. & Broome, *N. apocyni* Peck, and *N. aureofulva* Cooke & Ellis to *Bionectria*. The taxonomic position of additional species will be treated and detailed accounts of the morphology and the cultural behavior of these and other related species will be given in forthcoming publications.

2. Taxonomic part

Bionectria Spegazzini, Boln Acad. Nac. Cienc. 23: 563. 1919.

TYPE and only originally included species:

Bionectria tonduzii Speg., Boln Acad. Nac. Cienc. 23: 563. 1919 (as "*tonduzi*") **Fig. 6**

TYPE SPECIMEN (Fig. 6): COSTA RICA. San José, on leaves of *Buettneria cartagensis*, Oct. 1894, *A. Tonduz 1644* (LPS!). DESCRIPTION and ILLUSTRATION: SAMUELS (1988a).

The type specimen was studied. The perithecia are brownish orange, have whitish warts (Fig. 6) and show no color change in KOH. The ascospores are generally 1-septate (equally 2-celled), but few ascospores with 3 septa were also found, warted, measuring 19.6–26.0 x 5.3–6.9 µm. Differences from *N. cinnabarina* (Fig. 1) are found in the anatomy of the perithecial wall, and ecology (not described here). *Bionectria tonduzii* is only known from the type location. Although *B. tonduzii* is unusual in the genus because of its occurrence on living leaves rather than on a woody substratum, the true host appears to be an ascomycete. *Bionectria tonduzii* is consistent with members of the *N. ochroleuca* group in other characters of the perithecia.

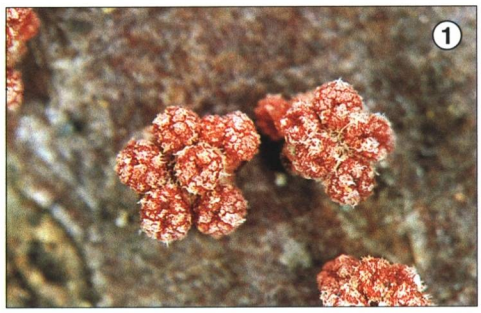
Bionectria ochroleuca (Schw.) Schroers & Samuels, comb. nov. **Fig. 2**

≡ *Sphaeria ochroleuca* Schweinitz, Trans. Amer. Philos. Soc. 2, 4: 204. 1834.
≡ *Nectria ochroleuca* (Schw.) Berk., Grevillea 4: 16. 1875.
≡ *Cucurbitaria ochroleuca* (Schw.) O. Kuntze, Revisio Gen. Plant. 3: 461. 1898.
≡ *Creonectria ochroleuca* (Schw.) Seaver, Mycologia 1: 183. 1909.
= *Nectria gliocladioides* Smalley & Hansen, Mycologia 49: 533. 1957.
For additional synonyms see SAMUELS (1976).

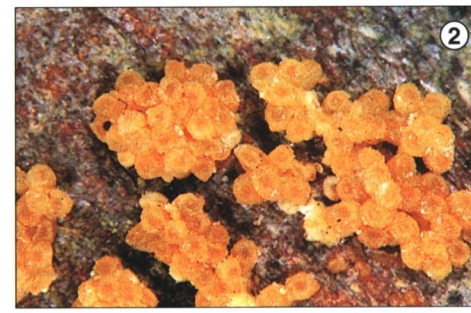
ANAMORPH: ***Gliocladium roseum*** Bainier (1907).

LECTOTYPE (SAMUELS, 1976): UNITED STATES. NORTH CAROLINA, Salem, on bark, *Schweinitz 1418* (PH, Collins Set no. 169!). ILLUSTRATED SPECIMEN (Fig. 2): JAMAICA. ST. ANDREW PARISH: Chesterville Youth Development Camp, above Newcastle, on bark of *Cecropia* sp., 8 Jan. 1971, *Korf & al., CUP-MJ 738, Rossman 355* (NY!, CUP), cultures CBS 289.78, 290.78, 291.78, 294.78A, 294.78B, 294.78C (each culture derived from a single ascospore, all spores having been formed in the same ascus, isolated by Rogerson, I-71-5. DESCRIPTION and ILLUSTRATION: SAMUELS, 1976.

The lectotype specimen and many others were studied. The lectotype was designated by SAMUELS (1976) after a critical comparison of specimens from the Schweinitz herbarium that were distributed to many collections and herbaria (SHEAR & STEVENS, 1917). The perithecia are orange, lack conspicuous warts but have a rough surface (Fig. 2). The ascospores are equally 2-celled, warted, measuring 7.3–14.3 x 2.3–4.7 µm. Specimens from tropical and temperate regions are identical. *Bionectria ochroleuca* is among the most common species of the genus.



200 µm



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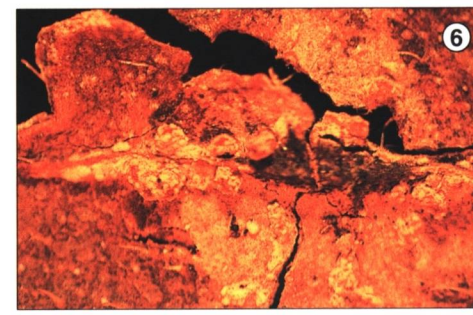

500 µm

Fig. 1-6: Habit of perithecia. The perithecia are seated on a stroma. In Figs 1-5, the stroma is erumpent through bark. **Fig. 1:** *Nectria cinnabarina*, note the red color of the perithecia. **Fig. 2:** *Bionectria ochroleuca*. **Fig. 3:** *Bionectria byssicola*, note the large warts on the perithecia. **Fig. 4:** *Bionectria aureofulva*. **Fig. 5:** *Bionectria apocyni*, note the small warts on the perithecia. **Fig. 6:** *Bionectria tonduzii*, stroma on or erumpent through the leaf surface, perithecia also warted.

Bionectria byssicola (Berk. & Broome) Schroers & Samuels, comb. nov. **Fig. 3**

≡ *Nectria byssicola* Berkeley & Broome, J. Linn. Soc. Bot. 14: 116. 1873.

≡ *Cucurbitaria byssicola* (Berk. & Broome) O. Kuntze, Revisio Gen. Plant. 3: 460. 1898.

For additional synonyms see SAMUELS (1976, 1990).

TYPE: SRI LANKA: *Thwaites 173d* (K!, isotype NY!). LECTOTYPE: SRI LANKA: *'Ceylon' 173 GHKT*, slide ex K (NY!, designated herewith). EPITYPE: VENEZUELA. SUCRE: NW of Irapa, trail from Los Pocitos, 90 min. walk toward Santa Isabel, on unidentified bark, 11 Jul. 1972, *K.P. Dumont, R.F. Cain, G.J.*

Samuels, G. Morillo, & J. Farfan, Dumont-VE 4681 (NY! VEN), culture CBS 364.78 = Rogerson 72-123. ILLUSTRATED SPECIMEN (Fig. 3): French Guiana. Vic. Cacao, Montagne Cacao; on branchlets of recently dead tree, 30 Mar. 1986, *G. J. Samuels* & C. *Feuillet 4571* (CAY, NY!, dried culture *G.J.S. 86-342*. DESCRIPTION and ILLUSTRATION: SAMUELS (1976, 1990).

The 'type', isotype and many other specimen were studied. The original collection *'Ceylon' 173* was subdivided into several parts (173a-d) (see also SAMUELS, 1976). On the 'type' of *N. byssicola* (*'Ceylon' 173d*, K!) no perithecia of the species as described by Berkeley & Broome and redescribed by SAMUELS (1976, 1990) were found, but perithecia of *Nectria subquaternata* Berk. & Broome and *Nectria pityrodes* (Mont.) Mont. are present. The isotype (NY!) consists of a very small piece of bark containing few perithecia that are immature. Slides from perithecia prepared from *'Ceylon' 173a* (NY! ex K) and *'Ceylon' 173 GHKT* (NY! ex K) show characters matching those given in the descriptions cited: the ascospores are smooth to warted and ca. 12 µm long, and therefore neither belong to *N. subquaternata* (ascospores striate, see SAMUELS, 1988b) nor to *N. pityrodes* (ascospores generally longer than 20 µm, see SAMUELS, 1990). The portion *'Ceylon' 173a* (K) is the type of *N. subquaternata*, yet, portions labeled '173a' were also found in the package *'Ceylon' 173 GHKT* (K) showing *B. byssicola* (SAMUELS, 1976). We therefore chose the slide *'Ceylon' 173 GHK*T from *'Ceylon' 173a* (NY!) as **lectotype** of *B. byssicola* and support it by the designation of another tropical specimen as **epitype** (*Dumont-VE 4681* (NY!)). *Bionectria byssicola* is easily recognized by perithecia that have rather large warts (Fig. 3), the cells of which are more heavily thickened on one side. The ascospores are equally 2-celled, warted, measuring 8.4–19.8 x 2.6–7.3 µm.

Bionectria aureofulva (Cooke & Ellis) Schroers & Samuels, comb. nov. **Fig. 4**

≡ *Nectria aureofulva* Cooke & Ellis, Grevillea 7: 8. 1978.

≡ *Cucurbitaria aureofulva* (Cooke & Ellis) O. Kuntze, Revisio Gen. Plant. 3: 461. 1898.

= *Nectria pallidula* Cooke, Grevillea 17. 1888.

For additional synonyms see SAMUELS (1990).

TYPE (Fig. 4): UNITED STATES. NEW JERSEY: Newfield, on *Magnolia* sp., *Ellis 2859* (NY!). DESCRIPTION and ILLUSTRATION: BOOTH (1959), as *N. pallidula*.

The types of *B. aureofulva* and *N. pallidula* were studied and found to be the same, based on the anatomy of the perithecial wall (not included here). Perithecia of *B. aureofulva* (Fig. 4) are orange, rather smooth but otherwise similar to those of *B. ochroleuca*. The ascospores are equally 2-celled, warted, measuring 8.4–14.8 x 2.6–5.1 µm. *Bionectria aureofulva* and *B. ochroleuca* differ in anamorphic characters (not included here).

Bionectria apocyni (Peck) Schroers & Samuels, comb. nov. **Fig. 5**

≡ *Nectria apocyni* Peck, Buffalo Soc. Nat. Sci. 1: 71. 1873.

≡ *Cucurbitaria apocyni* (Peck) O. Kuntze, Revisio Gen. Plant. 3: 460. 1898.

TYPE: UNITED STATES. NEW YORK: North Greenbush, on stems of *Apocynum cannabinum*, Oct. 1872, Peck (NYS, Isotype NY!). ILLUSTRATED SPECIMEN (Fig. 5): COLUMBIA. DEPT. NARINO: road between Pasto and Sibundoy at km 44, 6 km before Santiago, alt. 2400 m., on bark of branch, 7 Jul. 1978, *K. P. Dumont, F. Oberwinkler & M. Pulido, Dumont-CO 9531* (NY!). DESCRIPTION and ILLUSTRATION: SAMUELS (1976).

The type of *B. apocyni* was studied and compared with specimens from tropical regions. The perithecia are brownish orange (Fig. 5) and are less warted than, but otherwise similar to those of *B. tonduzii*. The ascospores are equally 2-celled, warted, measuring 16.0–32.9 x 4.5–9.4 µm.

For comparison: ***Nectria cinnabarina***. ILLUSTRATED SPECIMEN (Fig. 1): UNITED STATES. VIRGINIA: Giles Co., Mountain Lake, near Hotel, Pond Drain, alt. 1160 m, 37°22'N,80°31'W; on dead branchlets of *Acer* sp., 17 Sep. 1991, *G. J. Samuels BPI 1112880*!, living culture *G.J.S. 91-111*.

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