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Some critical notes on the classification and the generic concept of the Erysiphaceae

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Abstract: BRAUN, U. 1999: Some critical notes on the classification and the generic concept of the Erysiphaceae. Schlechtendalia **3**: 48-54.
Based on new results obtained by means of SEM as well as molecular examinations, it is proposed to divide the genus *Erysiphe* s.lat. into three smaller units, i.e. the genus *Erysiphe* s.str. (≡ *Erysiphe* sect. *Erysiphe*), *Golovinomyces* (≡ *Erysiphe* sect. *Golovinomyces*), and *Neoerysiphe* stat. et nom. nov. (≡ *Erysiphe* sect. *Galeopsidis*). Erysiphaceae tribe Erysipheae subtribe Golovinomycetinae subtribus nov. and subtribe Neoerysiphinae subtribus nov. are introduced, tribe Phyllactinieae is validated, and it is pointed out that tribe Sawadaeae V.P. Gelyuta is the correct name for tribe Sawadaeae (U. Braun) R.T.A. Cook et al. *Oidium* subgen. *Pseudoidium* Jacz. is the correct name for *Oidium* subgen. *Pseudoidium* (Y.S. Paul & J.N. Karpoor) R.T.A. Cook et al. (nom. illeg.). The new combinations *Golovinomyces* sect. *Depressi*, *Golovinomyces andinus, G. cichoracearum* var. *fischeri,* var. *latisporus,* var. *poonensis*, var. *transvaalensis*, *G. magnicellulatus* var. *robustus*, *G. leuceriae, G. rubi, G. sparsus* var. *euphorbiicola, Neoerysiphe chelones, N. cumminsiana, N. galeopsidis, N. galii,* and *N. geranii* are introduced. *Setoerysiphe kashmiriensis* is reduced to synonymy with *Erysiphe sambuci*, and it is pointed out that *Microsphaera indica* is indistinguishable from *Medusosphaera rosae*.

Zusammenfassung: BRAUN, U. 1999: Some critical notes on the classification and the generic concept of the Erysiphaceae. Schlechtendalia **3**: 48-54.
Auf Grundlage neuer elektronenmikroskopischer und molekularer Forschungsergebnisse wird vorgeschlagen, die Gattung *Erysiphe* s.lat. in drei kleinere Einheiten zu gliedern, nämlich in die Gattungen *Erysiphe* s.str. (≡ *Erysiphe* sect. *Erysiphe*), *Golovinomyces* (≡ *Erysiphe* sect. *Golovinomyces*) und *Neoerysiphe* stat. et nom. nov. (≡ *Erysiphe* sect. *Galeopsidis*). Erysiphaceae Tribus Erysipheae Subtribus Golovinomycetinae subtribus nov. und Subtribus Neoerysiphinae subtribus nov. werden eingeführt. Tribus Phyllactinieae wird validiert und es wird festgestellt, daß Tribus Sawadaeae V.P. Gelyuta der korrekte Name für Tribus Sawadaeae (U. Braun) R.T.A. Cook et al. ist. *Oidium* subgen. *Pseudoidium* Jacz. ist der korrekte Name für *Oidium* subgen. *Pseudoidium* (Y.S. Paul & J.N. Kapoor) R.T.A. Cook et al. (nom. illeg.). Die Neukombinationen *Golovinomyces* sect. *Depressi*, *Golovinomyces andinus, G. cichoracearum* var. *fischeri*, var. *latisporus,* var. *poonensis*, var. *transvaalensis*, *G. magnicellutatus* var. *robustus, G. leuceriae, G. rubi, G. sparsus* var. *euphorbiicola, Neoerysiphe chelones, N. cumminsiana, N. galeopsidis, N. galii* und *N. geranii* werden vorgeschlagen. *Setoerysiphe kashmiriensis* wird als Synonym von *Erysiphe sambuci* angesehen, und es wird festgestellt, daß *Microsphaera indica* nicht von *Medusosphaera rosae* unterscheidbar ist.

The present paper contains some critical notes on the classification and the generic concept of the Erysiphales. Based on new SEM and molecular examinations, a reassessment of *Erysiphe* s.lat. is proposed, some new combinations are introduced, and the classification of the Erysiphaceae is discussed.

1. *Erysiphe* s.lat.

The classical generic taxonomy of *Erysiphe* was predominantly based on features of the ascomata, above all of the appendages of the fruit bodies, but it turned out that the taxonomic value of these characters has been overestimated (BRAUN 1987, 1995). *Microsphaera* and

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Arthrocladiella are, for instance, characterized by having dichotomously branched appendages, but the anamorphs are quite distinct. *Uncinula, Pleochaeta,* and *Sawadaea* possess appendages with uncinate-circinate apices but are otherwise very different. For the differentiation of these genera, the anamorphs played an increasing, important role which has recently been confirmed by SEM examinations (COOK et al. 1997) and molecular data (TAKAMATSU et al. 1998, SAENZ & TAYLOR 1999). The heterogeneity of *Erysiphe* s.lat. represents a special complex problem. The genus *Blumeria* with *B. graminis* (≡ *Erysiphe graminis*) is now generally recognized. The ascomata are *Erysiphe*-like, but the features of the haustoria, mycelium, and conidiophores are strongly distinguished and represent a unique type. The pattern of the conidial surface viewed by SEM is unique as well (HAMMETT 1977, COOK et al. 1997). The isolated position of the genus *Blumeria*, which is not closely allied to *Erysiphe*, has recently been confirmed by SAENZ & TAYLOR (1999) and TAKAMATSU et al. (1998, 1999) by means of molecular studies.

BRAUN (1978, 1981) introduced *Erysiphe* sect. *Golovinomyces* and *E.* sect. *Galeopsidis*, respectively. The separation of *Erysiphe* into three sections was maintained by BRAUN (1987, 1995) although the heterogeneous, paraphyletic character of this genus was clearly indicated and discussed (see BRAUN 1987: 44, Pl. 8). GELYUTA (1988) elevated sect. *Golovinomyces* to generic rank, but his treatment was mainly based on the formation of conidia in chains. Hence, he assigned *Erysiphe galeopsidis, E. cumminsiana,* and *E. chelones* (sect. *Galeopsidis*) to *Golovinomyces* although the lobed appressoria and the number of ascospores per ascus agree with those of species of *Erysiphe* sect. *Erysiphe*. GELYUTA (1988) placed *Erysiphe ulmariae* Desm. in *Golovinomyces* although its anamorph clearly belongs in *Oidium* subgen. *Pseudoidium* (BRAUN 1987, 1995). NOMURA (1997) provided a full description and good illustration of the anamorph of this species, which is characterized by having lobed appressoria and conidia formed singly.The existence of the intermediate sect. *Galeopsidis* kept BRAUN (1995) from recognizing GELYUTA's genus *Golovinomyces*. In any case, the affinity of sect. *Galeopsidis* is closer to sect. *Erysiphe* than to *Golovinomyces*, which has been supported by COOK et al. (1997) and confirmed by molecular data provided by SAENZ & TAYLOR (1999). The intermediate sect. *Galeopsidis* represents a dilemma for the taxonomy of *Erysiphe* s.lat. There are only two acceptable alternatives, viz. the maintenance of *Erysiphe* s.lat. as heterogeneous, paraphyletic genus or the separation of *Erysiphe* into three smaller, homogeneous genera.

The molecular data published by TAKAMATSU et al. (1998) and SAENZ & TAYLOR (1999) clearly indicate that *Erysiphe* sect. *Golovinomyces* and sect. *Erysiphe* are not closely allied. The affinity between *Erysiphe* sect. *Erysiphe* and *Microsphaera* as well as *Uncinula* is much closer. Hence, the latter authors advised the recognition of *Golovinomyces* at generic rank and recommended leaving of the species of sect. *Galeopsidis* in *Erysiphe* s.str. I fully agree that it is not tenable to keep a comprehensive *Erysiphe*, including *Golovinomyces*, but the treatment of sect. *Galeopsidis* emphasized by SAENZ & TAYLOR (1999) does not solve the old taxonomic problem of the *Erysiphe* complex. Therefore, I propose to elevate sect. *Galeopsidis* to generic rank. This group of species represents a unique morphologically (BRAUN 1987, 1995) as well as genetically (SAENZ & TAYLOR 1999) defined unit of powdery mildews, so that it seems to be justified to introduce a new genus for these fungi. The pattern of the outer conidial wall is striate when viewed by SEM (GORTER 1987, COOK et al. 1997), whereas the conidial surface in *Erysiphe* s.str. is rugose, and *Golovinomyces* is characterized by having conidia with a „roughcast" pattern.

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Neoerysiphe U. Braun **stat. et nom. nov.**

Bas.: *Erysiphe* sect. *Galeopsidis* U. Braun, Nova Hedwigia 34: 690 (1981).

Type species: *Erysiphe galeopsidis* (≡ *Neoerysiphe galeopsidis*).
Anamorph: *Oidium* subgen. *Striatoidium* R.T.A. Cook, Inman & Billings.
Appressoria more or less lobed; conidia catenate, surface striate, not reticulate when wrinkled. Ascomata *Erysiphe*-like, non-dorsiventral, peridium multilayered, dark, appendages mycelioid, asci 2-8-spored, ascospores developed after overwintering.

Neoerysiphe chelones (Schwein.) U. Braun **comb. nov.**

Bas.: *Erysiphe chelones* Schwein., Trans. Am. Phil. Soc., N.S., 4: 270 (1834).

Neoerysiphe cumminsiana (U. Braun) U. Braun **comb. nov.**

Bas.: *Erysiphe cumminsiana* U. Braun, Mycotaxon 18(1): 124 (1983).

Neoerysiphe galeopsidis (DC.) U. Braun **comb. nov.**

Bas.: *Erysiphe galeopsidis* DC., Fl. Fr. VI: 108 (1815).

Neoerysiphe galii (S. Blumer) U. Braun **comb. nov.**

Bas.: *Erysiphe galii* S. Blumer, Beitr. Krypt.-Fl. Schweiz 7(1): 283 (1933).

Notes: *Erysiphe galii* sensu Braun (1987, 1995) is heterogeneous. *E. galii* s.str. is characterized by having catenate, striate (Cook et al. 1997) conidia, lobed appressoria, and ascospores developing after overwintering, so that this species can be placed in *Neoerysiphe*. *Erysiphe galii* var. *riedliana* (Speer) U. Braun (≡ *Ersiphe riedliana* Speer) has catenate, non-striate conidia, nipple-shaped appressoria, and 2-spored asci with ascospores developing in the current season before overwintering. Thus, this fungus belongs in *Golovinomyces* (*Golovinomyces riedlianus* (Speer) V.P. Gelyuta).

Neoerysiphe geranii (Y. Nomura) U. Braun **comb. nov.**

Bas.: *Erysiphe geranii* Y. Nomura, Taxonomical study of Erysiphaceae of Japan: 217, Yokendo LTD., Tokyo, 1997.

On account of the recognition of the genus *Golovinomyces*, the following new combinations are necessary:

Golovinomyces sect. ***Depressi*** (U. Braun) U. Braun **comb. et stat . nov.**

Bas.: *Erysiphe* sect. *Golovinomyces* subsect. *Depressae* U. Braun, Nova Hedwigia 34: 695 (1981).

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Golovinomyces andinus (Speg.) U. Braun **comb. nov.**

Bas.: *Erysiphe taurica* var. *andina* Speg., Anal. Mus. Nac. Buenos Aires 1902: 68 (1902).
≡ *Erysiphe andina* (Speg.) U. Braun, Mycotaxon 15: 133 (1982).

Golovinomyces cichoracearum var. ***fischeri*** (S. Blumer) U. Braun **comb. nov.**

Bas.: *Erysiphe fischeri* S. Blumer, Beitr. Krypt.-Fl. Schweiz 7(1): 262 (1933).
≡ *Erysiphe cichoracearum* var. *fischeri* (S. Blumer) U. Braun, Nova Hedwigia 34: 695 (1981).

Golovinomyces cichoracearum var. ***latisporus*** (U. Braun) U. Braun **comb. nov.**

Bas.: *Erysiphe cichoracearum* var. *latispora* U. Braun, Mycotaxon 18(1): 117 (1983).

Golovinomyces cichoracearum var. ***poonensis*** (Kamat) U. Braun **comb. nov.**

Bas.: *Erysiphe poonensis* Kamat, in Chiddarwar, Curr. Sci. 24(2): 421 (1955).
≡ *Erysiphe cichoracearum* var. *poonensis* (Kamat) U. Braun, Mycotaxon 16(2): 422 (1983).

Golovinomyces cichoracearum var. ***transvaalensis*** (G.J.M. Gorter & Eicker) U. Braun **comb. nov.**

Bas.: *Erysiphe cichoracearum* var. *transvaalensis* G.J.M. Gorter & Eicker, S. Afr. J. Bot. 1983(2): 130 (1983).

Golovinomyces leuceriae (Havrylenko) U. Braun **comb. nov.**

Bas.: *Erysiphe leuceriae* Havrylenko, Nova Hedwigia 63(1-2): 75 (1996).

Golovinomyces magnicellulatus var. ***robustus*** (R.Y. Zheng & G.Q. Chen) U. Braun **comb. nov.**

Bas.: *Erysiphe robusta* R.Y. Zheng & G.Q. Chen, Sydowia 34: 296 (1981).
≡ *Erysiphe magnicellulata* var. *robusta* (R.Y. Zheng & G.Q. Chen) U. Braun, Mycotaxon 22(1): 87 (1985).

Golovinomyces rubi (H.D. Shin & Y.J. La) U. Braun **comb. nov.**

Bas.: *Erysiphe rubi* H.D. Shin & Y.L. La, in Shin, Erysiphaceae of Korea [Ph.D. thesis], Graduate School of Seoul Nat. Univ. Korea: 84 (1988).
≡ *Erysiphe rubi* H.D. Shin & Y.L. La, Korean J. Pl. Pathol. 5(2): 182 (1989), nom. inval.

Golovinomyces sparsus var. ***euphorbiicola*** (Havrylenko) U. Braun **comb. nov.**

Bas.: *Erysiphe sparsa* var. *euphorbiicola* Havrylenko, Nova Hedwigia 63(1-2): 77 (1996).

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2. The classification of the Erysiphaceae

Cook et al. (1997) introduced a revised classification of the Erysiphaceae and proposed some new tribes and subtribes. The proposed new structure is largely recognized, but some minor corrections are necessary. Subtribe Erysiphinae is circumscribed by having *Pseudoidium* anamorphs. Hence, it is not tenable to retain *Golovinomyces* and *Neoerysiphe* in this subtribe. As a consequence of the new more natural generic structure, it is necessary to place these genera in separate subtribes.

Erysiphaceae tribe Erysipheae subtribe **Golovinomycetinae** U. Braun **subtribus nov.**

Type genus: *Golovinomyces* (U. Braun) V.P. Gelyuta.
Stat. anamorphosis: *Oidium* subgen. *Reticuloidium* Cook et al.
Ascomata erysiphoida. Appendices mycelioides. Ascosporae saepe 2. Asci semper maturi in foliis vivis.

Erysiphaceae tribe Erysipheae subtribe **Neoerysiphinae** U. Braun **subtribus nov.**

Type genus: *Neoerysiphe* U. Braun.
Stat. anamorphosis: *Oidium* subgen. *Striatoidium* Cook et al.
Ascomata erysiphoida. Appendices mycelioides. Ascosporae 2-8. Asci semper immaturi in foliis vivis.

Cook et al. (1997) introduced the new tribe „Phyllactinieae (Palla) R.T.A. Cook et al. comb. et stat. nov.“, based on subfam. Phyllactinioideae Palla, which is, however, invalid (ICBN, Art. 33.2, Note 1). These authors take the opportunity to validate this name in the present paper.

Erysiphaceae tribe **Phyllactinieae** (Palla) R.T.A. Cook, Inman & Billings **stat. nov.**

Bas.: subfam. Phyllactinioideae Palla, Ber. Dt. Bot. Ges. 17: 71 (1899).

The correct name for the tribe which includes the genus *Sawadaea* is:

Erysiphaceae tribe Sawadaeae V.P. Gelyuta, Biol. Ž. Armenii 41(5): 357 (1988)

= subtribe Sawadaeinae U. Braun, Beih. Nova Hedwigia 89: 40 (1987). ≡ tribe Sawadaeae (U. Braun) R.T.A. Cook, Inman & Billings, Mycol. Res. 101(8): 993 (1997), homonym.

Takamatsu et al. (1999) showed, based on molecular examinations, that *Brasiliomyces* and *Typhulochaeta* pertain to the *Pseudoidium* lineage, together with *Erysiphe* s.str., *Microsphaera*, etc. Hence, subtribe Typhulochaetinae should be reduced to synonomy with subtribe Erysiphinae.

3. *Oidium* subgen. *Pseudoidium*

Jaczewski (1927: 449) separated the genus *Oidium* into two morphological groups, viz. „*Eu-Oidium*“ (= „typical *Oidium*“) and „*Pseudoidium*“, classified these taxa as „podrod“

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(= subgenus), and provided descriptions and illustrations. Subgen. *Oidium* is the correct name for subgen. *Eu-Oidium*, and subgen. *Pseudoidium* Jacz. has to be adopted for subgen. *Pseudoidium* (Y.S. Paul & J.N. Kapoor) R.T.A. Cook et al. (1997), which is an illegitimate name (homonym).

4. *Medusosphaera* and *Setoerysiphe*

The genus *Medusosphaera* is monotypic. *Microsphaera indica* N. Ahmad, D.K. Agarwal & A.K. Sarbhoy (1987), described from India on *Rosa webbiana*, is indistinguishable from *Medusosphaera rosae* and undoubtedly conspecific. BRAUN (1987) found a few conida in the type material of this species which seemed to belong to a *Pseudoidium* anamorph. It is possibly necessary to reduce *Medusosphaera* to synonymy with *Microsphaera*, but for a final conclusion we need more details of the morphology of *M. rosae* and a confirmation that the anamorph belongs in *Oidium* subgen. *Pseudoidium*.

BRAUN (1995) reduced *Setoerysiphe* Y. Nomura to synonymy with *Erysiphe*. A mixture of short and long mycelioid appendages is not uncommon in *Erysiphe* species. Furthermore, the anamorph of *Setoerysiphe rodgersiae* Y. Nomura is a *Pseudoidium* (NOMURA 1997: 61-62, Figs. 76-77) which is characteristic for *Erysiphe* s.str. (COOK et al. 1997). The presence of a *Pseudoidium* anamorph supports BRAUN's (1995) treatment of this genus. AHMAD et al. (1998) described *Setoerysiphe kashmiriensis* on *Sambucus wightii* from India (Jammu & Kashmir). This species is also characterized by having lobed appressoria and a *Pseudoidium* anamorph. The features of the ascomata agree well with those of *Erysiphe sambuci* S. Ahmad, described from Pakistan. AHMAD et al. (1998) did not compare *S. kashmiriensis* with the latter species. It is necessary to compare type collections of *E. sambuci* and *S. kashmiriensis* carefully, but the latter species is undoubtedly conspecific with *E. sambuci*.

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