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SKOGEA IS A SYNONYM OF *BOEICA* (GESNERIACEAE)

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The genus *Skogea* U.B.Deshmukh, a replacement name for the recently described monospecific genus *Actinostephanus* F.Wen, Y.G.Wei & L.F.Fu and the correct name for the superfluous *Radiaticorollarus* Y.G.Wei, F.Wen & Lei Cai, is placed in synonymy with the genus *Boeica* C.B.Clarke. Neither the morphological characters nor the molecular data provide sufficient justification for generic recognition.

Keywords. *Actinostephanos*, *Actinostephanus*, Bacillariophyta, *Boeica*, China, *Radiaticorollarus*, *Skogea*.
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Introduction

The present paper addresses the status of the genus *Skogea* U.B.Deshmukh. This is the correct name for the genus recently described as *Actinostephanus* F.Wen, Y.G.Wei & L.F.Fu, a later homonym, and for which the superfluous name *Radiaticorollarus* Y.G.Wei, F.Wen & Lei Cai has also been published. Although the most detailed discussion of the genus was provided in the protologue of *Actinostephanus*, we refer to it here as *Skogea* and to the sole species as *Skogea enpingensis* (F.Wen, Y.G.Wei & Z.B.Xin) U.B.Deshmukh, unless referring specifically to the terminology as used in the protologue of *Actinostephanus*. Sometimes the phrase '*Skogea* (as *Actinostephanus*)' is used for clarity. Wen *et al.* (2022) considered *Skogea* (as *Actinostephanus*) to be closely related to *Boeica* C.B.Clarke and *Leptoboea* Benth. and placed it in the subtribe Leptoboeinae, tribe Trichosporeae, subfamily Didymocarpoideae, in the classification of Weber *et al.* (2013). After critical re-examination and evaluation of the morphological characters and the results of molecular analyses, we find that the data do not support recognition of a distinct genus. We discuss these issues here.

Taxonomic history

Skogea was originally described under the name *Actinostephanus* F.Wen, Y.G.Wei & L.F.Fu (Wen *et al.*, 2022). The name is, however, a later homonym of *Actinostephanos* Khursevich, a genus of diatoms (Bacillariophyta) (Khursevich, 1989). A request for a Binding Decision on the Application of the Code (Turland *et al.*, 2018), regarding whether these names should be treated as homonyms, was published by Deshmukh (2022), who wrote that the

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two names are “sufficiently alike to cause confusion despite belonging to different groups and geographical regions” (Deshmukh, 2022: 1127). Andersen (2023) reported that the Nomenclature Committee for Algae voted in favour of treating the names as homonyms, and Wilson (2024) reported that this recommendation was accepted by the General Committee. The Nomenclature Committee for Vascular Plants has also voted to treat the names as homonyms (Applequist, 2024). This means that *Actinostephanus* F.Wen *et al.* is a later homonym and hence illegitimate. In rapid succession, two replacement names were then published, namely *Skogea* U.B.Deshmukh (Deshmukh, 14 March 2024) and *Radiaticorollarus* Y.G.Wei, F.Wen & Lei Cai (Wen *et al.*, 25 April 2024), the latter of which must be treated as superfluous.

The only species of *Skogea* is *S. enpingensis*, originally described as *Actinostephanus enpingensis* F.Wen, Y.G.Wei & Z.B.Xin in Wen *et al.* (2022). The specific epithet alludes to Enping county, southern Guangdong province, China.

The case against recognition of the genus *Skogea*

The diagnosis given in the protologue of *Actinostephanus* (Wen *et al.*, 2022: 95) states that “*Actinostephanus* F.Wen, Y.G.Wei & L.F.Fu resembles two small genera, *Boeica* C.B.Clarke and *Leptoboea* Benth. according to the molecular evidence and some morphological data, but differs from the latter two by the following characters: leaves in whorls of three, all closely clustered at the top; corolla bowl-shaped, 5-lobed, actinomorphic; capsule hard, oblong-ovoid, short, 3–4 mm long, densely appressed villous, wrapped by persistent densely pubescent calyx lobes, style persistent.” In addition, in Table 1 of Wen *et al.* (2022), the characters of *Skogea* (as *Actinostephanus*), *Boeica* and *Leptoboea* are compared. As discussed below, we find that the distinguishing characters either do not hold up to closer scrutiny or are insufficient to distinguish genera in Gesneriaceae.

Leaf arrangement

Leaf arrangement is variable in subtribe Leptoboeinae, to which *Boeica* and *Skogea* belong (Weber *et al.*, 2013). The subtribe (excluding *Championia* C.B.Clarke) is strongly supported as monophyletic (Yang *et al.*, 2020, 2023; Ranasinghe *et al.*, 2024), but the morphological boundaries between the genera are less clear. *Boeica* and *Leptoboea* have traditionally been distinguished by an alternate vs opposite leaf arrangement, respectively, but this distinction is not reflected in floral characters. In addition, there are still species in *Boeica* that have an opposite leaf arrangement, such as *Boeica ferruginea* Drake. Also, in *Rhynchotechum* Blume, alternate and opposite phyllotaxis occurs in different species and even within species (Anderson & Middleton, 2013). For *Skogea* (as *Actinostephanus*), the description in Wen *et al.* (2022: 96) states that the leaves are “all basal, whorls of three, sometimes opposite, all closely clustered at top forming rosette, …” The photographs in figures 1 and 2 of that

publication do not, however, allow a clear determination of the leaf arrangement. The stem and stem internodes are short, making interpretation of the leaf arrangement difficult, particularly in herbarium specimens. According to Wen Fang, Fu Long-Fei (Guangxi Institute of Botany, China; personal communication) and Cai Lei (Kunming Institute of Botany, China; personal communication), most plants seen in the field have an opposite phyllotaxis, whereas plants with ternate phyllotaxis are in the minority. They also reported that plants in cultivation often show a change from ternate to opposite phyllotaxis.

In conclusion, the ternate phyllotaxis of *Skogea* differs from that of other species of *Boeica*, but because the genus and *Boeica* (and other genera of Leptoboeinae such as *Rhynchotechum* and *Leptoboea*) are variable in this feature and share an opposite leaf arrangement, differences in phyllotaxis alone cannot be grounds for recognition of separate genera.

Floral symmetry

The floral symmetry in *Skogea* is not distinct from that of *Boeica*. The actinomorphic corolla was highlighted by Wen *et al.* (2022) as one of the most important morphological characters distinguishing *Skogea* from *Boeica*. The authors stated that prior to the publication of *Skogea* (as *Actinostephanus*), only three species of Gesneriaceae with actinomorphic corollas were known from China: *Bournea sinensis* Oliv. (= *Oreocharis sinensis* (Oliv.) Mich.Möller & A.Weber), *Bournea leiophylla* (W.T.Wang) W.T.Wang & K.Y.Pan (= *Oreocharis leiophylla* W.T.Wang) and *Oreocharis esquirolei* H.Lév (= the former *Thamnocharis esquirolei* (Lévl.) W.T.Wang). These species not only have actinomorphic corollas but also actinomorphic flowers, meaning that the flowers are radially symmetrical; they also have an equal number of calyx lobes, corolla lobes and stamens, and the parts within each floral whorl do not vary in shape.

In addition to those listed by Wen *et al.* (2022), two further Chinese species with actinomorphic flowers can be added: *Conandron ramondioides* Siebold & Zucc. (in southeastern China, Japan, Taiwan and Vietnam) and *Petrocodon scopulorum* (Chun) Yin Z.Wang (= the former *Tengia scopulorum* Chun, restricted to Guizhou and Yunnan). Outside China, actinomorphic flowers are also found in *Championia* C.B.Clarke (Sri Lanka, 1 sp.), *Ramonda* Rich. (excluding the former *Jancaea* Boiss., Europe, 3 spp.) and *Bellonia* L. (Neotropics, 2 spp.). In conclusion, there are only around 10 species (out of > 3900) species of Gesneriaceae with truly actinomorphic flowers.

In Gesneriaceae, an actinomorphic flower type is found that is distinct from the far more common zygomorphic flower type, and a few species have a 5-lobed radially or almost radially symmetrical corolla with a stamen number of 4 or 2. This condition, sometimes referred to as subactinomorphic, is frequently found in flowers with flat-faced or campanulate corollas, and is the flower type found in *Leptoboea*, *Rhynchotechum* and

several species of *Boeica* (with 4 stamens). In their rotate appearance, the flowers of *Skogea* are very similar to those of *Boeica konchurangensis* B.H.Quang, D.V.Hai & Mich.Möller (Quang *et al.*, 2019). This was clarified and confirmed by a discussion with the authors of *Actinostephanus* (F. Wen, L. F. Fu, L. Cai, personal communication). In conclusion, we consider the floral symmetry in *Skogea* as not distinct from that of *Boeica*.

Fruits

The fruit type in *Skogea* is not distinct from that in *Boeica*. In the diagnosis, Wen *et al.* (2022) state that the fruit can distinguish *Skogea* (as *Actinostephanus*) from *Boeica* or other members of Leptoboeinae, and point to table 1 of their paper, where they describe the fruit as "Capsule oblong-ovoid, short, appressed villous, wrapped by persistent calyx lobes, and the calyx lobes also outside covered densely pubescent; hard when mature, style usually persistent, rarely dehiscent, occasionally split into 4-valves".

It is true that most species of *Boeica* and *Leptoboea* have long and slender capsules (usually referred to as "linear" in species descriptions). However, in *Boeica konchurangensis* the capsules have a similar shape as in *Skogea enpingensis* (described as "conoid" and illustrated in figure 2K of Quang *et al.*, 2019). The capsules of *Boeica glandulosa* B.L.Burtt are fusiform, 4.5–9.1 mm long, pubescent, and with persistent calyx lobes (D. J. Middleton, personal observation), those of *Boeica arunachalensis* D.Borah, R.Kr.Singh, Taram & A.P.Das are described as oblong and 1.2–1.4 cm long (Borah *et al.*, 2020: 872), and those of *Boeica clarkei* Hareesh, L.Wu, A.Joe & M.Sabu are described as linear-ovate (Hareesh *et al.*, 2018: 2).

Hairy capsules, from nearly glabrous to tomentose, are known in a number of *Boeica* species, such as *Boeica hirsuta* C.B.Clarke (Clarke, 1883: 136), *B. konchurangensis* (Quang *et al.*, 2019: 3), *Boeica ornithocephalanta* F.Wen, T.V.Do & Y.G.Wei (Wen *et al.*, 2016: 142) and *Boeica porosa* C.B.Clarke (Datta *et al.*, 2013: 117). Because there is clearly much variation in capsule length and indumentum in *Boeica*, the short and hairy capsule of *Skogea* is not diagnostic at the generic level. The mode of dehiscence is certainly the same as in *Boeica*: the capsule opens first loculicidally and then (occasionally or particularly in old fruits) septicidally (either in the upper part or down to base), so that the fruit appears 4-valved. The description of *Skogea* (as *Actinostephanus*) as "rarely dehiscent" is misleading and probably means that the capsule is tardily dehiscent. As shown in figure 4O of Wen *et al.* (2022), the capsule is certainly not hard in the sense of having a hard and bone-like surface. The consistency of the fruit wall in a given specimen depends on the state of maturity of the fruit, the collection conditions (dry or wet weather), and how the plant is dried for the herbarium specimen. In conclusion, we assert that there are no qualitative differences in the dehiscence of *Skogea* and that of *Boeica*. The fruit characters are therefore not diagnostic or conclusive for the establishment of a separate genus.

Molecular data

Existing molecular data are insufficient to distinguish *Skogea* from *Boeica*. Wen *et al.* (2022) provided molecular data based on Bayesian inference and maximum-likelihood analyses of a dataset of 80 encoded protein genes of the plastid genome. These analyses resulted in identical tree topologies, and both trees indicated that the three accessions of what is now called *Skogea enpingensis* form a strongly supported clade. This is not surprising, because the three plants were collected from the same population. However, this clade is in an unsupported sister position to *Boeica*, including *Rhynchotechum* Blume. The nesting of *Rhynchotechum* in *Boeica*, the two genera readily distinguished by morphological characters and not previously having been suggested to be so closely related, raises questions as to the robustness of the data presented in Wen *et al.* (2022) (but see Yang *et al.*, 2020, 2023). It also highlights the fact that the alliance around *Boeica* and *Leptoboea* (subtribe Leptoboeinae, Weber *et al.*, 2013) is not well understood and is in need of further research.

Although many genes were included in Wen *et al.* (2022), the taxon sample size is low and includes only two (plus an undescribed species) of the 16 species of *Boeica* (and only two of 18 *Rhynchotechum* species). Also, no nuclear data were added to test the one-genome (plastid) tree topology, and incongruences between nuclear and plastid phylogenies are long and well documented (e.g. Soltis & Kuzoff, 1995; Stull *et al.*, 2020). It is particularly regrettable that the type species of *Boeica*, *Boeica fulva* C.B.Clarke, is missing from the phylogenetic analyses of Wen *et al.* (2022). It is clear that the study would have benefitted from the inclusion of species with flowers highly similar to those of *Skogea enpingensis*, for example *Boeica konchurangensis*. The inadequate taxon sampling, especially in *Boeica*, and the lack of nuclear molecular markers, make it questionable whether or not the establishment of a new genus is justifiable.

Conclusions

In our opinion, the diagnostic morphological characters presented by Wen *et al.* (2022) are not sufficient to recognise *Skogea enpingensis* in a genus distinct from *Boeica*. Although many chloroplast genes were included in the study, the absence of nuclear data, the inclusion of few *Boeica* samples, the omission of the type species of *Boeica*, and the insufficient phylogenetic sampling of morphological diversity in the Leptoboeinae in the molecular analyses, coupled with the nesting of *Rhynchotechum* within *Boeica*, cast doubt on their conclusions. As a result, *Skogea* is placed here in synonymy with *Boeica*. Despite its shortcomings, the paper by Wen *et al.* (2022) provides new plastid data and some new evolutionary perspectives on the *Boeica* alliance that may serve as a valuable basis for further studies.

Taxonomic treatment

Boeica C.B.Clarke, Commelyn. Cyrtandr. Bengal. 118, t. 87 (1874) ("*Baeica*"). – Type species: *Boeica fulva* C.B.Clarke, lectotype designated by Morton & Denham, Taxon 21: 670 (1972).

Boeicopsis H.W.Li, Acta Bot. Yunnan. 4(3): 244 (1982). – Type species: *Boeicopsis yunnanensis* H.W.Li.

Skogea U.B.Deshmukh, Feddes Repert. 135: [1] (14 March 2024), **syn. nov.** – *Actinostephanus* F.Wen, Y.G.Wei & L.F.Fu in Wen *et al.*, PhytoKeys 193: 95 (2022), nom. illeg. – *Radiaticorollarus* Y.G.Wei, F.Wen & Lei Cai in Wen *et al.*, Guihaia 44(4): 620 (25 April 2024), nom. illeg. – Type species: *Skogea enpingensis* (F.Wen, Y.G.Wei & Z.B.Xin) U.B.Deshmukh.

Boeica enpingensis (F.Wen, Y.G.Wei & Z.B.Xin) A.Weber & Mich.Möller, **comb. nov.** – *Actinostephanus enpingensis* F.Wen, Y.G.Wei & Z.B.Xin in Wen *et al.*, PhytoKeys 193: 95 (2022). – *Skogea enpingensis* (F.Wen, Y.G.Wei & Z.B.Xin) U.B.Deshmukh, Feddes Repert. 135: [1] (14 March 2024). – *Radiaticorollarus enpingensis* (F.Wen, Y.G.Wei & Z.B.Xin) F.Wen, Y.G.Wei & Lei Cai in Wen *et al.*, Guihaia 44(4): 620 (25 April 2024). – Type: China, Guangdong province, Enping city, Naji town, Qixingkeng provincial natural reserve, c.153 m, *Chen Xiaoyun & Liang Junjie* 210519-01 (holotype IBK, isotype IBK).

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