Kiehn et al. 1998
+Hellmayr + Weber

# Chromosome numbers of Malayan and other paleotropical Gesneriaceae. I. Tribe Didymocarpeae.

Beitr. Biol. Pflanzen 70: 407-444.

REFNO: 2954

KEYWORDS:

Australia, Boea, Boeica, Borneo, China, Chirita, Chromosome Numbers, Cytology, Didissandra, Didymocarpus, Emarhendia, Henckelia, Hovanella, Indonesia, Madagascar, Malaysia, New Guinea, Ornithoboea, Paraboea, Ridleyandra, Senyumia, Spelaeanthus, Sumatra, Thailand, Trisepalum

*Sonderdruck aus:*

# Beiträge

zur

# Biologie der Pflanzen

Herausgegeben von

**Prof. Dr. Helmut Schraudolf**
**Prof. Dr. Stefan Vogel**
**Prof. Dr. Focko Weberling**

**70. Band · Zweites / Drittes Heft**

**Themenheft:**

**Taxonomic studies in South East Asian Gesneriaceae**
**Taxonomische Studien an südostasiatischen Gesneriaceen**

**DUNCKER & HUMBLOT / BERLIN 1997/98**

# Inhalt




Ausgegeben am 26. November 1998

Indexed in Current Advances in Biological Sciences

Beitr. Biol. Pflanzen 70, (1997), 407 - 444

# Chromosome numbers of Malayan and other paleotropical Gesneriaceae. I. Tribe Didymocarpeae

By M. KIEHN, E. HELLMAYR & A. WEBER

Institute of Botany, University of Vienna, Austria

(With 3 figures)

Keywords: Gesneriaceae, *Boea, Boeica, Chirita, Codonoboea, Didissandra, Didymocarpus, Emarhendia, Henckelia, Hovanella, Loxocarpus, Ornithoboea, Paraboea, Ridleyandra, Senyumia, Spelaeanthus, Trisepalum.* – Cytology, karyology, chromosome number, taxonomy. – Australia, Borneo, China, Indonesia, Madagascar, Malaya, Malaysia, Malesia, New Guinea, Sumatra, Thailand.

## Abstract

Chromosome numbers (including first counts for 63 species and 8 genera) and supplementary karyological data are reported for Malayan and some other paleotropical representatives of the tribe Didymocarpeae *[Boea, Boeica, Chirita, Didissandra, Didymocarpus, Emarhendia, Henckelia* (including 'Malesian *Didymocarpus', Codonoboea* and *Loxocarpus), Hovanella, Ornithoboea, Paraboea, Ridleyandra, Senyumia, Spelaeanthus* and *Trisepalum]* are reported. The taxonomic significance of these data is discussed, with particular reference to genera that have been redefined or newly established.

## Zusammenfassung

Für malaiische und einige weitere palaeotropische Vertreter der Tribus Didymocarpeae werden Chromosomenzahlen (darunter Erstzählungen für 63 Arten und 8 Gattungen) und ergänzende karyologische Daten mitgeteilt. Ihre taxonomische Relevanz wird diskutiert, insbesondere im Hinblick auf die erfolgte Emendierung oder Neubeschreibung von Gattungen.

## Introduction

During research trips to Peninsular Malaysia and Borneo by the third author (1979, 1984, 1986 and 1987), chromosome fixations of the plants collected were made. Results of the karyological studies relating to various families of di- and monocots have already been published (HELLMAYR & al. 1995). The data for the family Gesneriaceae are published here in two parts: the present paper refers to the large tribe Didymocarpeae, the following one (KIEHN & WEBER 1998) covers the tribes Cyrtandreae, Trichosporeae and Epithemateae (= Klugieae, BURTT 1997). Additionally, chromosome data are given for several taxa of the corresponding tribes cultivated at the Botanical Garden, University of Vienna (HBV) or collected by colleagues from the Institute of Botany, University of Vienna.

Karyological information on Gesneriaceae is already available to a fair extent (see review by SKOG 1984). As to genera, the hitherto established chromosome numbers are summarized in a table given by BURTT & WIEHLER (1995). The taxonomic significance is evident in many cases. For instance, chromosome numbers play a significant role in the recognition and circumscription of genera and tribes of neotropical Gesneriaceae (subfam. *Gesnerioideae;* see WIEHLER 1983). In paleotropical Gesneriaceae (subfam. *Cyrtandroideae*) the situation seems to be more diverse and complicated. There are several genera that include species with different base numbers. In part these can be related to subgeneric taxonomic categories (e.g., *Streptocarpus* subg. *Streptocarpus*, $2n = 32$, subg. *Streptocarpella* $2n = 30$; HILLIARD & BURTT 1971), but in other cases such a relationship is not obvious. Generally, there is still much to be learnt about the affinities between and within the paleotropical Gesneriaceae, and chromosome data are certainly important for the elucidation of relationships and the reconstruction of phylogenetic diversification (for general considerations see, e.g., RAVEN 1975, GREILHUBER & EHRENDORFER 1988).

## Material and methods

Chromosome fixations were made in the field using a fresh mixture of ethanol (c. 96 %) and glacial acetic acid (3:1). Fixations were carried in the field under cool conditions (thermos flask filled with ice). Collection data for the taxa investigated are included in Table 1. Voucher specimens are deposited in the herbarium of the University of Vienna (WU) or in the herbaria indicated in Table 1.

Additional fixations were made from plants cultivated at the Botanical Garden of the University of Vienna (HBV), grown from seeds collected in

the field. Sometimes a pretreatment with a solution of 0,002 m 8-hydroxychinolin (c. 6 hours at 8 - 10 °C) was employed.

Plant material used for fixation included young flower buds, ovary and anther tissues, apices of vegetative shoots, leaf bases and root tips. Chromosome staining was performed with Feulgen-reagent, Giemsa or a 2 % solution of acetocarmine (see KIEHN & al. 1991 for details of staining procedures).

In most cases Feulgen-staining yielded good results. In some cases the preparations were air-dried and either additionally stained with acetocarmine or stained with Giemsa. Permanent slides for most of the counts are deposited in the collection of the first author (MK).

Table 1

Chromosome counts

Explanation of abbreviations and signs: $n$ = haploid chromosome number, $2n$ = diploid chromosome number; ° first count for the species, °° first count for the genus, ¯ count deviating from earlier reports.
Investigated plant part/division stage: a = shoot apex, fi = base of filament, fl = flower-buds, EMC = embryo sac mother cells, ov = ovary, P = pollen mitosis, PMC = pollen mother cells, rt = root tip.
Pretreatment: 8HQ = 8-hydroxy-quinolin.
Staining technique: F = Feulgen, G = Giemsa, K = Acetocarmine.
HBV = Hortus Botanicus Vindobonensis, WU = Herbarium of the Institute of Botany, University of Vienna.

| Taxon<br>Locality[1], voucher specimen (herbarium) | $n$ | $2n$ | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| ***Boea*** | | | | |
| *B. hygrometrica* (Bunge) R. Br.<br>cult. HBV ex HB Peking (WU). | 9° | 18° | P, fl | F |
| *B. hygroscopica* F. Muell. vel aff.<br>HBV 13.4.88, ex HB Queensland (WU). | – | 32 - 34¯ | fi | F |
| *B. lawesii* H. O. Forbes<br>cult. HBV (from New Guinea) (WU). | – | 16 | fl | F |
| ***Boeica***°° | | | | |
| *B. brachyandra* Ridl.<br>Kedah; Pulau Langkawi, Telaga Tujoh;<br>STONE, SAW & WEBER 870426-1/10 (WU). | 12° | ± 22° | P | F + K |

[1] If not stated otherwise, the country is Malaysia.

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *Chirita* | | | | |
| *C. caliginosa* C. B. Clarke<br>Perak, Kinta distr.; Sg. Siput Selatan, near Chinese temple; limestone; WEBER & ANTHONYSAMY 870521-1/2 (WU). | – | 18 | ov | F |
| –<br>Perak, Kinta distr., Gunung Pipit (limestone outcrop N of Gopeng), quarry area; WEBER & ANTHONYSAMY 870521-2/1 (WU). | 9 | – | EMC | F |
| –<br>Pahang, Lipis distr., Gua Bama (13 km NW of Kuala Lipis); WEBER 870509-1/2 (WU). | – | 18 | fl | G |
| –<br>Selangor; Bukit Takun; limestone WEBER 870625-2/1 (WU). | – | 18 | ov | F |
| –<br>Selangor, Batu Caves, N Kuala Lumpur; WEBER 860914-2/1 (WU). | – | 18 | fl | G |
| *C.* cf. *hamosa* R. Br.<br>Thailand, Chiang Mai prov., about 6 km E of Chiang Dao; 11. XI. 1985, KURZWEIL HK 445 (WU). | – | 34 - 36 | rt, a | G |
| *C. involucrata* Craib<br>Pahang, Lipis district; Gua Rusa (limestone area c. 40 km S of Gua Musang, c. 10 km S of border Pahang/Kelantan); WEBER 870510-1/2 (WU). | – | 18 | a | F |
| –<br>Kelantan, Ulu Kelantan, limestone outcrop N of Ladang Sungai Teran (between Gua Musang and Bertam) WEBER 870511-1/3 (WU). | – | 18 | fl | G |
| *C. lacunosa* (Hook. f.) B. L. Burtt<br>Pahang, Lipis district; Gua Rusa (limestone area c. 40 km S of Gua Musang, c. 10 km S of border Pahang/Kelantan); WEBER 870510-1/8 (WU). | – | 18° | a | F; Fig. 1a |
| *C. sericea* Ridl.<br>Perak, Kinta distr.; Ipoh; limestone rocks and caves north of Ipoh; WEBER 860818-1/1 (WU). | – | 18 | ov | F; Fig. 1b |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen<br>(herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| ***Didissandra***°° | | | | |
| *D. frutescens* C. B. Clarke<br>Penang; Penang Hill, below top, Moniot's road; 700 - 800 m;<br>WEBER 840803-1/7 (WU, KEP). | – | 20° | a | F, K;<br>Fig. 1c |
| –<br>Penang, Penang Hill,<br>Fix. WEBER 14. VIII. 86 (no voucher) | – | 20° | fl | F |
| ***Didymocarpus*** | | | | |
| *D. antirrhinoides* A. Weber<br>Negeri Sembilan, Rembau distr.; Gunung Datuk (ascent from Kg. Batang Nymbok);<br>WEBER & ANTHONYSAMY 870526-2/3 (WU). | – | 20⁻ | a | F |
| –<br>Johore; G. Ledang, below dam, on path along pipeline;<br>WEBER 840717-1/1 (WU, KEP). | – | 22⁻ | fl | F |
| –<br>Negeri Sembilan, Rembau distr.; Ulu Pedas, watercatchment area;<br>WEBER & ANTHONYSAMY 860728-1/7, (WU)<br>(= S. ANTHONY SA 699, KEP). | – | 22⁻ | fl | F |
| –<br>Pahang; Old Genting road; B. Buah;<br>WEBER 870420-1/3 (WU). | – | 22⁻ | ov | F |
| –<br>Selangor; Fraser's Hill; road from gap to Kubu Bahru, km 3 - 4;<br>WEBER 840814-1/4 (WU, KEP). | 11⁻ | 22⁻ | PMC, fl | F;<br>Fig. 2a |
| *D. citrinus* Ridl.<br>Kedah, G. Jerai (Kedah Peak); near top; 1400 m;<br>WEBER 840801-1/4 (WU). | – | 22 | fl | F |
| *D. corchorifolius* [Wall. ex] A. DC.<br>Penang; Penang Hill (Bt. Bendera), E of Viaduct Station; 700 - 800 m;<br>WEBER 840803-1/4 (WU, KEP). | – | 22 | fl | F, K |

| tissue; pretreatment | staining; figure |
|---|---|
| ov | F |
| EMC | F |
| fl | G |
| ov | F |
| fl | G |
| rt, a | G |
| a | F |
| fl | G |
| a | F;<br>Fig. 1a |
| ov | F;<br>Fig. 1b |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *D. corchorifolius* [Wall. ex] A. DC. (cont.)<br>Penang; Penang Hill, upper part; on rock face at side of Moniot's road, near Viaduct Station;<br>WEBER 860814-1/7 (WU). | – | 22 | o | F, K |
| –<br>Kedah; Bukit Wang (Bkt. Perangin);<br>WEBER 860810-2/5 (WU). | – | 22 | fl | F |
| –<br>Kedah, Kuala Muda distr.; Gunung Jerai, southern foot, Sg. Bujang, c. 500 m;<br>WEBER 860813-1/2 (WU). | 11 | 22 | PMC, o | F; Fig. 2b |
| *D. cordatus* [Wall. ex] A. DC. var. *cordatus*<br>Penang, Penang Hill; below top, Moniot's road, east of viaduct station; 700 - 800 m;<br>WEBER 840803-1/8 (WU). | – | 28° | fl | F |
| –<br>Perak, Larut distr.; Maxwell's Hill; upper part of ascent road;<br>WEBER 840806-2/7 (WU, KEP). | – | 28° | fl | F |
| –<br>Perak, Larut distr.; Maxwell's Hill; on side of road leading to the radio station;<br>WEBER 860816-2/1 (WU). | 14° | – | PMC | F |
| *D. cordatus* var. *debilis* Ridl.<br>Kedah, Kuala Muda distr.; Gunung Jerai, Tanah Rimba, Sg. Teroi waterfall area;<br>WEBER 860811-2/1 (WU). | 14° | 28° | PMC, fl | F, K; Fig. 2c |
| –<br>Kedah, Kuala Muda distr.; Gunung Jerai, southern foot, Sg. Bujang (c. 500 m);<br>WEBER 860813-1/1 (WU). | – | 28° | fl | F |
| *D. cordatus* var. *ophirensis* Ridl.<br>Johore, G. Ledang; mountain base, near waterfall;<br>WEBER 840718-1/1 (WU). | – | 28° | fl | F |
| –<br>Johore, Muar distr.; Gunung Ledang (South foot);<br>WEBER 860913-2/4 (WU). | – | 26° | ov, fl | F + G |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen<br>(herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *D. sulphureus* Ridl.<br>Pahang, Cameron Highlands; Gunung Berembun, top area;<br>WEBER 860819-3/5 (WU). | – | 22 | ov | F |
| –<br>Pahang/Perak, Cameron Highlands; path from G. Brinchang to G. Irau (ridge along Pahang/Perak border);<br>WEBER 870623-2/9 (WU). | 11 | 22 | PMC, ov | F |
| ***Emarhendia***°° | | | | |
| *E. bettiana* (M. R. Hend.) Kiew & al.<br>Pahang, Kuantan distr.; Bkt. Charas;<br>WEBER & ANTHONYSAMY 860825-1/1 (WU). | – | 16° | ov, rt; 8HQ | F |
| *E. bettiana* (M. R. Hend.) Kiew & al.<br>Pahang, Kuantan distr.; Bukit Sagu;<br>WEBER 870608-1/1 (WU). | – | 16° | fl | F |
| ***Henckelia***°° | | | | |
| *H. alba* (Ridl.) A. Weber<br>Perak, Kinta/Batang Padang distr.; Gunung Bujang Melaka, below top;<br>WEBER & ANTHONYSAMY 870520-1/11 (WU). | – | 18° | ov | F |
| *H. albomarginata* (Hemsl.) A. Weber<br>Perak, Maxwell's Hill; base, waterfall area;<br>WEBER 840805-1/12 (WU). | – | 18° | rt, 8HQ | F, K |
| *H. alternans* (Ridl.) A. Weber<br>Perak, Kinta/Batang Padang distr.; Gunung Bujang Melaka, below top;<br>WEBER & ANTHONYSAMY 870520-1/9 (WU). | – | 18⁻ | fl | F, K; Fig. 3a |
| *H. anthonyi* (Kiew) A. Weber<br>Trengganu, Besut distr.; forest near Kg. Keruak (western foothills of Gunung Lawit);<br>WEBER & ANTHONYSAMY 860901-1/1 (WU). | – | 18° | fl | F |
| *H. atrosanguinea* (Ridl.) A. Weber<br>Trengganu, Besut distr.; Chalok F. R.;<br>WEBER & ANTHONYSAMY 860830-2/2 (WU). | – | 18° | fl | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. bombycina* s.l. (Ridl.) A. Weber[2]<br>Selangor, Klang Gates;<br>WEBER 840709-1/3 (WU). | 9 | 18° | EMC, ov | K |
| –<br>Selangor; Kanching F. R. (Templer Park);<br>WEBER 870625-1/3 (WU). | – | 18° | ov | F, K |
| –<br>Selangor/Pahang; Fraser's Hill; jungle walk Muar Cottage to Bishop's House;<br>WEBER 870504-4/1 (WU). | – | 18° | ov | F |
| –<br>Pahang, Bentong distr.; Air Terjun Chamang;<br>WEBER 870507-2/3 (WU). | – | 18° | o | F |
| –<br>Pahang, Lipis distr.; Hutan Lipur Terenggun (5 km NW of Kuala Lipis);<br>WEBER 870508-1/5 (WU). | 9 | 18° | PMC, o | F |
| –<br>Pahang, Cameron Highlands; Robinson Falls;<br>WEBER 860819-6/2 (WU). | – | 18° | o | F |
| –<br>Perak, Perak Hulu distr.; EW-Highway, c. 20 km NE of Gerik (Grik);<br>STONE, SAW & WEBER 870424-2/1 (WU). | – | 18° | o | F |
| *H. breviflora* (Ridl.) A. Weber<br>Selangor; Gombak F. R.,<br>WEBER 870421-1/1 (WU). | – | 18° | o | F; 3b |
| *H. aff. breviflora/craspedodroma* (Kiew) A. Weber<br>Pahang, Kuantan distr.; a few km S of Sg. Lembing;<br>WEBER & ANTHONYSAMY 860825-2/2 (WU). | – | 18° | fl | K |

[2] The plants referred here tentatively to *H. bombycina* are very variable. The leaves are usually softly hairy and flower colour varies from pure white to evenly bluish or white with blue corolla lobes. Plants of the latter coloration are considered to belong to *Didymocarpus quinquevulnera* (now *Henckelia quinquevulnera*) by KIEW (1989), which, however, typically has crimson or violet-purple corolla lobes and seems to occur only east of the Main Range.

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. aff. breviflora/craspedodroma* (Kiew) A. Weber (cont.)<br>Pahang, Pekan distr.; Maran, Hutan Lipur Teladas;<br>WEBER 870611-3/3 (WU). | – | 18° | o | F |
| *H. browniana* A. Weber s. str.<br>≡ *Loxocarpus incanus* R. Br.<br>Penang, Penang Hill, below top, near Moniot's road;<br>WEBER 840803-1/2 (WU). | – | 18° | fl | F |
| *H. browniana* A. Weber s.l.<br>Negeri Sembilan, Rembau distr., Ulu Pedas, water-catchment area;<br>WEBER & ANTHONYSAMY 860728-1/6 (WU). | 9 | 18° | EMC, ov | F |
| –<br>Trengganu, Brang distr., Sekayu waterfalls;<br>WEBER & ANTHONYSAMY 860829-1/10 (WU). | – | 18° | ov | F |
| *H. caerulea* (Ridl.) A. Weber<br>Perak, Larut distr., path from Maxwell's Hill (Bkt. Larut) to Gunung Hijau;<br>WEBER 860816-1/7 (WU). | 9° | 18° | EMC, ov | F |
| *H.* cf. *corneri* (Kiew) A. Weber<br>Trengganu, Kemaman distr.;<br>Ulu Bendong;<br>WEBER 870609-1/11 (WU). | 9° | 18° | EMC, ov | F |
| *H. crinita* (Jack) Spreng. (s.l.)<br>Perak, Larut distr.; upper part of road leading to Maxwell's Hill (Bkt. Larut);<br>WEBER 860816-3/1 (WU). | – | 18° | rt; 8HQ | F |
| –<br>Negeri Sembilan, Seremban distr.;<br>Gunung Angsi, N-flank, base (ascent from Hutan rekreasi, 13 miles W of Kuala Pilah);<br>WEBER & ANTHONYSAMY 860729-1/3 (WU). | – | 18° | ov | F |
| –<br>Negeri Sembilan, Kuala Pilah distr.;<br>Hutan Rekreasi; Jeram Toi (W of Kuala Pilah);<br>WEBER & ANTHONYSAMY 860730-1/1 (WU). | 9° | 18° | PMC, fl | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | $n$ | $2n$ | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. crinita* (Jack) Spreng. (s.l.) (cont.)<br>Kedah, Sik distr.; Hutan Simpan Rimba Teloi, Sg. Chepir;<br>WEBER 860812-1/5 (WU). | 9° | 18° | EMC, ov | F |
| –<br>Pahang, Cameron Highlands; G. Brinchang,<br>WEBER 860820-1/1 (WU). | – | 18° | fl | F |
| –<br>Pahang, Kuantan distr.; a few km S of Sg. Lembing;<br>WEBER & ANTHONYSAMY 860825-2/4 (WU). | – | 18 | rt; 8HQ | F |
| *H. curtisii* (Ridl.) A. Weber<br>Selangor/Pahang; Bukit Fraser, waterfall area (below top);<br>WEBER 840813-1/1 (WU, KEP). | – | (18) 20°[3] | fl | F |
| –<br>Selangor/Pahang; Bukit Fraser, forest slope near Raub Bungalow (above Petrol Station); montane forest;<br>WEBER 870505-6/1 (WU). | – | 18° | ov | K |
| –<br>Selangor/Pahang; Bukit Fraser, road to Jeriau waterfall;<br>WEBER 870503-5/4 (WU). | 9° | – | P | F |
| *H. densifolia* (Ridl.) A. Weber s.l.<br>Pahang; Pulau Tioman, Gunung Kajang;<br>WEBER 870605-1/5 (WU). | 8 - 9°[4] | 18 ± 1° | P, ov | F |
| *H. fasciata* (Ridl.) A. Weber<br>Pahang, Jerantut distr., Bukit Gendang;<br>WEBER 860910-3/1 (WU). | – | 18° | ov | F; Fig. 3d |
| *H. flavescens* (Ridl.) A. Weber<br>Selangor/Pahang; Bukit Fraser, small forested valley below Telekom Station;<br>WEBER 870505-4/2 (WU). | – | 18 | fl | F |
| *H. floribunda* (M. R. Hend.) A. Weber<br>Trengganu, Kemaman distr.; Ulu Bendong;<br>WEBER 870609-1/9 (WU). | – | 18° | fl | F; Fig. 3c |

[3] Possibly Robertsonian fission event.
[4] Irregular meiosis.

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | $n$ | $2n$ | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H.* aff. *floribunda* (M. R. Hend.) A. Weber<br>Pahang, Pekan distr.; Hutan Simpan Berkelah;<br>WEBER & ANTHONYSAMY 860824-2/1 (WU). | – | 18° | ov | F |
| *H. geitleri* (A. Weber) A. Weber<br>Pahang, Pekan distr.; Hutan Lipur Sungai Pandan;<br>WEBER & ANTHONYSAMY 860824-3/1 (WU). | – | 18 | fl | F |
| *H. glabrata* (Ridl.) A. Weber<br>Johore; G. Panti, upper part of ascent road from Kg. Batu Empat;<br>WEBER 840723-1/2 (WU, KEP). | – | 18° | fi | F |
| *H. hirta* (Ridl.) A. Weber<br>Selangor; G. Bunga Buah; ridge E of summit;<br>WEBER 840712-1/9 (WU, KEP). | – | 18° | fl | K |
| –<br>Selangor; side ridge of Gunung Bunga Buah;<br>WEBER 870420-2/9 (WU). | – | 18° | fl | F |
| –<br>Selangor/Pahang; Bukit Fraser, path below Bishop's House;<br>WEBER 870505-5/2 (WU). | – | 18° | fl | F |
| –<br>Selangor/Pahang; Bukit Fraser, forest slope near Raub Bungalow (above Petrol Station);<br>WEBER 870505-6/2 (WU). | – | 18° | ov | F |
| *H. hispida* (Ridl.) A. Weber<br>Perak, Larut distr.; path from Maxwell's Hill (Bkt. Larut) to Gunung Hijau;<br>WEBER 860816-1/8 (WU). | – | $4x$° | ov | F |
| –<br>Pahang, Cameron Highlands; lower part of Gunung Berembun (ascent from Tana Rata);<br>WEBER 860819-1/2 (WU). | – | 36 ± 1° | fl | F |
| –<br>Pahang, Cameron Highlands;<br>G. Brinchang, summit area;<br>WEBER 860820-2/1 (WU). | 18° | – | P | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | $n$ | $2n$ | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. hispida* (Ridl.) A. Weber (cont.)<br>Pahang, Cameron Highlands; path from Oly's Chalets to Gunung Jasar; montane forest;<br>WEBER 870622-1/1 (WU). | 18° | – | P | F |
| –<br>Perak, Kinta/Batang Padang distr.; Gunung Bujang Melaka, below top; montane forest;<br>WEBER & ANTHONYSAMY 870520-1/6 (WU). | – | 27° | ov, fl | F |
| –<br>Pahang, G. Ulu Kali, top;<br>WEBER 840815-2/3 (WU). | 18° | – | EMC | K |
| –<br>Pahang, Gunung Ulu Kali, summit area;<br>WEBER & ANTHONYSAMY 860801-1/2 (WU). | – | 34 - 36° | ov | F + G |
| *H. holttumii* (M. R. Hend.) A. Weber<br>Johore, Gunung Panti West, 500 m; near ridge top (ascent from Kg. Batu Empat);<br>WEBER 840723-2/1 (WU). | 9° | 18° | P, ov | F |
| *H. inaequalis* (Ridl.) A. Weber<br>Kedah; Pulau Langkawi, Gunung Machinchang;<br>WEBER 860808-1/2 (WU). | – | 18° | a, fl | F |
| *H. koerperi* (B. L. Burtt) A. Weber & B. L. Burtt<br>Sumatra, Indonesia,<br>ex HB München (WU). | 9° | 18° | PMC, ov | F |
| *H. leiophylla* (Kiew) A. Weber<br>Trengganu, Besut distr.; Ulu Setiu, eastern foothills of Gunung Lawit, near Kg. Seladang;<br>WEBER & ANTHONYSAMY 860831-1/2 (WU). | – | 18° | ov | F |
| *H. leucantha* (Kiew) A. Weber<br>Selangor, Gombak distr.; Ampang (near Kuala Lumpur);<br>WEBER 860727-1/6 (WU). | – | 18° | ov | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. longipes* (C. B. Clarke) A. Weber<br>Johore, G. Ledang, near and on top;<br>WEBER 840716-2/2 (WU, KEP). | – | 18; 20 | rt, 8HQ | F |
| *H. malayana* (Hook f.) A. Weber<br>Negeri Sembilan, Kuala Pilah distr.;<br>Gunung Telapak Burok, top area;<br>WEBER & ANTHONYSAMY 860730-3/6 (WU). | – | 18 | fl | F |
| –<br>Selangor, Fraser's Hill; road from gap to Kubu Bahru, betw. km 5 & 6;<br>WEBER 840815-1/1 (WU). | – | 18 | rt | F |
| –<br>Pahang; side ridge of Gunung Bunga Buah;<br>WEBER 870420-2/5 (WU). | – | 18 | fl | F |
| –<br>Perak, Kinta/Batang Padang distr.;<br>Gunung Bujang Melaka, below top;<br>WEBER & ANTHONYSAMY 870520-1/2 (WU). | – | 18 | rt | F |
| *H. marginata* (C. B. Clarke) A. Weber<br>Johore, Muar distr., G. Ledang, forest near water reservoir;<br>WEBER 840717-2/1 (WU, KEP). | 9 - 10° | (18) - 19° | PMC, P, ov | F |
| –<br>Johore, Muar distr.; near Asahan, NW foot of Gunung Ledang;<br>WEBER & ANTHONYSAMY 870527-4/6 (WU). | – | 18° | ov | F |
| *H. miniata* (Kiew) A. Weber<br>Trengganu, Dungun distr.; Bkt. Bauk (S of Dungun); Bkt. Bauk F. R.;<br>WEBER & ANTHONYSAMY 860827-2/2 (WU). | – | 18° | fl | F |
| *H. nana* A. Weber<br>(≡ *Didymocarpus pumilus* Ridl.)<br>Bukit Fraser, Jeriau waterfall;<br>WEBER 870503-6/3 (WU). | – | 18⁻ | ov | F |
| *H. nitida* (Kiew & A. Weber) A. Weber<br>Selangor, G. Bunga Buah, ridge E of summit; 1300 - 1400 m<br>WEBER & ANTHONYSAMY 840711-1/1 (WU). | – | 18° | fl | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. nivea* (Kiew) A. Weber<br>Pahang, Kuantan distr.; a few km S of Sg. Lembing;<br>WEBER & ANTHONYSAMY 860825-2/1 (WU). | – | 18° | fl | F |
| *H. parviflora* (Ridl.) A. Weber<br>Negeri Sembilan, Seremban distr.; Gunung Angsi, N-flank, ridge near summit (ascent from Hutan rekreasi, 13 miles W of Kuala Pilah);<br>WEBER & ANTHONYSAMY 860729-3/1 (WU). | 9° | 18° | EMC, ov | F |
| *H.? parviflora* (Ridl.) A. Weber<br>Pahang, Bentong distr.; Hutan Lipur Lentang (at Karak Highway near junction to Bentong);<br>WEBER & ANTHONYSAMY 860903-2/1 (WU). | – | 36° | fl, ov | F |
| *H.? parviflora* (Ridl.) A. Weber<br>Selangor, Templer Park, by the path near waterfall;<br>ANTHONYSAMY SA 501 (KEP). | – | 18 - 22°[5] | fl | F + K |
| *H. platypus* (C. B. Clarke) A. Weber<br>Johore, Kluang distr.;<br>Bukit Lambak (S of Kluang);<br>WEBER & ANTHONYSAMY 870529-1/5 (WU). | – | 18° | ov | F |
| –<br>Pahang, Pekan distr.; Hutan Simpan Lepar;<br>WEBER & ANTHONYSAMY 860824-1/1 (WU). | 9° | 18° | EMC, ov | F |
| –<br>Pahang, Pekan distr.; Maran, Hutan Lipur Teladas;<br>WEBER 870611-3/1 (WU). | 9° | 18° | EMC, ov | F |
| –<br>Trengganu, Kemaman distr.; mountains NW of Kg. Ayer Puteh;<br>WEBER & ANTHONYSAMY 860826-3/1 (WU). | – | 18° | ov | F |
| *H.* aff. *platypus* (C. B. Clarke) A. Weber<br>Trengganu, Ulu Trengganu distr.; Sekayu waterfalls (S of Kuala Brang);<br>WEBER & ANTHONYSAMY 860829-1/3 (WU). | – | 18° | ov | F |

[5] Irregularities in pollen meiosis and mitosis: pollen grains of different size and with different chromosome numbers.

Table 1 (continued)

| Taxon<br>Locality, voucher specimen<br>(herbarium) | $n$ | $2n$ | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. primulina* (Ridl.) A. Weber<br>Selangor, Klang Gates;<br>WEBER 840709-1/5 (WU). | – | 18° | a | F |
| *H. puncticulata* (Ridl.) A. Weber<br>Johore, G. Panti; near ridge top (ascent from Kg. Batu Empat); 450 m;<br>WEBER 840722-1/1 (WU). | 9° | 18° | PMC, fl | F |
| –<br>Johore, Kota Tinggi distr.;<br>Kota Tinggi waterfall;<br>WEBER & ANTHONYSAMY 870530-1/1 (WU). | – | 18° | ov | F |
| *H. puncticulata* (Ridl.) A. Weber s.l.<br>Trengganu, Kemaman distr.; some km N of Chukai (at km 68 to Kuantan);<br>WEBER & ANTHONYSAMY 860827-1/1 (WU). | – | 18° | ov | K |
| –<br>Trengganu, Dungun distr.;<br>Bkt. Bauk (S of Dungun);<br>WEBER 870514-4/7 (WU). | | 18° | ov | K |
| –<br>Trengganu, Dungun distr.;<br>Bkt. Bauk (S of Dungun); Bkt. Bauk F. R.;<br>WEBER & ANTHONYSAMY 860827-2/1 (WU). | – | 18° | rt | F |
| *H. pyroliflora* (Ridl.) A. Weber<br>Pahang, Pekan distr.; Hutan Lipur Teladas, Maran;<br>WEBER 860823-2/4 (WU). | 9° | – | EMC | F |
| –<br>ibid.<br>WEBER 870611-3/2 (WU). | – | 18° | ov | K |
| *H.* aff. *pyroliflora* (Ridl.) A. Weber<br>Johore, Kota Tinggi distr.; Kota Tinggi waterfall;<br>WEBER & ANTHONYSAMY 870530-1/2 (WU). | | 18° | ov | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen<br>(herbarium) | $n$ | $2n$ | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. quinquevulnera* (Ridl.) A. Weber s.l.[6]<br>Trengganu, Ulu Trengganu distr.;<br>Sekayu waterfalls area,<br>near an old logging track;<br>WEBER 840810-1/1 (WU, KEP). | 9° | 18° | EMC, ov | F |
| *H. reptans* (Jack) Spreng. s.l.<br>Kedah, Kulim distr.; Karangan F. R.;<br>WEBER 860815-1/1 (WU). | – | 18° | ov | F |
| –<br>Selangor; Klang Gates,<br>at water reservoir;<br>WEBER 840709-2/2 (WU). | 9° | – | PMC | K |
| –<br>Selangor, Gombak distr.;<br>Ampang (near Kuala Lumpur);<br>WEBER 860727-1/5 (WU). | – | 18° | ov | F |
| –<br>Negeri Sembilan, Seremban distr.;<br>Gunung Angsi, N-flank, base (ascent<br>from Hutan rekreasi, 13 miles W of Kuala<br>Pilah);<br>WEBER & ANTHONYSAMY 860729-1/4<br>(WU, KEP). | – | 18° | ov | F |
| *H. reptans* var. *monticola* (Ridl.)<br>A. Weber.<br>Perak, Maxwell's Hill;<br>lower part of ascent road;<br>WEBER 840806-1/3 (WU, KEP). | 9 | 18° | PMC, ov | F |
| –<br>Selangor/Pahang border; Gombak ridge;<br>WEBER 870612-1/5 (WU 2). | – | 18° | ov | F |
| *H. rugosa* (Ridl.) A. Weber<br>Trengganu, Kemaman distr.; some km N<br>of Chukai (at km 68 to Kuantan);<br>WEBER & ANTHONYSAMY 860827-1/3 (WU,<br>KEP under ANTHONYSAMY SA 590). | – | 18° | ov | F |

[6] The plants differ from typical *H. quinquevulnera* in the yellow corolla tube and are considered to belong to *Didymocarpus atrosanguineus (now Henckelia atrosanguinea)* by KIEW (1989).

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H. rugosa* (Ridl.) A. Weber (cont.)<br>Trengganu, Kemaman distr.; Rasan Kerteh Ulu Chukai, WEBER 870515-3/6 (WU). | – | 18° | ov | F |
| *H. salicinoides* (Kiew) A. Weber<br>Pahang, Kuantan distr.; Hutan Simpan Bukit Kuantan (some km E of Panching); WEBER & ANTHONYSAMY 860825-3/1 (WU). | – | 18° | ov | F |
| –<br>Trengganu, Dungun distr.; Bkt. Bauk (S of Dungun); WEBER 870514-4/6 (WU). | 9° | 18° | EMC, ov | F |
| –<br>Trengganu, Kemaman distr.; some km N of Chukai (at km 68 to Kuantan); WEBER & ANTHONYSAMY 860827-1/2 (WU). | – | 18° | ov | F |
| –<br>Trengganu, Kemaman distr.; Ulu Bendong; WEBER 870609-1/8 (WU). | – | 18° | ov | F |
| *H. semitorta* (C. B. Clarke) A. Weber<br>Johore, Muar distr., Gunung Ledang (= Mt. Ophir); WEBER 840716-2/1 (WU). | 9° | 18° | EMC, ov | F |
| *H. stolonifera* (Kiew) A. Weber<br>Pahang, Genting Highlands; Gunung Ulu Kali, summit area; WEBER & ANTHONYSAMY 860801-1/12 (WU). | – | 18° | fi, ov | F |
| *H. tiumanica* (Ridl.) A. Weber<br>Pahang; Pulau Tioman, Mukut waterfall; WEBER 870604-1/1 (WU). | – | 18° | ov | F |
| –<br>Pahang, Pulau Tioman, Gunung Kajang; WEBER 870605-1/13 (WU). | – | 18° | ov | F |
| –<br>Pahang; Pulau Tioman, upper part of Bt. Rokem, 700 m; WEBER 840726-2/1 (WU). | – | 18 - 20° | rt, 8HQ | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | $n$ | $2n$ | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *H.* aff. *tiumanica* (Ridl.) A. Weber<br>Pahang; Pulau Tioman, Gunung Kajang; WEBER 870605-1/14 (WU). | – | 18° | ov | F |
| *H.* cf. *tunkui* (Kiew) A. Weber<br>Johore, Kluang distr.; Kahang Timor (SE of Kg. Gajah, NW foot of Gunung Belumut), Air Terjun Sg. Kahang; WEBER & ANTHONYSAMY 870528-3/1 (WU). | – | 18° | ov | F |
| *H. venusta* (Ridl.) A. Weber<br>Pahang/Perak, Cameron Highlands; path from G. Brinchang to G. Irau (ridge along Pahang/Perak border); WEBER 870623-2/8 (WU). | – | 18° | fi, ov | F |
| –<br>Pahang, Cameron Highlands; Gunung Berembun, ascent to top; WEBER 860819-2/1 (WU). | – | 18° | fl | F |
| ***Hovanella***°° | | | | |
| *H. madagascarica* (C. B. Clarke) A. Weber & B. L. Burtt<br>Madagascar, Prov. Antsiranana, Montagne d'Ambre<br>FISCHER M 388 (VOGEL & al.), 24.9.1981; fix. no. 12 (WU). | – | 28° | fl | F |
| ***Ornithoboea*** | | | | |
| *O. arachnoidea* (Diels) Craib<br>cult. HBV, seed origin: N. Thailand, Doi Chiang Dao; leg. BILLENSTEINER 1977 (WU). | 17° | – | PMC | F |
| –<br>ibid.; PUFF 871223-1/5 (WU). | 17° | – | EMC | F |
| *O. flexuosa* (Ridl.) B. L. Burtt<br>Kedah, Kota Setar distr.; Gunung Keriang (N Alor Star); WEBER 860810-1/1 (WU). | – | 34 - 38° | ov | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| ***Paraboea*** | | | | |
| *P. acutifolia* (Ridl.) B. L. Burtt<br>Kedah; Pulau Langkawi, Bukit Terbak (limestone rocks E of Ayer Hangat, Durien-Perangin area);<br>WEBER 860805-2/1 (WU). | – | 34 ± 2° | fl | F |
| *P. bakeri* M. R. Hend.<br>Pahang, Kuantan distr.; Gua Charas (c. 25 km NW of Kuantan); limestone;<br>WEBER 870516-1/2 (WU). | – | 18° | ov | F |
| *P. bintangensis* B. L. Burtt<br>Kedah; Pulau Langkawi, Bukit Terbak (limestone rocks E of Ayer Hangat, Durien-Perangin area);<br>WEBER 860805-2/2 (WU). | 17 - 18° | 34 - 36° | EMC, ov | F |
| *P. capitata* Ridl.<br>cult. HBV, seed origin:<br>Perak, Kinta distr., Tambun hot springs;<br>WEBER 8705023-5/2 (WU). | – | 34 ± 2° | rt | F |
| *P. elegans* (Ridl.) B. L. Burtt<br>Kedah, Kuala Muda distr.; Gunung Jerai, lower part (at km 7);<br>WEBER 860811-1/1 (WU). | – | [(32) - 34] - 36° | fl | F |
| *P. ferruginea* (Ridl.) Ridl.<br>Kedah; Pulau Langkawi, Selat Panchor, near Country Club; in shady rock niches;<br>WEBER 860806-1/2 (WU). | – | 4*x*° | fl | F |
| *P. lanata* (Ridl.) B. L. Burtt<br>Kedah, Langkawi Islands; Pulau Dayang Bunting, W-coast, rocky sea shore (limestone);<br>WEBER 860807-1/2 (WU). | – | 4*x*° | fl | F |
| *P. obovata* Ridl.<br>Kedah; Pulau, Langkawi, Gunung Machinchang;<br>WEBER 860808-1/3 (WU). | 18° | – | PMC | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen<br>(herbarium) | *n* | 2*n* | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| ***Ridleyandra***°° | | | | |
| *R. atrocyanea* (Ridl.) A. Weber<br>Perak; Kinta/Batang Padang distr.; Gunung Bujang Melaka, below top; WEBER & ANTHONYSAMY 870520-1/12 (WU). | – | 32 - 34° | ov | F |
| *R. longisepala* (Ridl.) A. Weber<br>Pahang; Gunung Jasar, path from top to Hilltop Bungalow; WEBER 870622-3/9 (WU). | – | 34° | fl | F |
| *R. morganii* (Franch.) A. Weber<br>Pahang, Cameron Highlands; path from Gunung Berembun to Robinson Falls WEBER 860819-4/1 (WU). | 17° | 32 - 34° | PMC, ov | F + K |
| *R. porphyrantha* (A. Weber & Kiew) A. Weber<br>Selangor; G. Bunga Buah, on ridge E of summit; 1300 - 1400 m; WEBER & ANTHONYSAMY 840711-1/3 (WU, KEP). | – | 34 ± 2° | fl | F + K |
| *R. quercifolia* (Ridl.) A. Weber<br>Perak, Larut distr.; path from Maxwell's Hill to Gunung Hijau; WEBER 860816-1/1 (WU). | 17° | 34° | PMC, fl | K |
| *R. stellata* A. Weber<br>Perak, Kinta/Batang Padang distr.; Gunung Bujang Melaka, below top; WEBER & ANTHONYSAMY 870520-1/3 (WU). | 17° | – | EMC | F + K |
| ***Senyumia***°° | | | | |
| *S. minutiflora* (Ridl.) Kiew & al.<br>Pahang, Temerloh distr., Gunung Senyum; WEBER & ANTHONYSAMY 860823-1/4 (WU). | 9° | 18° | P, fl | F |
| ***Spelaeanthus***°° | | | | |
| *S. chinii* Kiew, A. Weber & B. L. Burtt<br>Pahang, Lipis distr., Gua Bama (limestone ridge c. 13 km N of Kuala Lipis) WEBER 870508-2/4 (WU). | 8° | 16° | P, fl | F |

Table 1 (continued)

| Taxon<br>Locality, voucher specimen (herbarium) | $n$ | $2n$ | tissue; pretreatment | staining; figure |
|---|---|---|---|---|
| *S. chinii* Kiew, A. Weber & B. L. Burtt (cont.)<br>Ibid., small cave at NW foot of Gua Bama ridge;<br>WEBER 870509-1/1 (WU). | – | 16° | v | F |
| ***Trisepalum*** | | | | |
| *T. speciosum* (Ridl.) B. L. Burtt<br>Kedah; Pulau Langkawi, Bukit Puteh (a few km N of Kuah);<br>WEBER 860805-1/1 (WU). | – | $4x$ | fl | F |

## Results and discussion

The data presented in Table 1 refer to 84 species of 14 genera. Chromosome analysis often proved difficult, especially in the genera *Ornithoboea, Paraboea* and *Trisepalum,* because of the small chromosome size and their tendency to clump together in metaphase. Therefore, exact chromosome numbers could not be established in all cases. Nonetheless, approximate numbers are communicated here when they allow at least the assessment of the ploidy level.

The taxa investigated are briefly commented on and the taxonomic significance of the karyological data is discussed.

### *Boea*

*Boea* is a genus that has been re-defined and limited to 17 species by BURTT 1984, who marked three of them as anomalous. In the present series of papers two of these, *Boea minutiflora* and *'Boea (Paraboea bettiana)'* are removed to genera of their own: *Senyumia* and *Emarhendia,* respectively (KIEW & al. 1998). Their chromosome numbers are reported below.

With the exclusion of these and the third anomalous species *(Boea herbacea)* which will be excluded before long (BURTT, in prep.), *Boea* seemed to emerge as a genus with a single base number, $x = 8$. Both diploids and tetraploids have been recorded (see SKOG 1984).

However, the present first count for the Chinese *B. hygrometrica* (China) revealed the surprising number $x = 9$ (with both the haploid and

diploid number, $n = 9$, $2n = 18$, having been established). It may be noted that this species (originally described as *Dorcoceras hygrometrica* Bunge) differs by the broad open corolla tube from the remaining species (with flat-faced 'saintpaulioid' flowers).

Another surprise is the count of (?) *B. hygroscopica* (Australia, Queensland). In contrast to earlier reports (LEE 1962, RATTER 1963: $n = 8$) we found $2n = 32 - 34$ and thus tetraploidy. BURTT (1984) marked the species as variable in leaf form and in the shape and colour of the corolla and this could be correlated with genome variation. Unfortunately, no precise locality can be given, as the investigated plants were grown from seeds obtained from the Queensland Botanical Garden without information on its origin. Re-identification is desirable.

The result obtained for *B. lawesii* (New Guinea) confirms the earlier report by RATTER & PRENTICE 1967 ($n = 8$, $2n = 16$).

### *Boeica*

With $n = x = 12$, the first report for the genus, *Boeica brachyandra*[7] exhibits a base number which is unusual for Didymocarpeae. The counts were obtained from (pro)metaphases of first mitosis in different pollen grains. Chromosomes at this stage measure c. 1.2 µm. They are elongated and (sub)metacentric. While there is no doubt about the correctness of the count, some caution is necessary before generalizing this result: the pollen grains showed a high degree of variation in size and were sterile to about 50% (no staining reaction of cytoplasm after treatment with acetocarmine). Mitotic divisions of diploid somatic cells could not be analyzed exactly, but seemed to have maximally $2n = 22$ chromosomes. Unfortunately, no meiotic stages could be investigated. Thus irregularities in pollen mitosis leading to aberrant numbers cannot be excluded, and confirmation of the reported number is much needed.

### *Chirita* (see Table 2)

Though the large genus *Chirita* has been recently revised twice (WOOD 1974, WANG 1985: Chinese species) it is still one of the problematic genera with regard to delimitation, homogeneity and subdivision. WOOD (1974) divided the genus into three sections: sect. *Gibbosaccus*, sect. *Chirita* and sect. *Microchirita*, but it seems necessary to reinstate

[7] The generic position of the two Malayan species that have been described under *Boeica* is problematic, as they are morphologically very distinct from the type and other species of that genus.

Table 2

Chromosome numbers in *Chirita*

| Species | *n* | 2*n* | Reference |
|---|---|---|---|
| **sect. *Chirita*** | | | |
| *C. anachoreta* Hance | | 18 | Ratter 1963 |
| *C. bifolia* D. Don | 14 | | Vasudevan 1976 |
| *C. macrophylla* Wall. | 9 | 18 | Ratter & Prentice 1967 |
| *C. moonii* Gardn. | | 18 | Kiehn & Lorence 1996 |
| *C. pumila* D. Don | 4 | | Ratter 1963 |
| *C. speciosa* Kurz | | 18 | Fussell 1958, Ratter 1963 (as *Chirita trailliana* Forrest & W. W. Sm.) |
| *C. urticifolia* Buch.-Ham. ex D. Don | | 34 | Ratter & Prentice 1964 |
| *C. walkeri* Gardner | 9 | | Milne 1975 |
| *C. zeylanica* Hook. | 10 | | Ratter & Prentice 1967 |
| **sect. *Gibbosaccus*** | | | |
| *C. lacunosa* (Hook. f.) B. L. Burtt | | 18 | this paper |
| *C. sinensis* Lindl. | | 36 | Ratter & Prentice 1964 |
| **sect. *Liebigia*** | | | |
| *C. asperifolia* (Blume) B. L. Burtt | 14 | | Lee 1962 (as *Chirita blumei* C. B. Clarke) |
| | 16 | 32 | Ratter & Prentice 1967 |
| **sect. *Microchirita*** | | | |
| *C. bimaculata* D. Wood | 17 | | Milne 1975 |
| *C. caliginosa* C. B. Clarke | 9 | | Ratter & Prentice 1967 |
| | 9 | 18 | this paper |
| *C. hamosa* R. Br. | 17 | | Milne 1975 |
| | | 34 - 36 | this paper |
| *C. involucrata* Craib | 9 | | Milne 1975 |
| | | 18 | this paper |
| *C. lavandulacea* Stapf | | 34 | Rogers 1954 |
| | | 34 | Ratter & Prentice 1964 |
| | 18 | | Sugiura 1938, 1940 (as *Didymocarpus lavandulacea*) |
| *C. micromusa* B. L. Burtt | 17 | | Ratter & Milne 1970 |
| *C.* cf. *rupestris* Ridl. | 9 | | Milne 1975 (as *C. caerulea* R. Br., see footnote p. 428) |
| *C. sericea* Ridl. | | 18 | Ratter 1963 |
| | | 18 | Hellmayr 1989, this paper |
| **sect. ?** | | | |
| *C.* sp. from Thailand | 9 | | Milne 1975 |

CLARKE's sect. *Liebigia* (which should include his sect. *Bilabium*); these plants represent a tropical group (around *C. asperifolia*) that is very different from sect. *Chirita*. The five species investigated here belong to two sections: sect. *Gibbosaccus (C. lacunosa)* and sect. *Microchirita*. With the exception of *C. hamosa* from Thailand ($2n$ = 34 - 36) they all exhibit diploidy on $x$ = 9 ($n$ = 9 and/or $2n$ = 18).

*C. lacunosa* (Fig. 1a) clearly differs in its rosette habit and flower shape/coloration from the other Malayan species. The only other cytologically known species from sect. *Gibbosaccus* is *C. sinensis*, which exhibits the same base number $x$ = 9, but is tetraploid ($2n$ = 36).

Though sect. *Microchirita* is comparatively small (18 species according to WOOD 1974) and morphologically well-defined, there are apparently two base numbers: $x$ = 9 ($n$ = 9, $2n$ = 18: *C. caliginosa, C. sericea, C. involucrata* and *'C. caerulea'* = *C.* cf. *rupestris*[8]), and $x$ = 17 ($n$ = 17, $2n$ = 34: *C. hamosa, C. bimaculata, C. micromusa* and *C. lavandulacea*, for the latter also the haploid number $n$ = 18 has been reported.). There seems to be an interesting phytogeographical correlation: all diploids with $n$ = 9 occur in the Malay Peninsula (with *C. involucrata* and *C. rupestris* also extending into S. Thailand), while the species with $x$ = 17 have a more northernly distribution (Central and N. Thailand, Vietnam). These species are possibly dys-tetraploids, derived from $n = 2x$ = 18. In this connection the discordant reports for *C. lavandulacea* (Vietnam) are of special interest. It may be that the material investigated has been obtained from different (but closely related) taxa or cytotypes, one still displaying the original tetraploid condition with $n$ = 18. But this is, of course, speculative. Chromosome number and distribution seem to be also paralleled by the flower colour: the Malayan diploids have blue or bluish flowers, the northern species white, yellow or orange flowers. *C. lavandulacea*, with pale blue/lavender flowers, again seems to mark the turning point.

Chromosome numbers reported for members of sect. *Chirita* exhibit several base numbers ($x$ = 4, 8, 9, 10, 14 , 17). No attempt seems to have been made so far to find out a morphological or geographical correlation.

Chromosome morphology is uniform in all the Malayan taxa investigated: they measure 1.0 - 1.3 µm in metaphase (*C. sericea:* 1.3 - 2.6 µm in prometaphase, Fig. 1b), are elongated and (sub)metacentric. Maximally two satellites are detectable in the diploid set. The chromosome morphology is similar to that of *Henckelia*, which has also $x$ = 9 (see below). *Chirita* cf. *hamosa* from Thailand, however, differs remarkably in having

[8] *Chirita caerulea* is a species from Java, Bali and Sumbawa which has been erroneously reported to occur also in Thailand by WOOD (1974). The chromosome count is from a Thailand plant. There is little doubt that this represents *C. rupestris*.

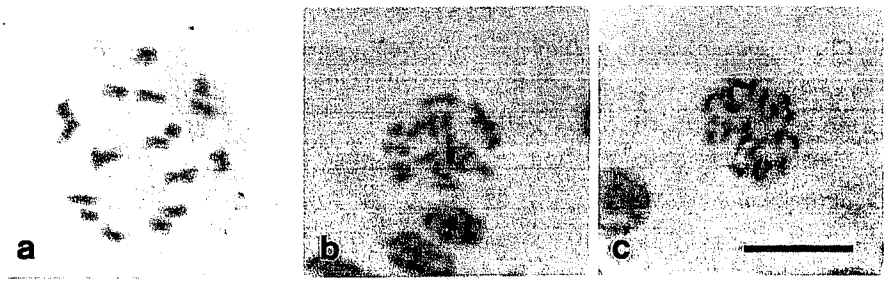


Fig. 1. a *Chirita lacunosa*, $2n = 18$, mitotic metaphase; b *C. sericea*, $2n = 18$, mitotic prometaphase; c *Didissandra frutescens* (WEBER 840803-1/7), $2n = 20$, mitotic prometaphase. – Bar 10 µm.

small dotlike chromosomes, scarcely exeeding 0.6 µm in prometaphase. Unfortunately, no literature data on chromosome morphology of *Chirita* are available, to which the present results could be related.

***Codonoboea*** (see under *Henckelia*).

***Didissandra***

Over 80 species spread all over S.-, E.- and S. E.-Asia have been attributed to this genus in the course of time (VITEK & al. 1998). After reference of some of the Sino-Himalayan species to new genera (CRAIB 1919) and the transfer of the species of *Didissandra* sensu CRAIB to *Corallodiscus* (BURTT 1947), some 30 species remained which were attributed to three genera by WEBER & BURTT 1998a. *Didissandra* s. str. emerged as a small alliance of c. 8 species, distributed in Sumatra, the Malay Peninsula, Borneo and Java.

The data for *D. frutescens* ($2n = 20$, Fig. 1c) are the first for the genus (an earlier report for *'Didissandra lanuginosa'* is not relevant here: this species must be referred to *Corallodiscus*, see VITEK & al. 1998). *D. frutescens*, occurring in the NW of the Malay Peninsula, is the type species of sect. *Cyrtandroides*. The only other species from this section, *D. anisanthera*, is found disjunctly in Borneo. Though the two plants match quite well in general habit and fruit characters, they display a rather different seed coat structure (see SONTAG & WEBER 1998). Chromosomal evidence that the two species are really closely related, would be welcome.

It is also unfortunate that none of the species of the type section (sect. *Didissandra*) is known cytologically so far. Though there can be little doubt that the species are closely interrelated (it is rather the species

Table 3

Chromosome numbers of *Didymocarpus* Wall. (sensu WEBER & BURTT 1998b). [ ] single discordant counts

| Species | *n* | 2*n* | Reference |
|---|---|---|---|
| *D. antirrhinoides* A. Weber | 22 | | RATTER & MILNE 1970 (as *D. corchorifolius*) |
| | | 22 | (KIEHN in) WEBER & BURTT 1985 |
| | 11 | [20] 22 | this paper |
| *D. aureoglandulosus* C. B. Clarke | 14 | | RATTER & MILNE 1970 (as *D. rodgeri* var. *siamensis*)[9] |
| *D. biserratus* Barnett | 28 | | MILNE 1975 |
| *D. citrinus* Ridl. | 11 | | RATTER & MILNE 1970 |
| | | 22 | this paper |
| *D. corchorifolius* R. Br. | | 22 | (KIEHN in) WEBER & BURTT 1985 |
| | 11 | 22 | this paper |
| *D. cordatus* A. DC. var. *cordatus* | 14 | 28 | this paper |
| *D. cordatus* A. DC var. *debilis* Ridl. | 14 | 28 | this paper |
| *D. cordatus* A. DC. var. *ophirensis* Ridl. | | [26] 28 | this paper |
| *D. insulsus* Craib[10] | | 28 | RATTER & PRENTICE 1967 (as *D.* sp. from Thailand) |
| *D. pedicellatus* R. Br. | 18 | | MEHRA & VASUDEVAN 1972 |
| *D. pedicellatus* R. Br. | | 24 | MALLA & al. 1974 |
| *D. praeteritus* B. L. Burtt & Davidson | 12 | | RATTER & PRENTICE 1964 |
| *D. purpureus* Ridl. | 16 | | RATTER & PRENTICE 1967 |
| *D. siamensis* Barnett | | 54 | RATTER & PRENTICE 1967 |
| *D. sulphureus* Ridl. | 11 | | (RATTER in) WEBER & BURTT 1983 |
| | 11 | 22 | this paper |

delimitation which poses some problems) the cytological relation to sect. *Cyrtandroides* would be of great interest.

[9] See HILLIARD & BURTT (1995).
[10] det. BURTT, pers. comm.

***Didymocarpus*** s. str. (see Table 3)

In its traditional use *Didymocarpus* was a huge, artificial genus that included around 250 species ranging from Madagascar to New Guinea. The study of WEBER & BURTT 1998b resulted in a split into three genera: *Didymocarpus* s. str., *Henckelia* (see there), and *Hovanella* (see there).

In the redefined sense *Didymocarpus* is an essentially Sino-Himalayan genus, comprising about 90 species, extending southwards through Myanmar, Vietnam and Thailand, with 6 species reaching the Malay Peninsula and thus penetrating into the everwet tropics.

In view of the large species number it is not surprising that the genus is cytologically heterogeneous. The following (basic) chromosome numbers have been reported so far: $x$ = 11, 12, 14, 16, and 18 (?). Polyploidy is known in several cases. Even in the small alliance of Malayan species, not less than three base numbers are found: $x$ = 11 [*D. antirrhinoides* (Fig. 2a), *D. corchorifolius* (Fig. 2b), *D. citrinus*, *D. sulphureus*], $x$ = 14 (*D. cordatus*, Fig. 2c), and $x$ = 16 (*D. purpureus*). Chromosome morphology is similar in all these species: the chromosomes are nearly globular with a length of c. 1.0 - 1.3 µm and a width of c. 1 µm in mitotic metaphase. Centromeres are difficult to detect. Bivalents of first meiotic divisions in pollen mother cells have a diameter of 1.3 - 1.7 µm.

**Polyploidy:** The Malayan taxa are diploids, but there is one tetraploid report ($n$ = 22) for *D. antirrhinoides* (as *D. corchorifolius*) by RATTER & MILNE (1970). Thus two cytotypes seem to be present in this species. Polyploidy is more frequently encountered in Himalayan species, and there is another example for two different cytotypes in a species (*D. pedicellatus*).

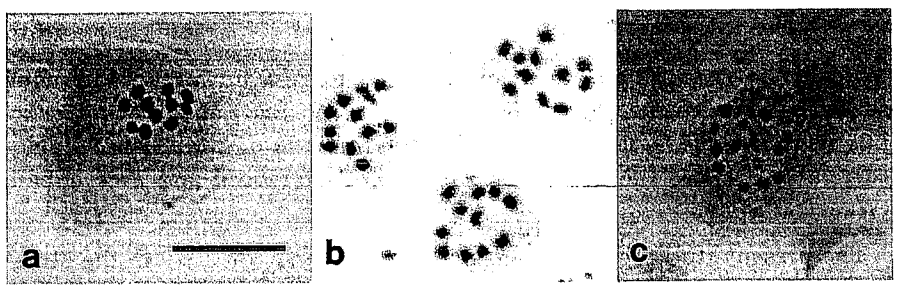


Fig. 2. a *Didymocarpus antirrhinoides* (WEBER 840814-1/4), $n$ = 11, pollen mothercell (PMC), metaphase of 1. meiotic division; b *D. corchorifolius* (WEBER 860813-1/2), $n$ = 11, PMC, metaphase of 1. meiotic division; c *D. cordatus* var. *debilis* (WEBER 860811-2/1), $n$ = 14, PMC, metaphase of 1. meiotic division. – Bar 10 µm.

**Discordant numbers:** The present study includes single discordant counts of $2n = 20$ for *D. antirrhinoides* (but four other accessions having $x = 11$) and of $2n = 26$ for *D. cordatus* var. *ophirensis* (a second accession of the same variety and five counts for other varieties of *D. cordatus* displayed $x = 14$, checked in several cells). Such discordant numbers are apparently the result of the fusion of two pairs of chromosomes (Robertsonian event), two larger chromosomes being detectable in each diploid cell. As only decreasing numbers ($14 \rightarrow 13$ and $11 \rightarrow 10$) have been found so far, decreasing dysploidy starting from $x = 16$ could be the mechanism of chromosomal evolution in the whole Malayan alliance.

*Emarhendia*

This new genus (KIEW & al. 1998) is based on a plant originally described as *Paraboea bettiana* M. R. Hend. For this taxon $x = n = 8$ and $2n = 16$ is reported here.

*Paraboea* itself is heterogeneous with regard to chromosome numbers (see below). So far the diploid number $n = 8$ ($2n = 16$) has not been reported, there is, however, one report of a tetraploid species (*P. speluncarum*, Borneo) with $n = 16$, $2n = 32$ (RATTER & PRENTICE 1967, as *Boea speluncarum*). Thus support from cytology for removing '*P. bettiana*' from *Paraboea* is not very strong. This also holds true with regard to *Boea*, in which genus the species was provisionally included by BURTT 1984 under the name '*Boea* (*Paraboea bettiana* M. R. Hend.)'. In this genus the number $n = 8$ even predominates (see discussion above). Nonetheless, from the morphological characters it is clear that the species belongs neither to *Paraboea* nor *Boea*. For possible relationships see the discussion in KIEW & al. 1998.

*Henckelia* (see Fig. 3 and Table 4)

*Henckelia* is part of *Didymocarpus* in its former, unwarrantably wide sense. It includes the species from S. India and Sri Lanka (*Didymocarpus* sect. *Orthoboea*, now sect. *Henckelia*), the bulk of 'Malesian *Didymocarpus*' as well as the genera *Loxocarpus*, *Codonoboea* and *Platyadenia* (WEBER & BURTT 1998b).

The present study reveals a remarkable constancy of $x = 9$ in the Malesian species which also applies to the former genera *Loxocarpus* and *Codonoboea* (no chromosome number is so far known for the former *Platyadenia*). This clearly differs from the situation in *Didymocarpus* s. str. (there is only a single record of $n = 18$ for *D. pedicellatus*, but a later count yielded $2n = 24$).

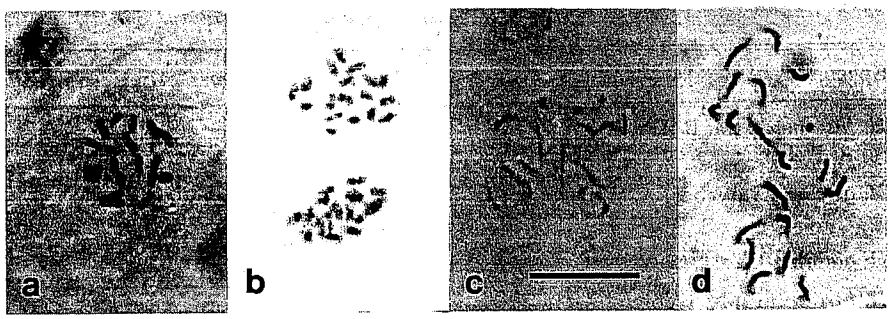


Fig. 3. a *Henckelia alternans*, $2n = 18$, mitotic prometaphase; b *H. breviflora*, $2n = 18$, mitotic ana-telophase; c *H. caerulea*, $2n = 18$, mitotic prophase; d H. fasciata, $2n = 18$, mitotic prophase. – Bar 10 µm.

Table 4

Chromosome numbers in *Henckelia*. [ ] single discordant counts.

| Species | $n$ | $2n$ | References |
|---|---|---|---|
| **sect. *Henckelia*** | | | |
| *H. floccosa* (Thwaites) A. Weber & B. L. Burtt | 16 | | MILNE 1975 (as *Didymocarpus floccosus* Thwaites) |
| *H. incana* (Vahl) Spreng. | 27 | | THATHACHAR 1942 (as *Didymocarpus tomentosus* Wight) |
| | ± 45 | ± 90 | RATTER & PRENTICE 1967 (as *Didymocarpus tomentosus* Wight) |
| **sect. *Didymanthus*[11]** | | | |
| *H. alba* (Ridl.) A. Weber | | 18 | this paper |
| *H. albomarginata* (Hemsl.) A. Weber | | 18 | this paper |
| *H. alternans* (Ridl.) A. Weber | 18 | | RATTER & MILNE 1970 (as *Didymocarpus alternans*) |
| | | 18 | this paper |
| *H. breviflora* (Ridl.) A. Weber | | 18 | this paper |
| *H. caerulea* (Ridl.) A. Weber | | 18 | this paper |
| *H. densifolia* (Ridl.) A. Weber s.l. | 8 - 9 | 18 ± 1 | this paper |
| *H. flavescens* (Ridl.) A. Weber | 9 | | RATTER & MILNE 1970 (as *Didymocarpus flavescens*) |
| | | 18 | this paper |

[11] In this section also those species are provisionally included that have been previously placed in *Didymocarpus* sects. *Salicini, Reptantes, Boeopsis, Pectinati* and *Venusti*. These sections have not been formally transferred to *Henckelia* (see WEBER & BURTT 1998b).

Table 4 continued

| Species | *n* | 2*n* | References |
|---|---|---|---|
| *H. floribunda* (M. R. Hend.) A. Weber | | 18 | this paper |
| *H. geitleri* (A. Weber) A. Weber | | 18 | (KIEHN in) WEBER 1989 |
| | | 18 | this paper |
| *H. glabrata* (Ridl.) A. Weber | | 18 | this paper |
| *H. hirta* (Ridl.) A. Weber | | 18 | this paper |
| *H. hispida* (Ridl.) A. Weber | 18 | ± 36 | this paper |
| | | 27 | this paper |
| *H. innominata* (B. L. Burtt) A. Weber & B. L. Burtt | 16 | 32 | RATTER & PRENTICE 1967 |
| *H. longipes* (C. B. Clarke) A. Weber | | 18 [20] | this paper |
| *H. malayana* (Hook. f.) A. Weber | 9 | | RATTER & MILNE 1970 (as *Didymocarpus malayanus*) |
| | | 18 | this paper |
| *H. marginata* (C. B. Clarke) A. Weber | 9 [10] | 18 | this paper |
| *H. nana* A. Weber | 19 | | RATTER & MILNE 1970 (as *Didymocarpus pumilus*) |
| | | 18 | this paper |
| *H. nitida* (Kiew & A. Weber) A. Weber | | 18 | this paper |
| *H. parviflora* (Ridl.) A. Weber | | 18 | this paper |
| *H.* aff. *parviflora* (Ridl.) Weber | | 36 | this paper |
| *H. primulina* (Ridl.) A. Weber | | 18 | this paper |
| *H. puncticulata* (Ridl.) A. Weber | 9 | 18 | this paper |
| *H. puncticulata* (Ridl.) A. Weber s.l. | | 18 | this paper |
| *H. reptans* (Jack) Spreng. var. div. | 9 | 18 | this paper |
| *H. reticulosa* (C. B. Clarke) B. L. Burtt | 9 | | RATTER & MILNE 1970 (as *Didymocarpus reticulosus*) |
| *H. salicinoides* (Kiew) A. Weber | 9 | 18 | this paper |
| *H. tiumanica* (Ridl.) A. Weber | | 18 | this paper |
| *H.* aff. *tiumanica* (Ridl.) A. Weber | | 18 | this paper |
| *H. venusta* (Ridl.) A. Weber | | 18 | this paper |

Table 4 continued

| Species | *n* | 2*n* | References |
|---|---|---|---|
| **sect. *Heteroboea*** | | | |
| *H. atrosanguinea* (Ridl.) A. Weber | | 18 | this paper |
| *H. bombycina* (Ridl.) A. Weber | | 18 | this paper |
| *H.* aff. *bombycina* (Ridl.) A. Weber | | 18 | RATTER & MILNE 1970 (as *Didymocarpus* aff. *bombycinus*) |
| *H. crinita* (Jack) Spreng. | 9 | 18 | this paper |
| *H. curtisii* (Ridl.) A. Weber | 9 | 18 [20] | this paper |
| *H. fasciata* (Ridl.) A. Weber | | 18 | this paper |
| *H.* cf. *corneri* (Kiew) A. Weber | 9 | 18 | this paper |
| *H. nivea* (Kiew) A. Weber | | 18 | this paper |
| *H. platypus* (C. B. Clarke) A. Weber | 9 | 18 | this paper |
| *H.* aff. *platypus* (C. B. Clarke) A. Weber | | 18 | this paper |
| *H. quinquevulnera* (Ridl.) A. Weber s.l. | 9 | 18 | this paper |
| *H. rugosa* (Ridl.) A. Weber | | 18 | this paper |
| **sect. *Glossadenia*** | | | |
| *H. inaequalis* (Ridl.) A. Weber | | 18 | this paper |
| *H. koerperi* (B. L. Burtt) A. Weber & B. L. Burtt | 9 | 18 | this paper |
| *H. pyroliflora* (Ridl.) A. Weber | 9 | 18 | this paper |
| *H.* aff. *pyroliflora* (Ridl.) A. Weber | | 18 | this paper |
| **sect. *Loxocarpus*** | | | |
| *H. browniana* A. Weber (= *Loxocarpus incanus* R. Br.) | 9 | 18 | HELLMAYR 1989, this paper |
| *H. aff. browniana* A. Weber | | 18 | this paper |
| *H. caerulea* (Ridl.) A. Weber | 9 | 18 | HELLMAYR 1989, this paper |
| *H. holttumii* (M. R. Hend.) A. Weber | 9 | 18 | this paper |
| *H. semitorta* (C. B. Clarke) A. Weber | 9 | 18 | this paper |
| *H.* cf. *tunkui* (Kiew) A. Weber | | 18 | this paper |

All taxa, including those formerly placed in *Loxocarpus* and *Codonoboea*, have a common chromosome morphology which clearly differs from *Didymocarpus* s. str.: the chromosomes are distinctly longitudinally stretched, with a length of c. 1.3 - 2.0 µm (in mitotic metaphase) or up to 3.5 µm (mitotic prophase), and a width of less than 0.8 µm. Centromeres are clearly detectable, the chromosomes are (sub)metacentric, one pair of satellites can be found in the diploid set.

**Polyploidy:** Most species of *Henckelia* are diploids. The literature reports tetraploidy for *D. alternans* (RATTER & MILNE 1970: $n = 18$), our collection, however, yielded diploidy ($2n = 18$, Fig. 3a) for this species. In sect. *Didymanthus* polyploids clearly do exist. Di- and tetraploidy seem to occur in the *H. parviflora*-alliance (see counts of *H.* aff. *parviflora*). *H. hispida* proved the only species in the whole genus to be exclusively polyploid: six origins proved tetraploid, but also one triploid ($2n = 27$) individuum was detected. It might have originated by hybridisation.

The cytologically known species from S. India and Sri Lanka (sect. *Henckelia*) are polyploids as well, probably based on $x = 9$ (*H. incana:* $6x$ and $10x$; *H. innominata* and *H. floccosa* with $n = 16$ could be tetraploid-dysploid species).

**Discordant numbers:** Two counts of $x = 10$ ($2n = 20$) were obtained in the Malesian group: *H. curtisii* (but two other plants from the same locality had $x = 9$), and *H. longipes* (with $x = 9$ in the same population). The switch from $x = 9$ to $x = 10$ thus must have taken place independently. To explain the mechanism of such changes, the following observation of chromosomal irregularities might be helpful: in *H. marginata* the usual number $2n = 18$ was found. Another accession (individuum) of the same species, however, showed a mitotic number of $2n = 19$. Its pollen meiosis was only slightly disturbed, but yielded pollen with either $x = 9$ or $x = 10$. The 'additional' chromosome was clearly smaller than the others. Its appears probable that it originated by fission of one chromosome of the $x = 9$ set. As in the above mentioned cases also one pair of chromosomes of $2n = 20$ appeared to be smaller, fission events provide a sound explanation for the occasional occurrence of deviating numbers. The literature report of $n = 19$ for *H. nana* (observed in metaphases of 2nd meiotic division, RATTER & MILNE 1970, under *Didymocarpus pumilus*) may indicate a similar event for this taxon followed by non-disjunction in meiotic division. Irregularities in meiotic divisions were observed in one flower of *H.* aff. *densifolia*. It displayed a high degree of pollen sterility; pollen mitosis resulted in cells with either $x = 8$ or $x = 9$. Cells from another flower (individuum?) from the same population had the usual number of $2n = 18$.

*Hovanella*

*Hovanella* is a new genus established for two species from Madagascar that have been hitherto referred to *Didymocarpus* (WEBER & BURTT 1998b). Though there is some similarity in habit and fruit morphology with 'Malesian *Didymocarpus*' (now in *Henckelia*), seed coat structure strongly suggests a close affinity with African genera such as *Streptocarpus, Saintpaulia* and *Schizoboea*. The chromosome number established here ($x$ = 14) strongly supports the separation from *Henckelia*, in which all Malesian species display the base number $x$ = 9.

*Loxocarpus* (see under *Henckelia*).

*Ornithoboea*

So far only the chromosome number of *O. wildeana* Craib (S. China, NW. Thailand) has been known ($n = \pm 16$, RATTER & PRENTICE 1967). The present counts for *O. arachnoidea* (with similar distribution as the former) yielded unequivocally $n$ = 17. Also the result ($2n$ = 34 - 38) for *O. flexuosa*, the southernmost of the 10 species (see BURTT 1958), occurring in NW. Malaysia and S. Thailand. The present count approximates the other data fairly well. The probable base number $n$ = 17 is not very common in paleotropical Gesneriaceae. As far as known it occurs consistently in *Ridleyandra* (see below), *Petrocosmea* (FUSSELL 1958, RATTER 1963, RATTER & PRENTICE 1967: data from three species), ?*Opithandra* (only one species counted; FUSSELL 1958, RATTER 1963), ?*Hexatheca* (only one species counted, RATTER & MILNE 1970) and *Cyrtandra* (see KIEHN & WEBER 1998). For the *Chirita* species exhibiting this number it is evident that it has originated by dysploidy from tetraploidy based on $x$ = 9 (see above).

*Paraboea* (see Table 5)

In its current definition (BURTT 1984, XU & BURTT 1991), *Paraboea* is a large genus with c. 100 species. Not unexpectedly, it is heterogeneous with regard to the chromosome number.

There are two reports for diploids, both based on $x$ = 9: *P. multiflora* from Thailand ($n$ = 9), and *P. bakeri*, a strict local endemic from the Malay Peninsula ($2n$ = 18).

Tetraploidy is much more common and seems, as far as can be concluded from the data available (in view of the very small chromosomes erroneous counts cannot be excluded), to be based on different numbers: $x$ = 16: *P. speluncarum* from Sarawak, $x$ = 17: *P. kerrii* from N. Thailand,

Table 5

Chromosome numbers in *Paraboea*

| Species | $n$ | $2n$ | Reference |
|---|---|---|---|
| *P. acutifolia* (Ridl.) B. L. Burtt | | 34 ± 2 | this paper |
| *P. bakeri* M. R. Hend. | | 18 | this paper |
| *P. bintangensis* B. L. Burtt | 17 - 18 | 34 - 36 | this paper |
| *P. capitata* Ridl. | 18 | | RATTER & PRENTICE 1967 |
| | | 34 ± 2 | this paper |
| *P. elegans* (Ridl.) B. L. Burtt | | [(32 -) 34 -] 36 | this paper |
| *P. ferruginea* (Ridl.) Ridl. | | $4x$ | this paper |
| *P. kerrii* (Craib) B. L. Burtt | 17 | | MILNE 1975 |
| *P. lanata* (Ridl.) B. L. Burtt | | $4x$ | this paper |
| *P. multiflora* (R. Br.) B. L. Burtt | 9 | | MILNE 1975 (as *Boea reticulata* Barnett) |
| *P. obovata* Ridl. | 18 | | this paper |
| *P. reticulata* Barnett | 9 | | MILNE 1975 |
| *P. speluncarum* B. L. Burtt | 16 | | RATTER & PRENTICE 1967 |
| *P. vulpina* Ridl. | | ± 36 | RATTER & PRENTICE 1967 |
| | | 36 | RATTER & PRENTICE 1970 |

and $x = 18$: *P. capitata*, *P. obovata*, and *P. vulpina*, all from the Malay Peninsula (for details and references see Table 5).

In the present study tetraploidy was found in five additional Malayan species, but due to the small chromosome size (less than 0.6 µm in mitotic metaphase), their overlapping and their tendency to clump together, no exact numbers could be established.

More morphological and karyological data are certainly needed to elucidate the taxonomic significance of the different numbers. It is, however, remarkable that all Malayan species have the base number $x = 9$, irrespective of major morphological differences especially in the fruit structure (long, short; straight or spirally twisted; 4-valved, bivalved or follicular; all types are represented in the cytologically known species). The diploid *P. bakeri* has short, 4-valved fruits, which perhaps represent the ancestral condition.

### *Ridleyandra*

This genus has been established for the accommodation of over 20 Malayan and Bornean species hitherto placed in *Didissandra*. They are morphologically very different and constitute a separate, well-defined alliance (WEBER & BURTT 1998a). No species belonging to that genus was cytologically investigated so far. In the present study the chromosome number of three species could be established precisely, and that of another three species in approximation. The data clearly suggest a base number of $x = 17$. All investigated species are from the Malay Peninsula and belong to the type section (sect. *Ridleyandra*). Chromosome data from sect. *Stilpnothrix* from Borneo are still lacking.

The number $x = 17$ is rare within paleotropical Gesneriaceae. (The only genera in which it seems to be consistent are mentioned under *Ornithoboea*). At the moment it is too speculative to suggest relationships between these genera. Nonetheless it may be stated that it has become clear that *Cyrtandra* (± constituting the tribe Cyrtandreae alone) is closely related to the Didymocarpeae[12] (the indehiscent sclerocarpous or fleshy, berry-like fruit being derived from a dehiscent capsule) and that the Malayan species of *Ridleyandra* have – in contrast to all other tropical Didymocarpeae – fruits with thick, slightly fleshy walls.

### *Senyumia*

*Senyumia* is a monotypic Malayan genus that has resulted from separating *Boea minutiflora* from *Boea* and placing it in a genus of its own (KIEW & al 1998). With the exclusion of this species and *'Boea (Paraboea bettiana)'* (see under *Emarhendia*), *Boea* s. str. does not occur in Western Malesia. The present count ($n = 9$, $2n = 18$) supports to a slight degree the removal of the species from *Boea*, in which the base number $x = 8$ prevails (the only exception being the Chinese *B. hygrometrica* with $x = 9$). The number $x = 9$ is found in several alliances of Malayan Gesneriaceae, including *Chirita, Henckelia* and *Paraboea*.

### *Spelaeanthus*

Like the former, *Spelaeanthus* is also a newly established genus and is based on a new species, *S. chinii* (KIEW & al. 1998). It comprises limestone plants occurring in the N. E. of the Malay Peninsula, and there is

[12] Results from analysis of the cpDNA atpB-rbcL spacer region of *Cyrtandra* and various Didymocarpeae even suggest a position of *Cyrtandra* within the Didymocarpeae (SAMUEL & al. 1997).

apparently another species in Vietnam (BURTT, in prep.). The present counts $n = 8$, $2n = 16$ indicate diploidy based on $x = 8$. This number is found in very few alliances: *Emarhendia* (see there), and *Paraboea* (one species from Borneo).

### *Trisepalum*

Only one fixation of *T. speciosum* could be investigated. No exact chromosome number could be obtained due to the small chromosomes clumping together, but tetraploidy could be stated with certainty. This is in agreement with the count of RATTER & PRENTICE (1967, as *Dichiloboea speciosa*), who report the haploid number $n = 18$. The number is in accordance with that of (at least the Malayan species of) *Paraboea*, to which *Trisepalum* is most closely related (see BURTT 1984).

## Acknowledgments

The authors are indebted to Mr. B. L. BURTT (E) and Dr. KWITON JONG (E) for critical reading and improvement of the paper. The financial support of the Austrian "Fonds zur Förderung der wissenschaftlichen Forschung" (project numbers: P 8166-B, P 6969-B, P 7984-BIO, P 09774-BIO) is gratefully acknowledged. Thanks are also due to Dr. R. KIEW (UPM, now SING) for hospitality and collaboration and to Mr. ANTHONYSAMY for field assistance during the collecting trips of A. W. in Malaysia. For technical help thanks go to Dr. E. VITEK, Mag. S. SONTAG, M. PASCHINGER, and J. SELINGER.

## References

BURTT, B. L.: *Corallodiscus* and *Didissandra*. – Gard. Chron. ser. 3, *122:* 204, 212 (1947).

— Studies in the Gesneriaceae of the Old World. XI. The genus *Ornithoboea*. – Notes Roy. Bot. Gard. Edinburgh *22:* 287 - 299 (1958).

— Id. XLVII. Revised generic concepts for *Boea* and its allies. – Notes Roy. Bot. Gard. Edinburgh *41:* 401 - 452 (1984).

— Old World Gesneriaceae. V. Suprageneric names. – Edinburgh J. Bot. *54:* 85 - 90 (1997).

— & H. WIEHLER: Classification of the family Gesneriaceae. – Gesneriana *1:* 1 - 4 (1995).

CRAIB, W. G.: *Didissandra* and allied genera in China and N. India. – Notes Roy. Bot. Gard. Edinburgh *11:* 255 - 268 (1919).

FUSSELL, C. P.: Chromosome numbers in the Gesneriaceae. – Baileya *6:* 117 - 125 (1958).

GREILHUBER, J. & F. EHRENDORFER: Karyological approaches to plant taxonomy. – ISI atlas of science: animal and plant sciences: 289 - 297 (1988).

HELLMAYR, E.: Chromosomenzählungen an Blütenpflanzen der Malaiischen Halbinsel. – 5. Österr. Botanikertreffen Innsbruck, 25. - 28. Mai 1989. Innsbruck: Universität (1989).

— M. KIEHN & A. WEBER: Chromosome numbers of Malayan rain-forest Angiosperms. – Beitr. Biol. Pflanzen *68:* 51 - 71 ('1994') (1995).

HILLIARD, O. M. & B. L. BURTT: *Streptocarpus*. An African plant study. – Pietermaritzburg: Univ. Natal Press (1971).

— — Old World Gesneriaceae. IV. Notes on *Didymocarpus* and *Lysionotus*. – Edinburgh J. Bot. *52:* 215 - 224 (1995).

KIEHN, M. & D. H. LORENCE: Chromosome counts on Angiosperms cultivated at the National Tropical Garden, Kaua'i, Hawai'i. – Pacific Sci. *50:* 317 - 323 (1996).

— E. VITEK, E. HELLMAYR, J. WALTER, J. TSCHENETT, C. JUSTIN & M. MANN: Beiträge zur Flora von Österreich: Chromosomenzählungen. – Verh. Zool.-Bot. Ges. Österreich 128, 19 - 39 (1991).

— & A. WEBER: Chromosome numbers of Malayan and other paleotropical Gesneriaceae. II. Tribes Trichosporeae, Cyrtandreae and Epithemateae. – Beitr. Biol. Pflanzen *70:* 445 - 470 (1998).

KIEW, R.: *Didymocarpus* (Gesneriaceae) on Gunung Tahan, Malaysia. – Gard Bull. Singapore *42:* 47 - 64 (1989).

— A. WEBER & B. L. BURTT: Three new genera of Gesneriaceae from limestone in Peninsular Malaysia. – Beitr. Biol. Pflanzen *70:* 383 - 403 (1998).

LEE, R. E.: Chromosome numbers in the Gesneriaceae. – Baileya *10:* 33 - 45 (1962).

MALLA, S. B., S. BHATTARAI, SHRESTA, MEERA & M. P. SINGH: In IOPB chromosome number reports. XLVI. – Taxon *23:* 801 - 812 (1974).

MEHRA, P. N. & K. N. VASUDEVAN: In IOPB chromosome number reports. XXXVI. – Taxon *21:* 333 - 346 (1972).

MILNE, C.: Chromosome numbers in the Gesneriaceae: V. – Notes Roy. Bot. Gard. Edinburgh *33:* 523 - 525 (1975).

RATTER, J. A.: Some chromosome numbers in the Gesneriaceae. – Notes Roy. Bot. Gard. Edinburgh *24:* 221 - 229 (1963).

— A survey of chromosome numbers in the Gesneriaceae of the Old World. – Notes Roy. Bot. Gard. Edinburgh *33:* 527 - 543 (1975).

— & C. MILNE: Chromosome numbers in the Gesneriaceae: IV. – Notes Roy. Bot. Gard. Edinburgh *30:* 183 - 187 (1970).

— & H. T. PRENTICE: Chromosome numbers in the Gesneriaceae: II. – Notes Roy. Bot. Gard. Edinburgh *25:* 303 - 307 (1964).

— — Chromosome numbers in the Gesneriaceae: III. – Notes Roy. Bot. Gard. Edinburgh *27:* 205 - 209 (1967).

RAVEN, P. H.: The basis of angiosperm phylogeny: cytology. – Ann. Missouri Bot. Gard. *62:* 724 - 764 (1975).

ROGERS, O. M.: Some chromosome counts in the Gesneriaceae. – Baileya *2:* 14 - 18 (1954).

SAMUEL, R., W. PINSKER & M. KIEHN: Phylogeny of some species of *Cyrtandra* (Gesneriaceae) inferred from the atpB/rbcL cpDNA intergene region. – Bot. Acta *110:* 503 - 510 (1997).

## Technical Instructions for Completing the Manuscript

10. Manuscripts should be submitted ready for press, i.e. type-written, double spaced with a 4 cm wide margin. Paragraphs on "Material and Methods" as well as less important sections should be marked for small type by narrow spacing to facilitate a rapid assimilation of the contents.

11. The title page must list: 1. title of the article; in German manuscripts an English translation of the title should be added, in English or French manuscripts a German translation, 2. list of the additional catchwords (fields), 3. first names and name(s) of author(s), 4. institute(s) at which the research was carried out, 5. running title (headings on each page) not exceeding 65 letters, and 6. address of the author(s) for corrections.

12. The typescript must be unobjectionable regarding form and contents to avoid later amendments in the proofs. Otherwise the author(s) will have to be charged with the arising costs. Scientific names of genera, species and subspecies (not orders, families etc.) must be marked by a *wavy underlining*. Names of authors cited in the text will be set in capitals (except the names of authors belonging to binomials). Names to be set in CAPITALS must be underlined in green color. For phrases which should be especially emphasized the s p a c e d t y p e or **demi-bold** type can be used.

13. Literature references in the text must state the names of the authors and the year of publication. The bibliographic references are to include: 1. initials and name of all authors, 2. the full title of the paper, 3. the title of the journal (according to standard international abbreviations), 4. number of volume, 5. number of first and last pages, 6. year of publication. References to books are to include: 1. names of authors, 2. full title, 3. edition, 4. publisher, 5. place of publication, and 6. year of publication. The bibliography should be arranged alphabetically according to authors' names. It should list only those papers actually mentioned in the text.

14. Graphs and figures should as far as possible be submitted double the final size of the figures and drawn in black Indian ink or printed with a laserprinter. Lettering must be ready for reproduction or – unless this is not possible – inserted in pencil.

15. Photographs should – if possible – be grouped; the available space must be taken into account.

16. All illustrations must consecutively be numbered. A short legend must be provided for each illustration. The legends for all illustrations are added to the manuscript on a separate sheet of paper in their respective order.

17. If a proof is not returned in a reasonable time, the editors will correct the proofs to the best of their ability, but assume no responsibility.