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Three new genera of Gesneriaceae from limestone of Peninsular Malaysia

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(With 10 figures)

Keywords: Gesneriaceae, *Boea, Emarhendia, Orchadocarpa, Ornithoboea, Paraboea, Senyumia, Spelaeanthus*. – Taxonomy, morphology. – Malaya, Malaysia, Malesia.

Abstract

Three superficially similar species from Malayan limestone, *Boea minutiflora* Ridl., *Paraboea bettiana* M. R. Hend. and an unnamed plant from Taman Negara have been investigated from newly available material. Differential characters of flowers and fruits override the vegetative similarities, which are probably due to ecological convergence in their shady, limestone habitats. It is concluded that these plants represent three distinct genera. These are described as *Emarhendia* (for *Paraboea bettiana*), and *Senyumia* (for *Boea minutiflora*), while the unnamed plant becomes *Spelaeanthus chinii*. Possible relationships are discussed and the formal taxonomy, together with a key to genera and necessary descriptions and transfers, is set out.

Zusammenfassung

Drei äußerlich ähnliche calcicole Arten, *Boea minutiflora* Ridl., *Paraboea bettiana* M. R. Hend. und eine neue Art vom Taman Negara National Park werden anhand von neuen Aufsammlungen untersucht und auf Grund der unterschiedlichen Blüten- und Fruchtmerkmale in eigene Gattungen, *Senyumia, Emarhendia* und *Spelaeanthus*, gestellt. Die Ähnlichkeiten in den vegetativen Merkmalen gehen offenbar auf Konvergenz, d.h. auf Anpassungen an das spezifische Habitat (schattig-luftfeuchte Kalkhöhlen) zurück. Mögliche Verwandtschaftsbeziehungen werden diskutiert.

Introduction

Around cave-mouths and on shaded cliffs at the foot of limestone massifs in Pahang and Kelantan, the gesneriad flora of the Malay Peninsula

includes three interesting but hitherto little-known species. These are *Boea minutiflora* Ridl. (only known from Gunung Senyum, Pahang), *Paraboea bettiana* M. R. Hend. (Bukit Cheras, Pahang; a closely related plant was recently discovered on Bukit Sagu, Pahang) and a third species which will be described here as *Spelaeanthus chinii*. The latter was first collected at Batu Luas, Taman Negara (KIEW 1985), but has been recently found – (perhaps with varietal differences) – in a wider area in west Pahang and south Kelantan.

One remarkable fact about these three species is their restriction to shady limestone habitats and all three species show similar anatomical features of their leaves that equip them for life in such places. Yet the species have never been found growing together, nor even on the same massif. They occur in good sized populations and the presence of seedlings shows that the populations are regenerating. Left to themselves they are not at risk: it is their habitats that are in danger of destruction (KIEW 1991). Clearance or burning of vegetation around the base of these limestone massifs would let in too much light and too much dry air – just as is happening to the habitats of *Saintpaulia ionantha*, the African Violet, at the Amboni caves near Tanga in Tanzania (cf. JOHANNSON, D. R., in Biological Conservation 14: 45 - 62. 1978). All three sites are listed as botanically important and recommended for conservation (KIEW 1994).

The conclusion reached here is that each of these species must be placed in a separate genus. In order to simplify their discussion, and to avoid any possibility that comments on *Boea minutiflora* or *Paraboea bettiana* might be associated with those genera as a whole, the new names proposed here will be used throughout the remainder of the text.

These names are:

Emarhendia bettiana (syn. *Paraboea bettiana*)

Senyumia minutiflora (syn. *Boea minutiflora*)

Spelaeanthus chinii (the plant from Batu Luas, Taman Negara).

While this paper was in draft, one of us (B. L. B.) was also working on Gesneriaceae for 'Flore du Cambodge, Laos et Vietnam' and found an unnamed collection from N. Vietnam (W. T. TSANG 30386) which seems to be congeneric with *Spelaeanthus chinii*. However, only the three main species are considered in this paper, as the other material does not affect the generic discussion. The plant closely allied to *Emarhendia bettiana* and the variants allied to *Spelaeanthus chinii* will be dealt with separately (by A. W.), as will the Vietnamese plant (by B. L. B.)

The three Malayan plants bear a strong superficial resemblance to one another, chiefly because of (1) their thin membranous, coarsely toothed

leaves, (2) their indumentum (very long slender uniseriate hairs intermingled with shorter glandular hairs which make – especially in *Emarhendia bettiana* and *Spelaeanthus chinii* – the stem and the leaves sticky) and (3) their very small flowers (around 5 mm long). All these features are unusual in Malayan Gesneriaceae of the Tribe *Didymocarpeae,* where these plants undoubtedly belong.

BURTT (1984: 406, 420) referred to these plants in a paper redefining the genera *Boea* and *Paraboea*. He indicated that they were out of place in either of these genera, but suggested that they themselves were congeneric. Since then all three species have been recollected and studied in the field by R. KIEW and/or A. WEBER. Critical examination brought out unexpected differences, especially in the flower and fruit morphology, but also in anatomical, pollen and chromosome characters (Table 1). The view that they are congeneric has to be abandoned.

Morphological characters

Leaves: Each species is distinct in the form of the lamina and its marginal teeth (Table 1). The common feature is the thin membranous texture and the indumentum of long hairs. Another shade-loving Malayan calcicole, *Ornithoboea flexuosa* (Ridl.) B. L. Burtt, has the same type of leaf (thin membranous, shape as in *Emarhendia bettiana,* but indumentum consisting of glandular hairs only). This suggests that the distinctive leaf characters may result from ecological convergence.

Flowers: The small size of the corolla is a conspicuous common feature, but there are marked differences in form.

Spelaeanthus chinii (Fig. 8a, b) has a broad open tube with a bilabiate limb, the upper lip distinctly shorter than the lower; in general terms it can be described as obliquely campanulate, a fairly common shape in Gesneriaceae, most often associated, as in *Spelaeanthus,* with white flowers. In this genus the corolla is also somewhat ventricose.

The fact that in *Spelaeanthus chinii,* as well as in *Senyumia minutiflora,* the fruit set is very constant and nearly 100 %, strongly suggests that the flowers are autogamous; this could well be one reason for their small size. The flowers of *Senyumia minutiflora* (Fig. 4b, 5a - c) display, despite the possibility of autogamy, the character syndrome of oligandrous pollen flowers (VOGEL 1978): corolla with an extremely short tube, more or less flat limb, large yellow, fully exposed anthers, and disc absent. The flowers in *Senyumia* are resupinate, but this is not part of the normal syndrome, but an exceptional feature.

Table 1

Distinctive characters of the genera *Senyumia, Spelaeanthus* and *Emarhendia.*

	Senyumia	*Spelaeanthus*	*Emarhendia*
Lamina form	lanceolate	ovate	ovate
Lamina base	cuneate, unequal	cordate, equal, with sinuses	cordate, unequal without sinuses
Petiole length	about to half as long as lamina	nearly as long as lamina or longer	
Shape of teeth	blunt	blunt	pointed
Crystals in midrib	none	none	present
Flower position	resupinate	normal	normal
Corolla	short tubed, limb flat	broad, short, tube	"campanulate"
Corolla colour	white	white	lilac to dark lavender
Glandular hairs on upper lip	sparsely and evenly distributed on whole upper lip; (Fig. 5b)	only at margins of upper lobes (Fig. 9b)	dense and forming conspicuous white, well defined patches on upper lobes (Fig. 2b - d, 3a, b)
Gland structure	stalk long, several-celled, head 1 - 2 celled	stalk short, 1 - 2-celled, head 2 - 4-celled	stalk 2-celled, head c. 15-celled
Anthers	exposed, yellowish	included, white	included, white
Pollen size	c. 8 µm	c. 15 µm	c. 13 µm
Exine	finely perforate (Fig 10e, f)	perforate-verrucate (Fig. 10g - h)	perforate-verrucate (Fig. 10a - d)
Fruit position	orthocarpic	orthocarpic	plagiocarpic
Fruit length	5 mm	4 mm	10 - 20 mm
Fruit dehiscence	both sides	both sides	upper side
Fruit valves	twisted	slightly twisted or straight	straight
Seed	350 × 210 µm	300 × 130 µm	180 × 110 µm
Chromosome number	$n = 9$	$n = 8$	$n = 8$

laeanthus and *Emarhendia*.

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;, l, head l	stalk 2-celled, head c. 15-celled
white	included, white
	c. 13 µm
h)	perforate-verrucate (Fig. 10a - d)
:	plagiocarpic
	10 - 20 mm
	upper side
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m	180 × 110 µm
	$n = 8$

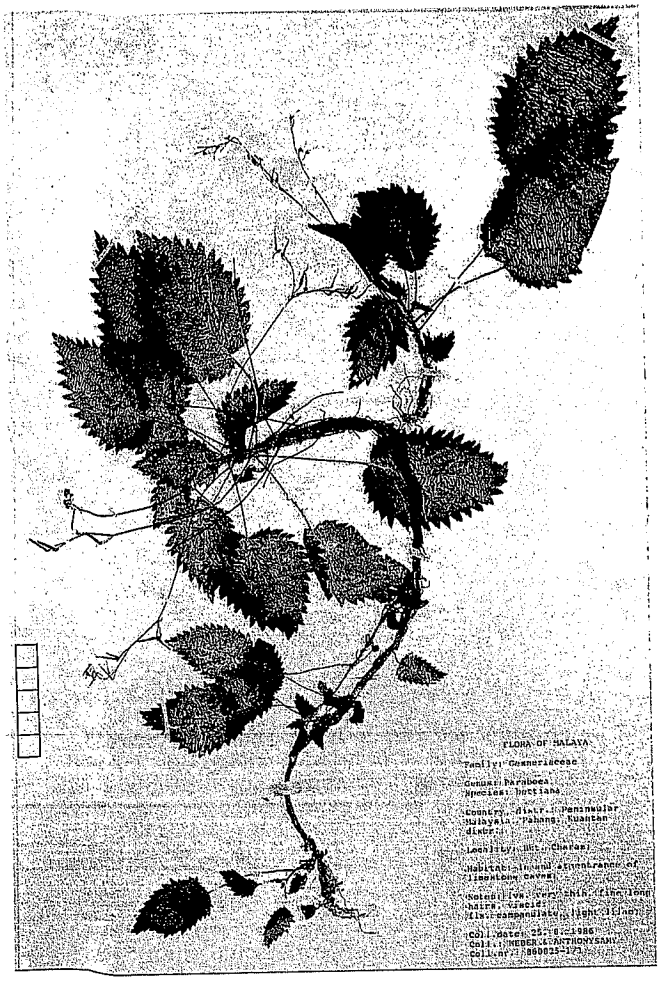


Fig. 1. *Emarhendia bettiana;* herbarium specimen (WEBER & ANTHONYSAMY 860825 - 1/1) showing the habit and leaf form of the plant. Bar: 5 cm.

In *Emarhendia bettiana* (Fig. 2, 3) the most conspicuous feature is the presence of a well circumscribed area of short and densely packed white glands on the upper corolla lobes (Fig. 2b, d, 3a, b). The glands consist of a short, usually 2-celled stalk and a several-celled round head (Fig. 3c - e). The glands emerge from epidermal cells; the cells bearing no glands have a small hemispherical knob in the centre (Fig. 3f) which apparently represents a rudimentary gland. The epidermal cells outside the gland area do not have such knobs.

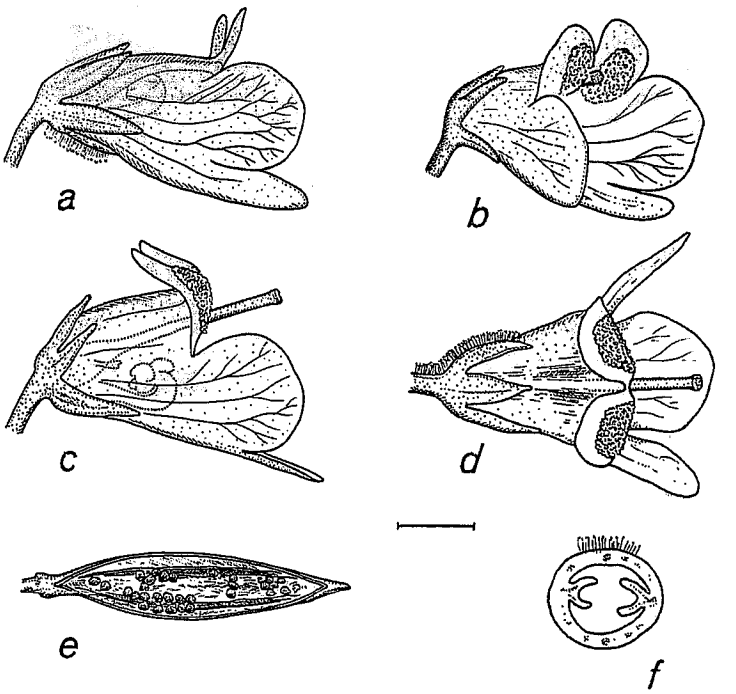
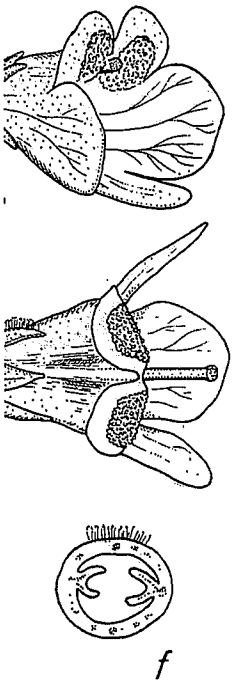


Fig. 2. *Emarhendia bettiana;* a, b flower of male stage in side and half-front view; c, d flower in female stage in side and apical view; e open fruit from above; f section through the ovary, ovules not shown. Bar: 1 mm.

The conspicuous appearance, the density and the white colour of the glands raise the question of their functional significance. Because of their similarity to "elaiophores" (VOGEL 1974), plants grown from seeds were sent to Prof. Dr. Stefan VOGEL (then at the University of Mainz) who was able to establish that the glands do indeed secrete oil. It may be suspected that the oil plays a role in pollination: what role, however, is still enigmatic. Direct observations of pollination and the insect pollinators are needed.

Glandular hairs are found in the two other species as well, but differ in structure and density; in *Senyumia minutiflora* long-stalked glands (with a 1- to 2-celled head) are found sparsely distributed throughout the upper lip (Fig. 5b, 6). In *Spelaeanthus chinii* there are short glandular hairs at the margin of the upper lobes (Fig. 9). There is no indication that these glands correspond to the dense glands on the upper lobes of *Emarhendia bettiana.*



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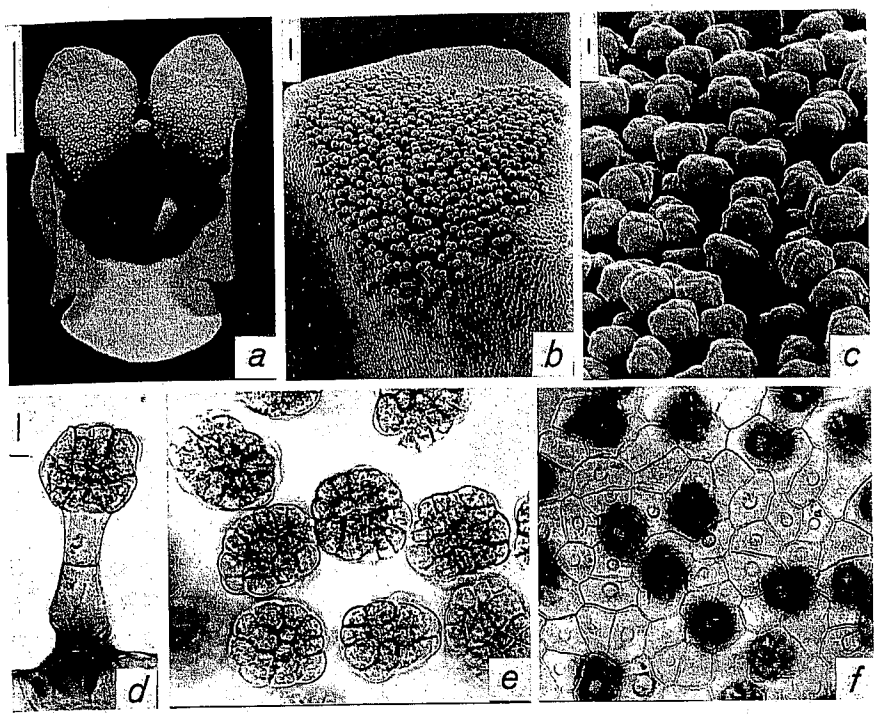


Fig. 3. *Emarhendia bettiana;* flower in front view (male stage); b upper corolla lobe with patch of glands; c glands enlarged; d gland in side view; e heads of glands from above; f epidermis of upper corolla lobe, dark spots with central ring: glands (heads not in focus) with stalk in optical section, note remaining epidermal cells with central circular knob = rudimentary gland; b - c SEM-micrographs, d - f LM-photographs. Bar: 1 mm (a), 100 µm (b), 10 µm (c), 10 µm (d - f).

Pollen: *Senyumia minutiflora* has notably small grains (diameter c. 8 µm) with a finely perforate tectum (Fig. 10e, f). The grains of *Spelaeanthus chinii* and *Emarhendia bettiana* are roughly twice as big and have a perforate-verrucate tectum (Fig. 10a - d, g, h). The exine similarity has probably little taxonomical bearing, as similar patterns occur in numerous gesneriads (e.g. *Boea hygrometrica* and species of *Didymocarpus, Loxocarpus, Paraboea* and *Streptocarpus,* LUEGMAYR 1989, 1993).

Fruit: *Emarhendia bettiana* has straight fruits, opening along the upper side (Fig. 2e). The fruit makes an angle with the pedicel (by curvature at the top of the pedicel) and is held ± horizontally. Thus it closely resembles the fruits of most Malayan *Didymocarpus*.

Both in *Senyumia minutiflora* and *Spelaeanthus chinii* the fruit is "orthocarpic" (continuing the pedicel in a straight line) and opens along

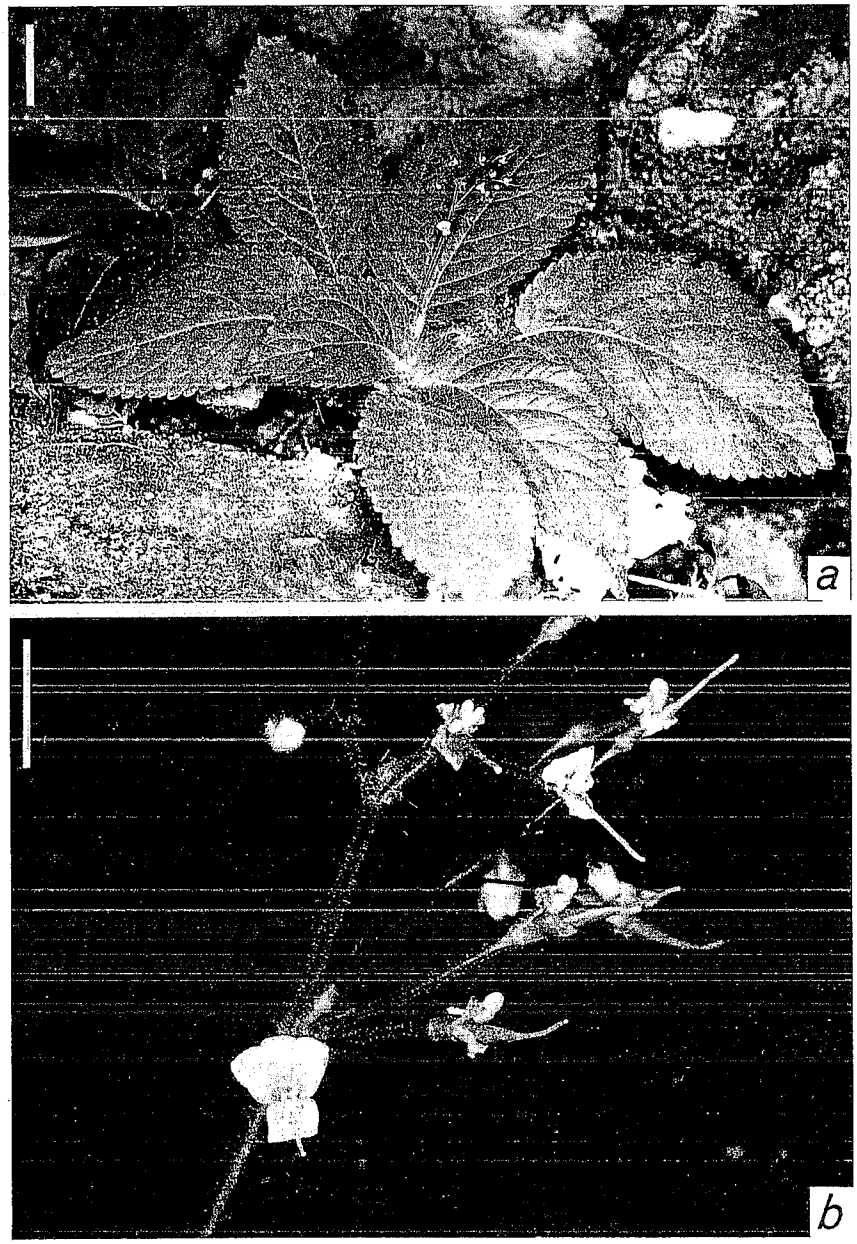


Fig. 4. *Senyumia minutiflora;* a habit; b close up of inflorescence, note resupinate flowers (anthers above style). Bar: 2 cm (a), 5 mm (b).

florescence, note resupinate (a), 5 mm (b).

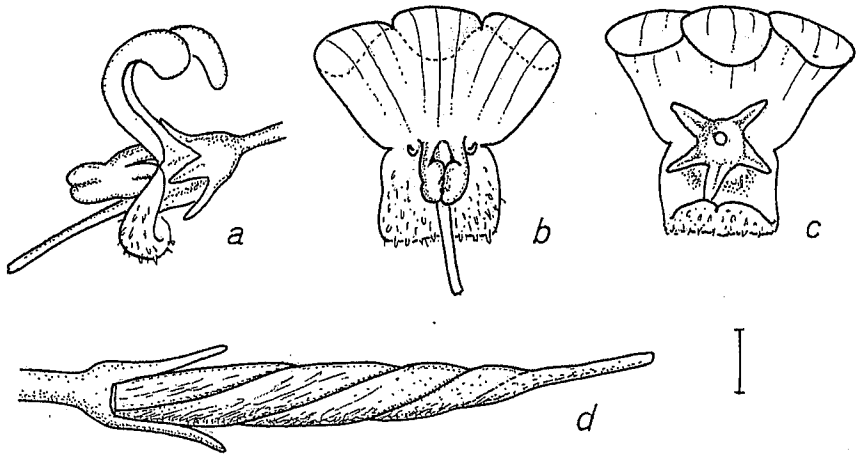


Fig. 5. *Senyumia minutiflora;* a - c (resupinate) flower in side, front and back view; d unripe fruit, one sepal removed. Bar: 1 mm.

both sutures. In *Senyumia minutiflora* the valves twist very strongly (Fig. 5d), but in *Spelaeanthus chinii* twisting is slight and apparently even lacking in some of its variants (Fig. 8c, d).

The taxonomic bearing of the fruit characters is difficult to assess. In contrast to former authors such as FRITSCH (1893), who placed all genera with twisted fruits in a single tribe, we are well aware today that twisted fruits have originated several times in independent evolutionary lines. The twisted fruit of *Senyumia minutiflora,* therefore, cannot be regarded as a strong indicator of relationship, either with *Boea* or *Paraboea* (where both straight and twisted fruits occur, BURTT 1984), or with *Spelaeanthus chinii.*

Chromosome number: The chromosome numbers were established by M. KIEHN & al. (1998). *Spelaeanthus chinii* and *Emarhendia bettiana* share the number $n = 8$, while *Senyumia minutiflora* has $n = 9$.

It is noteworthy that the number $n = 8$ is (as far as known) not found in any other member of Malayan *Didymocarpeae.* It does, however, occur in *Boea* outside Malaya (BURTT 1984). In contrast $n = 9$ is found in quite a number of Malayan genera *(Chirita, Didymocarpus, Loxocarpus).* In the genus *Paraboea* (sensu BURTT 1984), *P. bakeri* also has $n = 9$, the other species, so far as known, are tetraploids with $n = 18$ (KIEHN & al. 1998).

Discussion and conclusions

Apart from the similarity in habit, which may well be associated with the special habitat, there is little positive evidence that the three species discussed here are closely related. The only character that links *Senyumia* and *Spelaeanthus chinii* closer together, other than the vegetative features, is the orthocarpic twisted fruit; *Spelaeanthus* and *Emarhendia* have little more in common than the same chromosome number and the fact that the pollen grains of both are twice as large as those of *Senyumia;* finally, there are no critical characters in common between *Emarhendia* and *Senyumia.*

It is clearly impossible to unite all three species in a single genus, nor are there sound reasons for so uniting any two of them.

So far we have been chiefly concerned to investigate the interrelationships of these three species and the conclusion that they belong to three separate genera fairly represents the state of our knowledge. It opens up the possibility that their individual relationships to the rest of the tribe *Didymocarpeae* may differ.

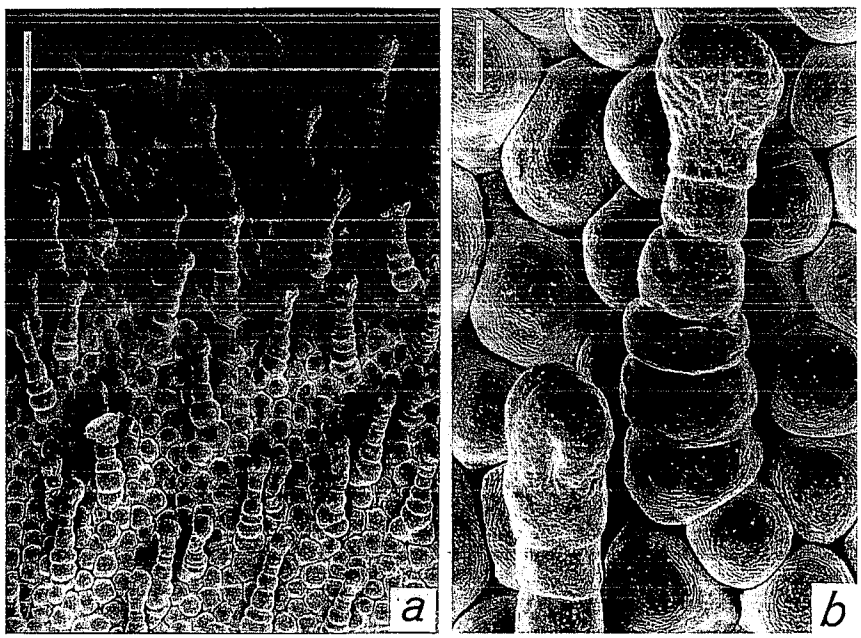


Fig. 6. *Senyumia minutiflora;* a upper corolla lobe with glandular hairs; b close up of glandular hair. Bar: 100 μm (a), 10 μm (b).

Relationships to other genera.

Boea and *Paraboea,* with which *Senyumia* and *Emarhendia* were respectively associated, have recently been redefined (BURTT 1984), and even more recently the essentially Malesian element that had hitherto been placed under *Didymocarpus* (that is the whole of the genus in that area except sect. *Didymocarpus* and sect. *Elati*) and the whole of *Loxocarpus* have been transferred to the revived genus *Henckelia* Spreng. (WEBER & BURTT 1998). In discussing the relationships of the genera newly recognized here we shall use these revised concepts.

Boea, as now defined, does not occur in Malaya; although it has a wide distribution from China to N. E. Australia it follows the northern track (Philippines, Sulawesi, New Guinea) and is absent from the Sundaland bloc (Malay Peninsula, Sumatra, Java & Borneo), its southernmost records on the Asiatic mainland being from central Thailand and Cambodia. *Boea hygrometrica* (Bunge) R. Br. from China and *B. hygroscopica* F. Muell. from Queensland, at the opposite end of the generic range, are both known to be poikilohydric ('resurrection plants'); that is to say, their leaves have considerable powers of recovery when rehydrated after desiccation. The species that are geographically nearest to these Malayan

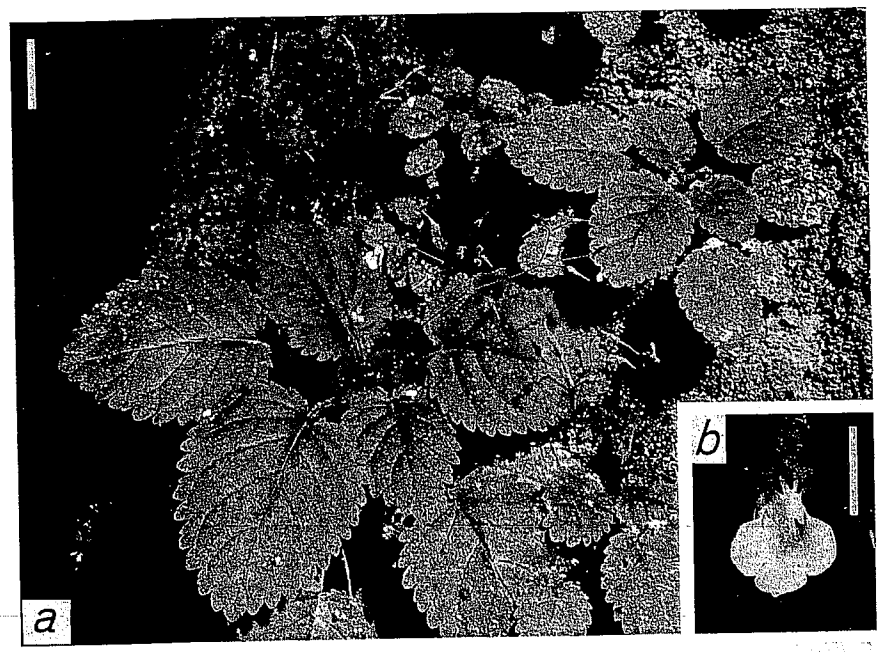
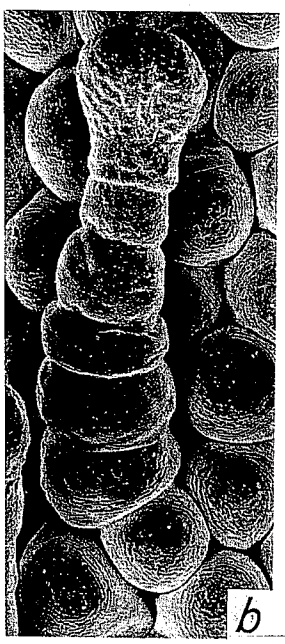


Fig. 7. *Spelaeanthus chinii:* a habit, b flower. Bar: 2 cm (a), 5 mm (b).



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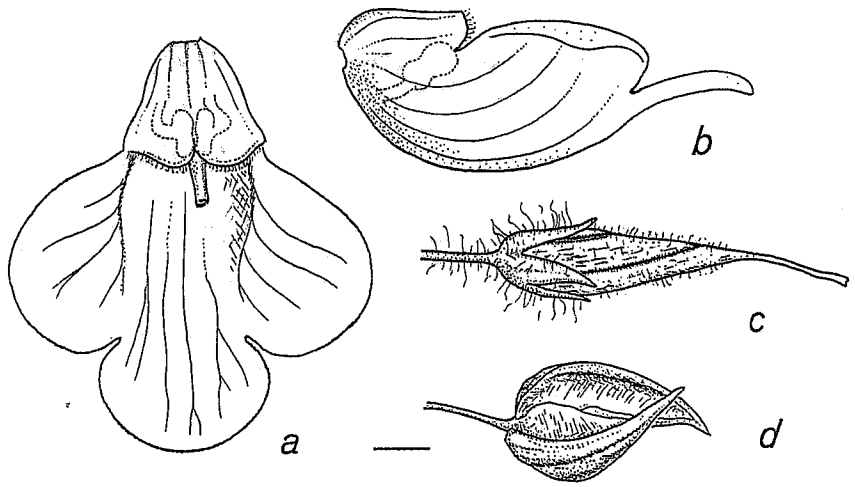


Fig. 8. *Spelaeanthus chinii;* flower from above (a), and side view (b), unripe fruit (c), old, empty fruit (d). Bar: 1 mm.

limestone plants, those in central Thailand, Cambodia and Sulawesi, also have tight rosettes of thick almost entire leaves and very probably show the same ability. A better known plant with the same power of revival is the European *Ramonda myconi.* They are thus very different from *Senyumia* and *Spelaeanthus* which have the loosely arranged, membranous, toothed leaves suited to their humid, shaded habitats.

Where known, the chromosome number in *Boea* is $n = 8$ or 16, *Senyumia,* the old *Boea minutiflora,* has $n = 9$. It is true that *Boea herbacea* has $n = 18$, but (as already pointed out – BURTT 1984: 409, 420) this species was only left in *Boea* pending further investigation and it is likely that it will shortly be removed from the genus. *Spelaeanthus* has $n = 9$ and a slightly twisted fruit, but the straggly habit, tiny flowers and fruit, and the differences in leaves mentioned above, as well as its isolated location, collectively justify its exclusion from *Boea.*

Boea herbacea, together with a related species yet to be described, will form a genus sharing certain features with *Spelaeanthus.* However its habit is quite different; it throws up annual flowering stems whose basal leaves are reduced to truncate pale green cataphylls; these stems die down after flowering. Far from having the long slender hairs that are a feature of *Spelaeanthus,* and of *Senyumia,* it has a characteristic indumentum of short erect gland-tipped hairs. *Boea herbacea,* which has a wide range from Moulmein, near Martaban in Burma, across central

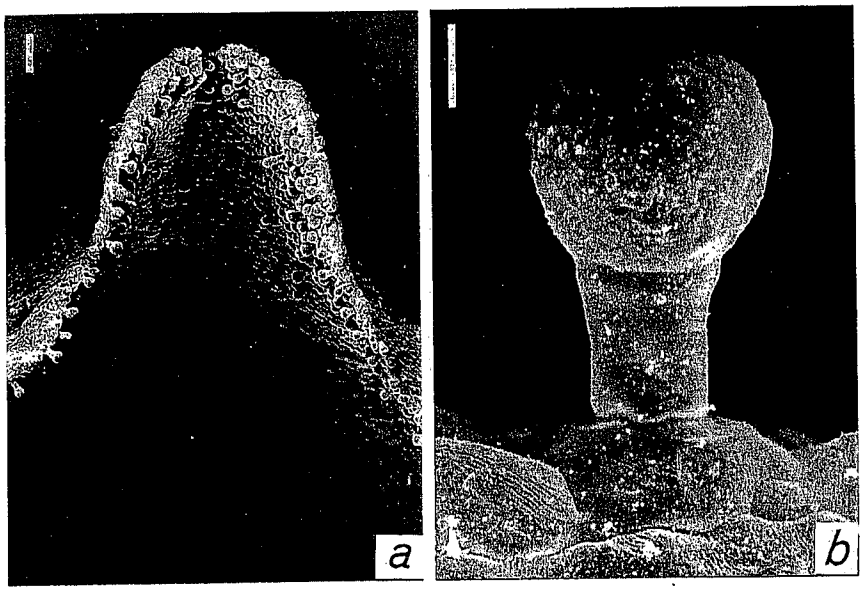


Fig. 9. *Spelaeanthus chinii;* a upper lip of corolla, note glands near margin; b gland enlarged. Bar: 100 μm (a), 10 μm (b).

Thailand to Bassac on the Mekong in Laos, has so far only been recorded from granite or sandstone habitats.

For *Senyumia* and *Spelaeanthus* we have been looking for affinities with *Boea* and related plants, largely because these genera have a tendency towards fruits with twisted valves or at least fruits dehiscing along both sutures. *Emarhendia* has a fruit held horizontally (is plagiocarpic) and opens only along the upper suture. Fruits of this type are characteristically found in *Henckelia* (where most Malayan *Didymocarpus* and all *Loxocarpus* are now placed), but they are also found sometimes in *Paraboea,* and the possibility that *Paraboea* and *Emarhendia* are truly allied cannot be dismissed, but it has to be remembered that the plagiocarpic fruit (opening along the upper suture) is developed in *Paraboea* only in association with a subcapitate inflorescence (e.g. in *P. capitata* Ridl. or *P. burttii* Xu); most species, whether the fruit valves be straight or twisted, are orthocarpous, with fruits opening along both sutures. Then, of course, *Paraboea* is nearly always distinguished by thick leaves having wool on the underside with some of the hairs branched T-wise near the base, or, when there is only a thin indumentum, the hairs are dendroid. *Emarhendia* with its thin leaves and simple hairs does not conform to this pattern.

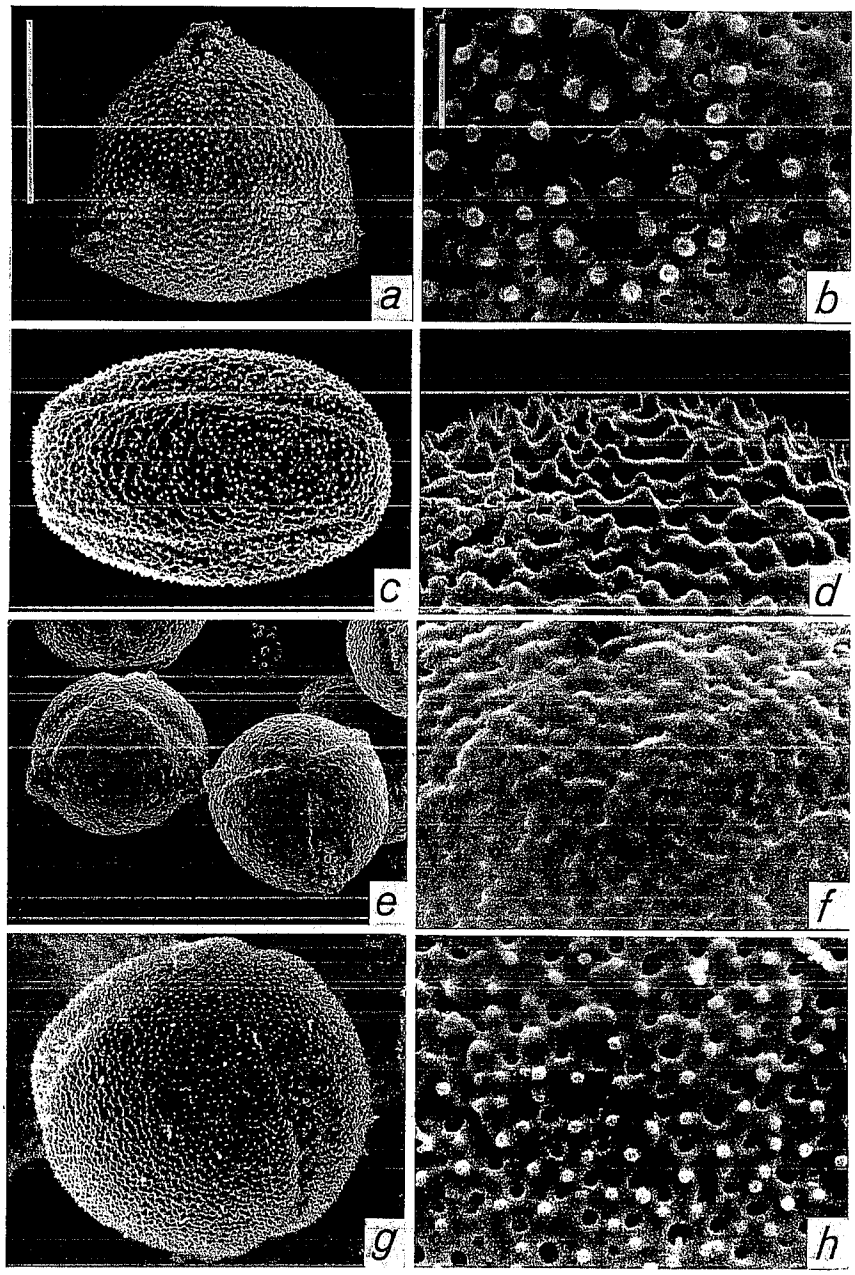
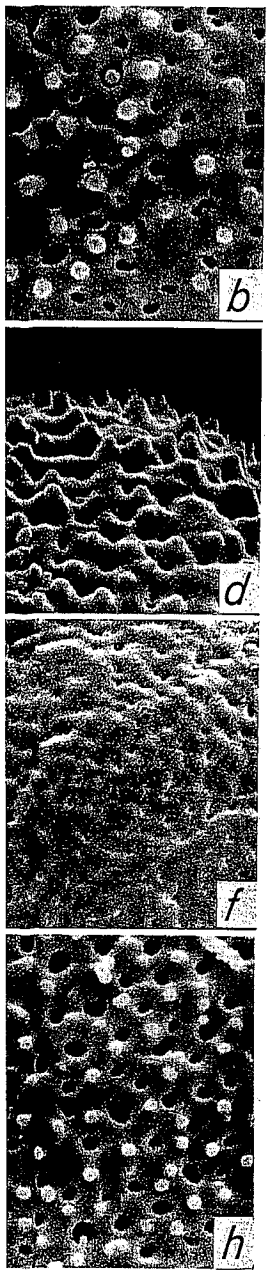


Fig. 10. Pollen and exine structure; a - d *Emarhendia bettiana,* (a) hydrated pollen grain in apical view, (b) dry grain in equatorial view, (c, d) exine from above and from side; e - f *Senyumia minutiflora,* (e) hydrated grains, (f) exine; g - h *Spelaeanthus chinii,* (g) hydrated grain, (h) exine. Bar: 10 μm (a, c, e, g), 1 μm (b, d, f, h).



tiana, (a) hydrated pollen d) exine from above and ins, (f) exine; g - h *Spe-* (a, c, e, g), 1 µm (b, d, f, h).

Key to the genera discussed

1	Corolla with heavily bearded palate and a circlet of hairs round the mouth; calyx divided to base, at least 5 mm long, often spreading or reflexed. Fruit usually with twisted valves	*Ornithoboea*
1*	Corolla not as above	2
2	Corolla with two upper lobes bearing a dense central pad of stalked glands; fruit held horizontally at sharp angle to pedicel, dehiscing only along the upper suture	*Emarhendia*
2*	Upper lobes of corolla lacking a central pad of stalked glands though scattered gland-tipped hairs may be present; fruit held in line of continuation of pedicel.	3
3	Fruit slender, at least 10 mm long	4
3*	Fruit much shorter, not exceeding 8 mm long, excluding the sometimes persistent style	5
4	Indumentum of simple hairs only; fruit always with twisted valves	*Boea*
4*	Indumentum on underside of leaf woolly, the hairs densely interwoven, at least some branched T-wise near the base – if indumentum not woolly then hairs branched in dendroid or stellate fashion; fruit-valves straight or twisted	*Paraboea*
5	Fruit enclosed in calyx; corolla lilac or violet. Compact rosette plant	*Orchadocarpa*
5*	Fruit exserted from calyx; corolla white	6
6	Corolla lobes forming a flat limb hiding the very short tube; flower resupinate; anthers exserted, fruit valves distinctly twisted	*Senyumia*
6*	Corolla with broad tube, lobes directed forwards or somewhat spreading, but all five never forming a flat limb; anthers included, pale; fruit valves straight or slightly twisted	7
7	Straggly herb with persistent vegetative terminal bud; flowers in independent axillary cymes; indumentum always with a component of long slender glandular hairs (shorter gland-tipped hairs also present); anthers glabrous	*Spelaeanthus*
7*	Flowering stems erect, annual; basal leaves reduced to broad cataphylls; indumentum entirely of short gland-tipped hairs; anthers hairy on back; in well-grown specimens, leaves and axillary cymes decrease in size upwards and form a terminal thyrse	*"Boea herbacea"*

Taxonomy

Emarhendia R. Kiew, A. Weber & B. L. Burtt, **gen.nov.**

Generic diagnosis: Herba, caule pilis longis viscidis induto. Folia ad apicem caulis opposita, rosulata, petiolata, uti caulis viscido-pilosa. Inflorescentiae axillares, pedunculatae, bifloro-cymosae. Calyx c. 1 mm longus, ad basin divisus. Corolla 3 - 3,5 cm longa, violacea, bilabiata; lobi superiores erecti vel reflexi, area centrali glandulis pedicellatis densissime obsita, labium inferius porrectum, trilobum. Stamina fertilia duo; filamenta crassa, prope basin corollae orientia ad apicem sursum recurva; antherae coram cohaerentes, thecis divaricatis demum confluentibus. Discus nullus. Ovarium ovoideum vel oblongum, c. 1,5 cm longum, pubescens; stylus ovario aequilongus; stigma discoideum et peltatum. Capsula ad 20 mm longa, horizontaliter disposita, sutura dorsali tantum dehiscens. Semina reticulata.

Type species: *Emarhendia bettiana* (M. R. Hend.) R. Kiew, A. Weber & B. L. Burtt

Etymology: The name of the genus commemorates M. R. HENDERSON, pioneer in the study of the limestone flora in Peninsular Malaysia, who between 1923 and 1935 collected from most limestone hills amassing over 700 specimens. He published the first account of this flora (HENDERSON 1939).

***Emarhendia bettiana* (M. R. Hend.) R. Kiew, A. Weber & B. L. Burtt, comb. nov.,** Fig. 1 - 3

≡ *Paraboea bettiana* M. R. Hend., Gard. Bull. Straits Settl. 7: 116 (1938); Hend., J. Malayan Branch Roy. Asiat. Soc. 17: 61 (1939); Chin, Gard. Bull. Sing. 32: 152 (1979).

≡ *Boea* (*Paraboea bettiana* M. R. Hend.); B. L. Burtt, Notes Roy. Bot. Gard. Edinburgh 41: 420 (1984).

Type: Peninsular Malaysia, Pahang, Bukit Cheras c. 25 miles WNW of Kuantan, 150 m, at mouth of limestone caves; 11. X. 1931, HENDERSON SFN 25250 (holo SING, iso K).

Description: Perennial herb; stem up to 45 cm long, 0,5 cm thick, sometimes branched at base, somewhat fleshy-succulent and very fragile, densely and softly tomentose from 1 - 3 mm long (*in vivo* whitish and sticky) hairs, growing ± appressed to the rock surface, clinging by fine, fibrous roots; lower part of stem bare of leaves, but sometimes bearing side rosettes; upper part curving upwards, leaves crowded towards the top. Leaves membranous, very thin and delicate, opposite, but spreading radially and forming tufts or rosettes. Petiole 4 - 7 (- 15) cm long, den-

sely clad with silky hairs 2 mm long; lamina broadly ovate to ovate, tip acute, base shallowly (and often obliquely) cordate, average size c. 8 × 5 cm up to 18,5 × 10 cm; margin deeply and coarsely serrate, in larger leaves doubly serrate; veins 6 - 7 pairs; petiole and lamina *(in vivo)* sticky from long, uniseriate, whitish, gland-tipped hairs. Inflorescences 18 - 22 cm long, axillary; peduncles slender, ± upright, 7 - 13 cm long, softly (sticky) hairy becoming glabrous. Flowers 6 - 20 arranged in a pair-flowered cyme (double-cincinnus). Pedicel 6 - 7 mm long. Sepals 5, c. 2 mm long, free to base, oblong-triangular, pale green to whitish, densely covered with sticky glandular hairs. Corolla, 3 - 6 mm long and 3 - 6 mm wide, tubular-campanulate 2 - 2,5 mm long, limb bilabiate; upper lip with rounded, recurved lobes 2 - 5 × 2 mm, each lobe with a patch of short, densely packed glands on the lower half; gland patch white, upper half of lobe lilac fading with age; lower lip with 3 smaller rounded lobes, projecting forwards, pale blue-lilac. Stamens 2, enclosed in corolla tube, filaments short, curving upwards, anthers white, 1,5 mm long, cohering, protandrous; staminodes 2, clavate, 1 mm long. Disc lacking. Ovary narrowly conical, c. 1 - 2 mm long, pubescent, narrowed into the style; style (in the female stage) 2 - 3 mm long, slightly protruding from the upper lip; stigma discoid and peltate. Capsule straight, c. 8 - 18 mm long, making an angle with the pedicel and held horizontally, ± pubescent, thick-walled and splitting only on the upper side, style persistent. Seeds numerous, small (c. 180 by 100 µm), blackish, testa reticulate from the contiguous walls of the surface cells.

Leaf anatomy: Lamina 120 µm thick. Epidermal cells oblong in T. S., sinuous in outline. Spongy mesophyll of a single layer of cells. Midrib with two vascular strands. Most common trichome type is the stalked glandular trichome with a stalk of 3 - 7 cells and (150 -) 600 (- 1900) µm long with some long eglandular trichomes of 6 - 8 cells, 1400 - 2010 µ long. Short glandular hairs 25 - 40 µm long consisting of a unicellular stalk and a multicellular broad head, infrequent. Clusters of small and some large prismatic crystals present in parenchyma of midrib.

Distribution: Known only from the type locality, Bukit Cheras, and the nearby Bukit Panching, Pahang. A related plant on Bukit Sagu will be considered separately (by A. W.)

Specimens: Pahang, Bukit Cheras, WEBER 840811 - 1/2 (KEP, WU). – Ibid. 26. XI. 1984, R. KIEW RK 1558 (KEP). – Ibid., WEBER & ANTHONYSAMY 860825 - 1/1 (WU). – S. ANTHONY SAS 73 (KEP). – Ibid., WEBER 870607 - 2/2 (WU). – Bukit Panching (near Bukit Cheras), 26. IX. 1984, R. KIEW RK 1569 (KEP).

***Senyumia* R. Kiew, A. Weber & B. L. Burtt, gen. nov.**

Generic diagnosis: Herba caule breviter effuso dense lanato-piloso pilis longis mollibus (vix viscidis) induto. Folia ad apicem caulis aggregata, opposita, petiolata. Inflorescentiae axillares, bifloro-cymosae. Flores resupinati. Calyx c. 2 mm longus, ad basin divisus. Corolla alba, tubo perbrevi, limbo bilabiato, lobis patentibus ad apices recurvis. Stamina fertilia duo; antherae ellipsoideae, flavae, exsertae. Ovarium ovoideum, stylo aequilongo, stigmate punctiformi. Capsula ad 5 mm longa, glabra, utrinque dehiscens, valvis spiraliter tortis.

Type species: *Senyumia minutiflora* (Ridl.) R. Kiew, A. Weber & B. L. Burtt

Etymology: The generic name refers to the locality of the only species, Gunung Senyum.

***Senyumia minutiflora* (Ridl.) R. Kiew, A. Weber & B. L. Burtt, comb. nov.**, Fig. 4 - 6

≡ *Boea minutiflora* Ridl., J. Fed. Malay States Mus. 10: 148 (1920); Ridl., Fl. Malay Penins. 2: 537 (1923); M. R. Hend., J. Malay Branch Roy. Asiat. Soc. 17: 60 (1939); Chin, Gard. Bull. Sing. 32: 149 (1979); B. L. Burtt, Notes Roy. Bot. Gard. Edinburgh 41: 420 (1984); Kiew, R., State of nature conservation in Malaysia, chap. 6, Fig. 2 (1991).

Type: Pahang, Gunung Senyum; VI. 1917, Evans s.n. (holo K, iso SING).

Description: Perennial herb. Stem decumbent, 5 - 12 cm long, rather stout and somewhat woody, c. 0.7 mm thick, densely woolly-hairy from long soft white (not or scarcely sticky) hairs. Leaves opposite, arranged in a dense tuft or many-leaved rosette at the top of the stem, thin membranous; petiole 1,5 - 6 cm long, usually less than half length of lamina, densely woolly-hairy from white hairs to 4 mm long; lamina broadly lanceolate to ovate-lanceolate, 12 - 15 by 4 - 7 cm, apex bluntly acuminate, base usually cuneate or attenuate, rarely slightly cordate, ± unequal; long hairy on both sides; margin deeply and coarsely serrate, teeth blunt; veins 6 - 8 pairs. Inflorescences 9 - 16,5 cm long axillary; peduncle 6,5 - 10 cm long, hairy at base, becoming glabrous upwards, brown in life, slender. Flowers arranged in a pair-flowered dichasial cyme, cyme branches spreading, often accessory cyme branches present. Flowers resupinate. Pedicel very thin, to 10 mm long. Sepals 5, linear-lanceolate, 1 - 2 mm long, brownish. Corolla completely white, tube very short, limb bilabiate, lobes strongly reflexed, nearly 2 mm long; upper lip loosely studded with glandular hairs (several-celled stalk, 1 - 2-celled head). Stamens 2, filaments 1,5 mm long, anthers large 1,5 mm long,

ellipsoid, yellow and projecting beyond the corolla tube, cohering. Ovary narrowly ovoid 2 mm long, style 3 mm long projecting beyond the anthers, stigma punctiform. Capsule 4 - 5 mm long, spirally twisted, glabrous, opening along the dorsal and ventral suture, style 4 mm long persistent. Seeds numerous, 350 by 210 µm, testa reticulate.

Leaf anatomy: Lamina 100 µm thick. Epidermal cells quadrangular in T. S., jagged in outline. Spongy mesophyll of 1 or 2 layers of cells. Midrib with a single vascular strand. Crystals absent. Trichomes: the most common type is the short eglandular trichome of 2 - 3 cells and (180 -) 230 (- 300) µm long. Longer simple eglandular trichomes of 7 - 11 cells and 830 - 940 µm long with a multicellular raised base are occasional on lamina but more frequent on veins and midrib. Simple glandular trichomes with a stalk of 3 cells, (150 -) 200 (- 270) µm long are mostly on margins. Short glandular cells are absent.

Distribution: known only from the type locality and nearby G. Jebak Puyuh, Pahang.

Specimens: Type. – Pahang, base of G. Senyum, low alt.; 30. VII. 929, HENDERSON SFN. 22392 (K). – Ibid., 28. XI. 1984, KIEW RK 1585 (E, KEP). – Ibid., WEBER & ANTHONYSAMY 860623 - 1/4 (WU). – Pahang, G. Jebak Puyuh (near G. Senyum), 10. II. 1986, KIEW RK 2148 (KEP).

***Spelaeanthus* R. Kiew, A. Weber & B. L. Burtt, gen. nov.**

Generic description: Herba monopodialis, caule breviter effuso. Folia opposita, subaequalia. Inflorescentiae axillares, pedunculatae, bifloro-cymosae. Calyx parvus (c. 2 mm longus) ad basin divisus. Corolla alba c. 6 mm longa, tubo lato, labio inferiore quam superiore distincte longiore. Stamina fertilia 2; filamenta basin versus corollae orientia; antherae thecis divaricatis, demum apice confluentibus. Ovarium breviter conicum stylo ± aequilongo; stigma punctiforme. Capsula ad 6 mm longa, plus minusve conica, orthocarpica utrinque dehiscens, valvis aut rectis aut leviter tortis. Semina c. 300 × 130 µm.

Type species: *Spelaeanthus chinii* R. Kiew, A. Weber & B. L. Burtt.

Etymology: spelaion, gk. = cave; anthos, gk. = flower.

***Spelaeanthus chinii* R. Kiew, A. Weber & B. L. Burtt, sp. nov.**, Fig. 7 - 9

= *Boea* sp. nov. R. Kiew, Malayan Naturalist 38 (3): 32 & Fig. 3 (1985).

Diagnosis: Caulis breviter effusus, pilis viscidis praeditus. Folia inferiora internodiis 1 - 1,5 cm sejunctis, superiora aggregatis; petioli laminam aequantes vel excedentes. Inflorescentiae axillares, pedunculatae, bifloro-cymosae; pedicelli 8 - 13 mm longi. Calyx parvus (c. 2 mm

longus) pilis longis glandulosis indutus. Corolla ad 6 mm longa. Capsula conica, utrinque dehiscens.

Type: CHIN 1306 (holo E, iso KLU).

Etymology: The species is named for Dr. CHIN SEE CHUNG, who, following HENDERSON's footsteps, produced the revised version of the limestone flora (CHIN 1977, 1979, 1983a, 1983b) and who was the first to collect specimens of this new genus/species.

Description: Stem 3 - 10 cm long with soft sticky hairs, purplish in life, rhizomatous at base. Leaves spaced 1 - 1,5 cm apart on lower part of stem, crowded at top, up to 8 × 6,5 cm, grey-green in life, apex acute-rounded, base cordate sometimes rounded or unequal, margin coarsely serrate, apex of teeth rounded; veins 5 - 6 pairs. Petiole the same length or longer than lamina, to 9 cm long, purplish with sticky hairs 4 mm long. Inflorescence 4 - 13 cm long, peduncles slender 3 - 8 cm long, light brown in life and softly hairy, pedicels erect 8 - 13 mm long. Calyx densely covered with long glandular hairs 2 mm long. Corolla completely white, 6 mm long, tube shaped like a shallow bowl (actually more like a coal scuttle), sparsely hairy outside, 3 lower lobes 1 × 3 mm projecting beyond the upper to form a wide open mouth 4 × 3 mm, upper 2 lobes more or less joined, less than 1 mm long, covered by microscopic glandular hairs. Anthers 1,5 mm long, bilobed, white and enclosed within mouth of corolla tube. Ovary oblong to conic, finely pubescent, 2 mm long narrowed into style 2 mm long; stigma punctiform. Capsule straight, finely pubescent, 4 - 5 mm long with persistent style 2 mm long, thin-walled, splitting at first on upper side eventually splitting (but not twisting) on lower side, as well. Seed 300 by 130 µm, testa reticulate.

Leaf anatomy: Lamina 88 - 104 µm thick. Epidermal cells quadrangular in T. S., sinuous in outline. Spongy mesophyll of a single layer of cells. Midrib with two vascular strands. Crystals absent. Trichomes: the most common type is the glandular trichome with a stalk of 3 cells, (156 -) 285 (- 455) µm long. Long eglandular trichomes of 9 - 21 cells, 520 - 2112 µm long, with multicellular base are less common. Short eglandular and short glandular trichomes are absent. Trichomes on upper corolla lobes are 26 µm long with a unicellular stalk.

Specimens: Pahang, Jerantut distr., Taman Negara, Batu Luas (near Kuala Kenyam), 2 - 300 m, 2. VIII. 1971, CHIN 1306 (E, KLU; type). – Ibid., 21. X. 1982, KIEW RK 1229 (KEP). – Ibid., 21. X. 1982, KIEW RK 1230 (KEP). – Ibid., 2. X. 1984, KIEW RK 1388 (KEP, L, SING).

Visual records (KIEW & YONG 1985): Batu Kepayang, B. Kumbang and B. Subuh. All these are limestone hills in the vicinity of Batu Luas (Gua Luas), Taman Negara National Park.

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