Is it really worthwhile revising the same flora repeatedly? A case study in Thai Orchidaceae

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Is it really worthwhile revising the same flora repeatedly? A case study in Thai Orchidaceae

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ABSTRACT. For many purposes, scientific Floras (dealing with one, several or all plant families on a national or regional scale) are the most intensively used surveys and identification tools for species of vascular plants. Flora of Thailand will be the first real standard Flora to cover all families of flowering plants in Thailand. Nevertheless, the Thai representatives of a number of plant groups have undergone one or more revisions previously. Is it worthwhile revising such groups again for Flora of Thailand – and would it even make sense to start thinking of a second edition? To throw some light on this, I compared three successive revisions of the orchid subfamily Orchidoideae in Thailand (published in 1958–1964, 1977–1978 and 2011, respectively). The series of revisions exhibited a progressive increase in the net number of accepted taxa. The relative increase was highest from the first to the second revision, but still substantial from the second to the third. The net results obscured an even higher number of changes (additions end exclusions of taxa) that partly neutralized each other – and other changes were in themselves neutral in relation to the net number of taxa accepted. Classification at species level, but not at genus level, tended to stabilize over time. Altogether, the results demonstrate that both the second and the third revision were worthwhile indeed, as each of them provided comprehensive changes (arguably improvements) compared to the latest previous revision.

KEY WORDS: Flora of Thailand; floristics; Orchidoideae; taxonomy.

INTRODUCTION

Many facets of biodiversity conservation require the application of taxonomic knowledge, especially at species level (e.g. Schuiteman & de Vogel, 2003; Mace, 2004). As far as vascular plants are concerned, such knowledge is mainly established through revisions (including monographs and critical treatments in scientific Floras). For many purposes, national and regional flora handbooks (dealing with one, several or all plant families in the area concerned) are the most intensively used surveys and identification tools (e.g. Funk, 2006). The most thorough and comprehensive flora handbooks in each region are usually called "standard Floras". Especially in those parts of the western world that have been floristically explored for several centuries, a succession of standard Floras have been published for each area – see, for example, Eriksson's (2004) historical survey of Flora writing in the Nordic region. In the generally late-explored tropics, on the other hand, repeated revision of the same Flora is much less pronounced. For example, the yet unfinished Flora of Thailand will be the first real standard Flora to cover all families of flowering plants in Thailand.

Although the critical treatments in Flora of Thailand constitute the first true revision of many genera (and even families) in a Thai context, the Thai representatives of a number of plant groups have undergone one or more revisions previously. In a time when rapidly changing land use in Thailand and other parts of tropical Asia threatens plant diversity and reduces the time that we have left to document it (e.g. Webb et al., 2010), is it really worthwhile revising these groups again for Flora of Thailand – and would it make any sense at all to start thinking of a second edition of this national standard Flora?

In order to assess the degree of scientific relevancy of repeated revisions of the same flora, I performed a case study of the orchid subfamily Orchidoideae in Thailand. This was done by comparing the taxonomic content of three subsequent revisions of this group (published in 1958–1964,

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1977–1978 and 2011, respectively). I primarily focused on exploring changes at species level, whereas changes at the genus level, which is generally considered less critical in a flora context, was only given secondary attention. Already from the beginning, it was my belief that the signals from my case study could, to some extent, give an impression of the scientific relevancy of repeated revisions of other groups of vascular plants, not only in Thailand but also on a wider geographic scale.

METHODS

The Thai representatives of the Orchidoideae (as circumscribed by Pridgeon et al., 2001–2003), have been revised thrice. The first revision was published in "The Orchids of Thailand: a Preliminary List" (Seidenfaden & Smitinand, 1958–1964; the Orchidoideae were mainly treated in part I from 1958, but a few emendations appeared in part IV(2) from 1964). The second revision appeared in parts V and VI of "Orchid Genera in Thailand" (Seidenfaden, 1977, 1978), and the third revision was recently published in "Flora of Thailand" (Pedersen et al., 2011). In the present study, the first and the second revision were compared at species and genus level, as were the second and the third revision – to map all changes according to the following categories:

• Species or genera added from the early to the late revision. Additions include: taxa described as new based on material from Thailand; new national records; taxa revived from the synonymy of other taxa occurring in Thailand.

• Species or genera excluded from the early to the late revision. Exclusions include: taxa reduced to heterotypic synonyms of names already applied to other material from Thailand; taxa that were accepted as members of the Thai flora in the early revision, but excluded in the late revision, as they were considered to represent misidentifications.

• Changes neutral to the selection of Thai species or genera recognized in the early and the late revision, but changing the names under which some of them are treated. Neutral changes include: nomenclatural corrections; emendations reflecting adjustments in taxonomic synonymy (not involving other taxa occurring in Thailand); emendations reflecting adjustments in generic recognition or delimitation.

• Complex changes that overlap between two or more of the above categories.

For each pair of revisions, Sørensen's (1948) index of similarity was calculated (at species and genus level, respectively) as: $IS_S = [c / 0.5(A + B)] \times 100\%$, where c is the number of taxon names common to both revisions, whereas A and B are the total numbers of taxon names recognized in the early and the late revision, respectively. In comparison to Jaccard's original index of similarity ($IS_J = [c / (A + B - c)] \times 100\%$), Sørensen's index expresses the actually measured coinciding taxon occurrences against the maximally possible ones. As noted by Mueller-Dombois & Ellenberg (1974), this may be mathematically more satisfactory, as it includes a statistical probability term. In order to visualize the relationships between the three revisions at species and genus level, respectively, two cluster analyses employing the IS_S values were performed. The dendrograms were constructed in NTSYSpc 2.0 (Rohlf, 1998) by means of the unweighted pair-group method using arithmetic averages (UPGMA) algorithm (Legendre & Legendre, 1983).

RESULTS

Changes at species level from first to second revision

From the first to the second revision, nine species were described as new based on material from Thailand (Table 1), and additionally 43 species were added as new national records (Table 2).

On the negative side, five species were reduced to taxonomic synonyms of species names already applied to other material from Thailand (Table 3). Similarly, nine species that were accepted as members of the Thai flora in the first revision were excluded in the second revision, as they were considered to represent misidentifications (Table 4).

Finally, a number of neutral changes occurred from the first to the second revision. Thus, 16 species were recognized in both revisions, but under different names. In 14 cases, the change of name reflected a change in taxonomic synonymy (Table 5), whereas in the other two cases it reflected a change in generic recognition or delimitation (Table 6).

Table. 1. Survey of species of Thai Orchidoideae added from one revision to the next, I. Species described as new based on material from Thailand.

Species added from first to second revision
Cheirostylis didymacantha Seidenf.
Cheirostylis thailandica Seidenf.
Goodyera thailandica Seidenf.
Habenaria falcatopetala Seidenf.
Habenaria longitheca Seidenf.
Habenaria thailandica Seidenf.
Pecteilis sagarikii Seidenf.
Peristylus kerrii Seidenf.
Zeuxine grandis Seidenf.
Species added from second to third revision
Amitostigma thailandicum Seidenf. & Thaithong
Brachycorythis neglecta H.A. Pedersen
Corybas ecarinatus Anker & Seidenf.
Habenaria anomaliflora Kurzweil & Chantanaorr.
Habenaria hastata Seidenf.
Hetaeria armata Ormerod & H.A. Pedersen
Hetaeria youngsayei Ormerod
Peristylus carnosipetalus Kurzweil
Peristylus phuwuaensis Kurzweil
Peristylus rigidus Kurzweil
Platanthera angustilabris Seidenf.
Sirindhornia mirabilis H.A. Pedersen & Suksathan
Sirindhornia pulchella H.A. Pedersen & Indham.

Table 2. Survey of species of Thai Orchidoideae added from one revision to the next, II. Species added as new records for Thailand.

Species added from first to second revision
Anoectochilus abbreviatus (Lindl.) Seidenf.
Anoectochilus lanceolatus Lindl.
Anoectochilus roxburghii (Wall.) Lindl.
Cheirostylis spathulata J.J.Sm.
Cheirostylis yunnanensis Rolfe
Cystorchis aphylla Ridl.
Dicerostylis lanceolata Blume
Erythrodes blumei (Lindl.) Schltr.
Erythrodes herpysmoides (King & Pantl.) Schltr.
Goodyera fumata Thwaites
Goodyera schlechtendaliana Rchb.f.
Habenaria acuifera Wall. ex Lindl.
Habenaria austrosinensis Tang & F.T. Wang
Habenaria avana Hook.f.
Habenaria erostrata Tang & F.T. Wang
Habenaria godefroyi Rchb.f.
Habenaria holotricha Gagnep.
Habenaria limprichtii Schltr.

Table 2. Continued

Habenaria reniformis (D. Don) Hook.f.
Habenaria rostrata Wall. ex Lindl.
Habenaria rumphii (Brongn.) Lindl.
Habenaria trichosantha Lindl.
Habenaria vidua C.S.P. Parish & Rchb.f.
Habenaria viridiflora (Rottler ex Sw.) R.Br.
Hetaeria alta Ridl.
Hetaeria elongata (Lindl.) Trimen
Hetaeria obliqua Blume
Hetaeria rotundiloba J.J.Sm.
Hetaeria rubens (Lindl.) Benth. ex Hook.f.
Peristylus affinis (D. Don) Seidenf.
Peristylus constrictus (Lindl.) Lindl.
Peristylus holttumii Seidenf.
Peristylus parishii Rchb.f.
Peristylus tipuliferus (C.S.P. Parish & Rchb.f.) Mukerjee
Platanthera angustata (Blume) Lindl.
Spiranthes sinensis (Pers.) Ames
Vrydagzynea albida (Blume) Blume
Vrydagzynea lancifolia Ridl.
Vrydagzynea tristriata Ridl.
Zeuxine clandestina Blume
Zeuxine flava (Wall. ex Lindl.) Benth. ex Hook.f.
Zeuxine glandulosa King & Pantl.
Zeuxine longilabris (Lindl.) Benth. ex Hook.f.

Species added from second to third revision

Brachycorythis galeandra (Rchb.f.) Summerh.
Brachycorythis laotica (Gagnep.) Summerh.
Cheirostylis moniliformis (Griff.) Seidenf.
Cheirostylis octodactyla Ames
Diplomeris pulchella D. Don
Goodyera bifida (Blume) Blume
Goodyera pusilla Blume
Habenaria ciliolaris Kraenzl.
Habenaria humidicola Rolfe
Habenaria mandersii Collett & Hemsl.
Habenaria myriotricha Gagnep.
Habenaria pantlingiana Kraenzl.
Habenaria poilanei Gagnep.
Macodes petola (Blume) Lindl.
Odontochilus macranthus Hook.f.
Peristylus hamiltonianus (Lindl.) Lindl.
Peristylus maingayi (King & Pantl.) J.J. Wood & Ormerod
Peristylus mannii (Rchb.f.) Mukerjee
Rhomboda lanceolata (Lindl.) Ormerod
Satyrium yunnanense Rolfe
Sirindhornia monophylla (Collett & Hemsl.) H.A. Pedersen & Suksathan
Zeuxine bidupensis Aver.
Zeuxine violascens Ridl.

Table 3. Survey of species of Thai Orchidoideae excluded from one revision to the next, I. Species reduced to taxonomic synonyms of species names already applied to other material from Thailand.

Accepted in first revision	In second revision a synonym of
Habenaria columbae Ridl.	*Habenaria lindleyana* Steud.
Habenaria trichochila Rolfe ex Downie	*Habenaria medioflexa* Turrill
Zeuxine pumila (Hook.f.) King & Pantl.	*Myrmechis pumila* (Hook.f.) Tang & F.T. Wang
Zeuxine pusilla Kerr & Rolfe	*Myrmechis pumila* (Hook.f.) Tang & F.T. Wang
Zeuxine vittata Rolfe ex Downie	*Zeuxine nervosa* (Wall. ex Lindl.) Benth. ex Clarke
Accepted in second revision	**In third revision a synonym of**
Brachycorythis obovalis Summerh.	*Brachycorythis acuta* (Rchb.f.) Summerh.
Cheirostylis didymacantha Seidenf.	*Cheirostylis spathulata* J.J.Sm.
Hetaeria nitida Ridl.	*Hetaeria oblongifolia* Blume
Peristylus tipuliferus (C.S.P. Parish & Rchb.f.) Mukerjee	*Peristylus tentaculatus* (Lindl.) J.J.Sm.
Zeuxine grandis Seidenf.	*Zeuxine affinis* (Lindl.) Benth. ex Hook.f.

Table 4. Survey of species of Thai Orchidoideae excluded from one revision to the next, II. Species excluded from the late revision because they were considered to represent misidentifications.

Accepted in first revision	Thai material in second revision referred to
Anoectochilus clarkei (Hook.f.) Seidenf. & Smitinand	*Anoectochilus lanceolatus* Lindl.
Anoectochilus grandiflorus Lindl.	*Anoectochilus lanceolatus* Lindl.
Anoectochilus reinwardtii Blume	[Correct identification not indicated]
Habenaria andamanica Hook.f.	*Habenaria holotricha* Gagnep.
Habenaria kingii Hook.f.	*Habenaria longitheca* Seidenf.
Habenaria linguella Lindl.	[Correct identification not indicated]
Habenaria oligoschista Schltr.	*Habenaria limprichtii* Schltr.
Spiranthes lancea (Thunb. ex Sw.) Backer, Bakh. & Steenis	*Spiranthes sinensis* (Pers.) Ames
Zeuxine violascens Ridl.	*Zeuxine longilabris* (Lindl.) Benth. ex Hook.f.
Accepted in second revision	**Thai material in third revision referred to**
Brachycorythis henryi (Schltr.) Summerh.	*Brachycorythis neglecta* H.A. Pedersen
Zeuxine longilabris (Lindl.) Benth. ex Hook.f.	*Zeuxine affinis* (Lindl.) Benth. ex Hook.f.

Table 5. Survey of species of Thai Orchidoideae recognized both in one revision and the next, but under different names, I. Name changes reflecting changes in taxonomic synonymy at the species level.

Name in first revision	Name in second revision
Anoectochilus multiflorus Rolfe ex Downie	*Anoectochilus moulmeinensis* (C.S.P. Parish & Rchb.f.) Seidenf.
Cheirostylis macrantha Schltr.	*Cheirostylis griffithii* Lindl.
Goodyera cordata (Lindl.) G. Nicholson	*Goodyera viridiflora* (Blume) Blume
Habenaria aurantiaca Rolfe ex Downie	*Habenaria marginata* Colebr.
Habenaria buchneroides Schltr.	*Peristylus densus* (Lindl.) Santapau & Kapadia
Habenaria garrettii Rolfe ex Downie	*Peristylus tentaculatus* (Lindl.) J.J.Sm.
Habenaria graminifolia Gagnep.	*Habenaria khasiana* Hook.f.
Habenaria recurva Rolfe ex Downie	*Habenaria lucida* Wall. ex Lindl.
Habenaria roseata Ridl.	*Habenaria rostellifera* Rchb.f.
Habenaria sutepensis Rolfe ex Downie	*Habenaria stenopetala* Lindl.
Herminium angustifolium (Lindl.) Benth. ex Hook.f.	*Herminium lanceum* (Thunb. ex Sw.) Vuijk
Peristylus chloranthus Lindl. ex Benth.	*Peristylus lacertiferus* (Lindl.) J.J.Sm.
Zeuxine leucochila Schltr.	*Zeuxine parvifolia* (Ridl.) K.Schum. & Fedde
Zeuxine sutepensis Rolfe ex Downie	*Zeuxine affinis* (Lindl.) Benth. ex Hook.f.
Name in second revision	Name in third revision
Disperis siamensis Rolfe ex Downie	*Disperis neilgherrensis* Wight
Erythrodes herpysmoides (King & Pantl.) Schltr.	*Erythrodes hirsuta* (Griff.) Ormerod
Hetaeria rubens (Lindl.) Benth. ex Hook.f.	*Hetaeria affinis* (Griff.) Seidenf. & Ormerod
Hetaeria rotundiloba J.J.Sm.	*Hetaeria anomala* (Lindl.) Rchb.f.
Pecteilis sagarikii Seidenf.	*Pecteilis hawkesiana* (King & Pantl.) C.S. Kumar

Table 6. Survey of species of Thai Orchidoideae recognized both in one revision and the next, but under different names, II. Name changes reflecting changes in generic recognition or delimitation.

Name in first revision	Name in second revision
Anoectochilus pumilus (Hook.f.) Seidenf. & Smitinand	*Myrmechis pumila* (Hook.f.) Tang & F.T. Wang
Haemaria discolor (Ker Gawl.) Lindl.	*Ludisia discolor* (Ker Gawl.) Blume
Name in second revision	**Name in third revision**
Anoectochilus abbreviatus (Lindl.) Seidenf.	*Rhomboda abbreviata* (Lindl.) Ormerod
Anoectochilus brevistylis (Hook.f.) Ridl.	*Odontochilus brevistylis* Hook.f.
Anoectochilus elwesii (Clarke ex Hook.f.) King & Pantl.	*Odontochilus elwesii* Clarke ex Hook.f.
Anoectochilus lanceolatus Lindl.	*Odontochilus lanceolatus* (Lindl.) Blume
Anoectochilus moulmeinensis (C.S.P. Parish & Rchb.f.) Seidenf.	*Rhomboda moulmeinensis* (C.S.P. Parish & Rchb.f.) Ormerod
Anoectochilus tortus (King & Pantl.) King & Pantl.	*Odontochilus tortus* King & Pantl.
Dicerostylis lanceolata Blume	*Hylophila lanceolata* (Blume) Miq.
Evrardia poilanei Gagnep.	*Odontochilus poilanei* (Gagnep.) Ormerod

Changes at species level from second to third revision

From the second to the third revision, 13 species were described as new based on material from Thailand (Table 1), and additionally 23 species were added as new national records (Table 2). Furthermore, *Zeuxine membranacea* Lindl. was revived from the synonymy of *Z. strateumatica* (L.) Schltr.

On the negative side, five species were reduced to taxonomic synonyms of species names already applied to other material from Thailand (Table 3). Similarly, two species that were accepted as members of the Thai flora in the second revision were excluded in the third revision, as they were considered to represent misidentifications (Table 4).

Also a number of neutral changes occurred from the second to the third revision. Thus, 15 species were recognized in both revisions, but under different names. In five cases, the change of name reflected a change in taxonomic synonymy (Table 5), whereas in eight cases it reflected a change in generic recognition or delimitation (Table 6). The substitution of the illegitimate name *Hetaeria elongata* (Lindl.) Trimen (second revision) with the new name *H. finlaysoniana* Seidenf. (third revision) was a simple nomenclatural correction. On the other hand, the name change from *Anoectochilus calcaratus* (Hook.f.) Ridl. (second revision) to *Odontochilus uniflorus* (Blume) H.A. Pedersen & Ormerod (third revision) reflected changes in both generic recognition/delimitation and taxonomic synonymy at species level.

Finally, two more complex changes occurred from the second to the third revision. One of them was concerned with *Anoectochilus albolineatus* C.S.P. Parish & Rchb.f., *A. reinwardtii* Blume and *A. siamensis* Schltr. Thus, *A. reinwardtii* (accepted in the third revision) had been misidentified as *A. albolineatus* in the second revision. In the third revision, *A. siamensis* (accepted in the second revision) was considered conspecific with the true (and earlier described) *A. albolineatus*.

The other complex change was concerned with *Anoectochilus repens* (Downie) Seidenf. & Smitinand, *A. duplex* Holttum and *A. tortus* (King & Pantl.) King & Pantl. – a group belonging to a larger fraction of *Anoectochilus* Blume that was recognized as a distinct genus, *Odontochilus* Blume, in the third revision. *Anoectochilus repens*

was accepted in the second revision, but in the third revision it was considered conspecific with the earlier described *Odontochilus tortus* King & Pantl. (a species already accepted as *Anoectochilus tortus* in the second revision). On the other hand, the species *Odontochilus duplex* (Holttum) Ormerod (in the second revision considered conspecific with the earlier described *Anoectochilus repens*) was revived from synonymy in the third revision – to cover a misidentified part of the Thai material referred to *A. repens* in the second revision.

Changes at genus level

From the first to the second revision, six genera were added. Thus, *Myrmechis* (Lindl.) Blume (previously considered a synonym of *Zeuxine* Lindl.) was reinstated, whereas the following genera represented new records for Thailand: *Cystorchis* Blume, *Dicerostylis* Blume, *Erythrodes* Blume, *Platanthera* Rich. and *Vrydagzynea* Blume. On the other hand, the inclusion of the illegitimate name *Haemaria* Lindl. in the synonymy of *Ludisia* A.Rich. represented a neutral nomenclatural change.

From the second to the third revision, eight genera were added. Thus, both *Odontochilus* and *Rhomboda* Lindl. (previously considered synonyms of *Anoectochilus*) were reinstated, *Sirindhornia* H.A. Pedersen & Suksathan was described as new, and the following genera represented new records for Thailand: *Amitostigma* Schltr., *Corybas* Salisb., *Diplomeris* D. Don, *Macodes* (Blume) Lindl. and *Satyrium* Sw. On the other hand, *Evrardia* Gagnep. was reduced to a synonym of *Odontochilus*. Similarly, *Dicerostylis* was reduced to a synonym of *Hylophila* Lindl., but this change was neutral as only one and the same Thai species has been assigned to either genus.

Overall comparison of revisions

Summing up, 52 species of Orchidoideae were added to the Thai flora from the first to the second revision, whereas 37 were added from the second to the third revision. Fourteen species were excluded from the first to the second revision, whereas seven were excluded from the second to the third revision. Changes that were neutral to the selection of Thai species recognized in two subsequent revisions (but changed the names under which some them were treated) occurred in 16 cases from the first to the second revision and in 15 cases from the second to the third revision. Finally, two complex changes that overlap between the above categories occurred from the second to the third revision. From the first to the second revision, the net number of accepted species increased by 49% (from 78 to 116), whereas the net number increased by 26% (from 116 to 146) from the second to the third revision.

Six genera of Orchidoideae were added to the Thai flora from the first to the second revision, whereas eight were added from the second to the third revision. One genus was excluded from the second to the third revision. A single change that was neutral to the selection of Thai genera recognized in two subsequent revisions (but changed the name under which one of them was treated) occurred both from the first to the second revision and from the second to the third revision. From the first to the second revision, the net number of accepted genera increased by 35% (from 17 to 23), whereas the net number increased by 30% (from 23 to 30) from the second to the third revision.

For each pair of revisions, the index of similarity (IS_S) ranged between 35% and 70% at

Table 7. The index of similarity (IS_S) given for each pair of revisions of Thai Orchidoideae. Values at species level are found to the lower left, those at genus level to the upper right.

	Revision 1	Revision 2	Revision 3
Revision 1	-	80%	63%
Revision 2	49%	-	79%
Revision 3	35%	70%	-

species level and between 63% and 80% at genus level (Table 7). In the cluster analyses, the second and the third revision formed a cluster at species level (Fig. 1), whereas the first and the second revision formed a cluster at genus level (Fig. 2).

DISCUSSION

Taxonomic dynamics in three subsequent revisions of the Thai Orchidoideae

Both at species and genus level, the series of revisions exhibited a progressive increase in the net number of accepted taxa. At both taxonomic levels, the relative increase was highest from the first to the second revision (49% for species, 35% for genera), but also the increase from the second to the third revision was noticeable (26% for species, 30% for genera). For both species and genera, however, these net results represent an even higher number of changes (additions and exclusions of taxa) that partly neutralized each other. Furthermore, yet other changes were in themselves neutral in relation to the net number of taxa accepted.

At species level, the proportion of taxa added from the first to the second revision ("step A") was 67%, whereas it was 32% from the second to the third revision ("step B"). This difference was mainly caused by a 55% increase through new records (Table 2) at step A (20% at step B), whereas the relative increase through species described as new from Thailand (Table 1) was almost the same at step A (12%) and step B (11%). At step B only, a single species was revived from the synonymy of another species occurring in Thailand (representing a 1% increase).

On the negative side, the proportion of species excluded was 18% at step A and 6% at step B. Whereas the proportion of species being rejected as misidentifications (Table 4) was much higher at step A (12%) than at step B (2%), the proportions of species reduced to heterotypic synonyms of species names already applied to other material from Thailand (Table 3) were almost identical (6% at step A, 4% at step B).

Changes neutral to the net number of accepted species influenced 21% of the species names at step A and 13% at step B. The neutral changes at step A were dominated by emendations reflecting adjustments in taxonomic synonymy at the species level (Table 5; 88% of the neutral changes at step A); at step B, on the other hand, they were dominated by emendations reflecting adjustments in generic recognition or delimitation (Table 6; 53% of the neutral changes at step B).

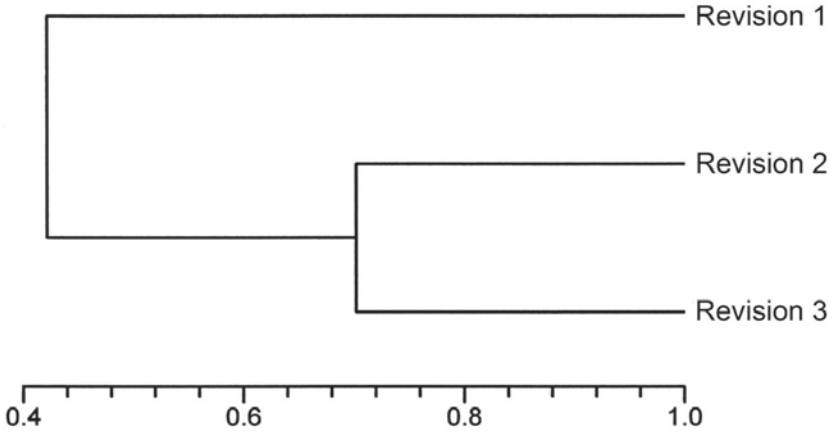

Figure 1. Dendrogram showing the relationships between the three revisions of Thai Orchidoideae at species level. The dendrogram is based on IS_S values and constructed by the UPGMA algorithm.

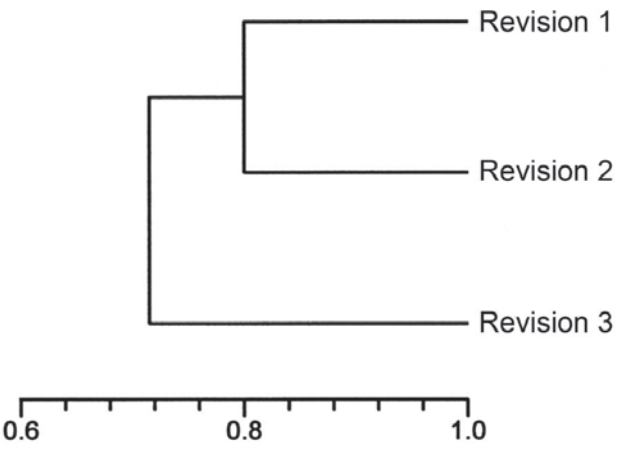

Figure 2. Dendrogram showing the relationships between the three revisions of Thai Orchidoideae at genus level. The dendrogram is based on IS_S values and constructed by the UPGMA algorithm.

It should be noted that two groups of changes at step B were too complicated to allow for inclusion in the detailed assessment above (descriptions of these complex changes are given under "Changes at species level from second to third revision" in the "Results" section).

Both at step A and step B, the proportion of genera added was 35%. However, the relative increase through new records was higher at step A (29%) than at step B (22%), whereas the relative increase through genera being revived from the synonymy of other genera occurring in Thailand was higher at step B (9%) than at step A (6%). At step B only, a genus was described as new (representing a 4% increase). On the negative side, the reduction of *Evrardia* to a synonym of *Odontochilus* represented a 4% decrease at step B, whereas no genera were excluded at step A. Finally, both at step A and step B, a single neutral change occurred at genus level.

In conclusion, significant changes – much more comprehensive than reflected by the net number of accepted taxa – occurred both at step A and step B (at species as well as genus level). Whereas the overall similarity between the classifications is highest between the second and the third revision at species level (Table 4, Fig. 1), it is highest between the first and the second revision at genus level (Table 4, Fig. 2). This indicates that classification at species level – but not at genus level – exhibited a tendency towards stabilization during the period covered by this case study.

Is it really worthwhile revising the same flora repeatedly?

The results of my case study in the Thai Orchidoideae clearly demonstrate that both the second and the third revision have been worthwhile indeed, as they have provided comprehensive changes (arguably improvements!) compared to the first revision.

In a paper on changes of "Flora-information" over time, Friis (2012) distinguishes between: (1) "real changes", i.e. species enter the region by natural dispersal or become extinct; (2) "floristic changes", i.e. species known from elsewhere are discovered; (3) "taxonomic changes", i.e. species are discovered and described, taxonomic revisions change the status of previously known species. His examples from Ethiopia and Eritrea and from the Nordic countries all demonstrate considerable chronological changes belonging to each of the three categories. Thus, the results reached by Friis (2012) correspond to those of my own case study, although I chose to define the categories of changes somewhat differently. Together, the results obtained by Friis and myself suggest that repeated floristic revision at the species level is indeed worthwhile in both temperate and tropical regions (see also Bebber et al. 2010).

The circumstance that classification at genus level (contrary to classification at species level) did not tend to stabilize over time in my case study probably reflects the high recent activity in re-classifying genera by means of modern phylogenetic analysis (for the Orchidoideae, see Pridgeon et al., 2001–2003 and references therein). The same phenomenon must be expected in most other plant groups – meaning that modern floristic treatments of previously treated groups tend to adopt generic classifications with a consistently higher proportion of phylogenetically well-defined genera. Although regional floras are usually studied and characterized with main emphasis on the diversity at species level, our increasing ability to arrange the species in a more natural generic framework adds to the scientific soundness and, hence, usefulness of the flora handbooks for multiple purposes.

Perspectives on future revisions

This study has focused exclusively on the taxonomic/floristic dynamics exhibited by repeated revisions. However, it should not be forgotten that also methodological and technological developments pertaining to communication and utilization of the results have improved markedly over the years – and continue to do so. These developments, too, mean that repeated revisions will continue to offer significantly improved surveys and tools for the user. Initiatives for increasing the usefulness, and hence the relevancy, of future revisions of previously revised plant groups could involve, for example, preparation of multi-informative distribution maps (cf. Jonsell, 2004), increased utilization of molecular data for interpreting morphological variation (cf. Pedersen, 2004) and combining hard-copy publications with information-technological facilities such as multi-access keys, online utilities and virtually unlimited space for digital images (cf. Kress, 2004; Guarino et al., 2009; Brach & Boufford, 2011).

It can hardly be denied that field exploration of the remaining tropical forests is much more urgent than repeated revisions. However, such exploration often takes place as an integrated part of major Flora projects, and such projects often depend largely on external funding. The results presented in this paper document that funding of major Flora projects is not only relevant to the extent that the activities involve field exploration – also the repetitive side of the projects must be expected to provide comprehensive new knowledge. This issue should be highlighted in future applications for funding of Flora projects.

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