CHROMOSOME NUMBERS AND CROSS-COMPATIBILITY IN THE GENUS CYMBIDIUM AND SOME RELATED TROPICAL GENERA (ORCHIDACEAE)

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Chromosome Numbers and Cross-Compatibility in the Genus Cymbidium and Some Related Tropical Genera (Orchidaceae)

Abstract

Investigations on chromosome numbers and cross-compatibility were made with species and hybrids of Cymbidium and other tropical genera of the family Orchidaceae.

Chromosome number determinations were made of 163 plants. One hundred nineteen counts of Cymbidium clones were made of which 92 are reported for the first time. Diploid, triploid, tetraploid, hexaploid and aneuploid individuals were determined. Triploid cultivars of two species, C. insigne 'Bierii' and C. pumilum 'Yashima' were found. Forty-four counts of intergeneric hybrids and genera other than Cymbidium were made. The hybrid status of 17 progenies of intergeneric pollinations was determined by analysis of somatic chromosome numbers. Nine plants derived from colchicine treated protocorms were identified as polyploids; 8 being euploid and 1 a mixoploid. The origin of the polyploid nature of some of the hybrids not subjected to colchicine treatments is discussed. It was verified cytologically that Cymbidium did hybridize with Ansellia and Catasetum. The origin of seedlings of 6 intergeneric pollinations is discussed. The origin of the registered but questionable hybrid Phaiocymbidium Chardwarense is discussed.

Cymbidium species were categorized into 3 groups (I, II, and III) based on morphological features of plants, flowers, and inflorescences. A cross-compatibility study was made utulizing 21 species and 28 hybrid Cymbidium and 26 species and hybrids of other genera. A total of 2,466

pollination was made with 265 (10.7%) fruits harvested of which 182 (68.7%) contained an average of 31.3% seeds with apparently viable embryos. One hundred forty-two fruits (53.6% and 78.0% of those that contained apparently viable embryos) produced seedlings. It has been demonstrated that species of groups I and II are more cross-compatible within groups than between groups. It is also demonstrated that species of groups I and II are more cross-compatible between these groups than they are with species of group III. Thirty-eight intergeneric pollinations resulted in seedlings of which 10 are confirmed hybrids, 2 are false hybrids and 26 were not verified cytologically. The discovery of a unidirectional cross-incompatibility system was made whereby Ansidium seedlings are rarely produced when Ansellia is used as a female parent and are easily produced when Cymbidium is used as a female. Individual Cymbidium species and hybrids were evaluated for their intra- and inter-generic combining abilities.

The diploid and tetraploid forms of C. Peter Pan 'Greensleeves' were compared for 14 morphological features. A formula was developed for determining changes in symmetry as a result of polyploid induction.

A discussion of various incompatibility systems in the Orchidaceae is presented.

Criteria and recommendations for a breeding program designed to produce commercially acceptable Cymbidiums capable of flowering at low elevations in Hawaii are presented.

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INTRODUCTION

Cymbidium is an important orchid cut-flower. It is Hawaii's number 2 orchid cut-flower and ranks fifth in total cut-flower production behind anthurium, rose, chrysanthemum, and dendrobium (Garrett 1977). Because of the long lasting quality (up to 6 weeks after cut), shipability, and longer period of productivity than when grown in the U.S. mainland, the Hawaiian-grown Cymbidium is profitably marketed in competition with the U.S. mainland grown product. Because of the requirement for cooler climate for initiation of flowers, commercial production of high quality Cymbidium flowers is confined to the volcano area with some production in Kamuela and upper Kona on the island of Hawaii and the Kula area of Maui. It would be beneficial to the industry if Cymbidiums could be developed that would grow and flower well under the prevailing low elevation environmental conditions in Hawaii. If such "warm-temperature-tolerant" Cymbidium could be developed, cut-flower and potted plant production could be expanded to warmer areas where present commercial varieties do not flower.

The purpose of this dissertation is to investigate the possibilities of developing such warm-temperature-tolerant varieties by screening from species and hybrids of Cymbidium and other genera those plants that flower at 2 Manoa locations (low elevation), determining their somatic chromosome number, performing cross-compatibility studies among them, and recommending a preliminary breeding program which may ultimately yield the desired warm-temperature-tolerant cultivars.

LITERATURE REVIEW

The genus Cymbidium Swartz consists of approximately 70 species which are native to Africa, Australia, China, India, Japan, Korea, The Malagassey Republic, New Guinea, Philippines, Taiwan, Vietnam, and other Indo-Malayan regions (Crosby 1951a; Hawkes 1963; Lohschuta 1973; Swartz in King and Pantling 1898; Withner 1948). Of these only 7, C. eburneum, C. giganteum, C. grandiflorum, C. insigne, C. lowianum, C. parishii, and C. tracyanum have been hybridized extensively in the development of commercial cut-flower varieties. These 7 are all from temperate regions of the world and do not or rarely bloom under warm conditions. The majority of the species, many of which are tropical or subtropical in origin, have been seldom, if at all, used in hybridization.

Of the original 43 species listed by Swartz in 1799 most have been transferred by Lindley and Reichenbach (Anonymous 1956), Bentham and Hooker (1883) and others into various other genera. Additional contributions to the genus have come from no fewer than 45 botanists as listed by Menninger (1961).

A few botanists have attempted to subdivide parts of the genus into botanical sections (Crosby 1951a,b; King and Pantling 1898; Rolfe 1917) but there has, in general, been little agreement among the proposed sections. No one has attempted to subdivide the entire genus as it is known today. Hooker (1894) recognized Cymbidium and Cyperorchis as 2 closely related yet distinct genera. King and Pantling (1898) recognized Cyperorchis as a section of Cymbidium. They acknowledged all of the species Hooker recognized and added C. eburneum. The criteria King and

Pantling used to divide the genus into sections are as follows: Section Eucymbidium - Sepals and petals spreading; pollinia transversely ovoid or pyriform, their points divergent; rostellum not beaked. Section Cyperorchis - Sepals and petals sub-equal, erect and connivent (in some species spreading), long and narrow; lip narrow with the apical lobe small and sub-orbicular pollinia cuneate or obovoid; rostellum beaked. (King and Pantling 1898). Schlechter in 1914 (Holttum 1966) suggested that the genus could be separated into 2 distinct genera. Ten years later he divided all the known species of Cymbidium into 2 genera; Cymbidium with 8 sections and Cyperorchis with 4 sections. Holttum (1966) agrees that there is good justification for the existence of the genus Cyperorchis but states that he does not think such recognition is either necessary or desirable. Pfitzer (Anonymous 1956) grouped all the members of Cymbidium known to him into 3 relatively poorly defined sections based almost exclusively on the angle of the inflorescence. His 3 sections were: I - Iridorchis (arching), II - Erecta (erect), and III - Pendula (pendulous). Crosby (1951a,b) considers only the large flowered species and groups them into 2 subdivisions based on morphological features of the flower, inflorescence, foliage, and pseudobulbs. Rolfe (1917), in discussing some of the coriaceous-leaved members of the genus, refers to what may be called the section Aloifoliae. Mehlquist (1954) refers, in a horticultural sense, to the "early-flowering group" and the "miniature group" as do many of the commercial growers.

The Cymbidium flower has 3 sepals and 3 petals, 1 of which is modified into a labellum which is 3-lobed with the front lobe usually reflexed and having 2 longitudinal calli. The dorsal sepal frequently

bends forward over the column and lip. The column is long and arching. The 1 or imperfectly 2-celled anther is at the column apex. The anther contains 2 waxy grooved pollinia which adhere to the viscid disk (Swartz in King and Pantling 1898). The 3 sepals and 2 lateral petals are nearly equal and usually free. The flowers vary more in size than in shape (Lohschutz 1973; Sheehan and Sheehan 1972). Individual flowers, depending on species, vary from 2 to 10 cm. Exceptional exhibition type polyploid hybrids occasionally attain sizes of 18 cm.

Inflorescences emerge from basal or nearly basal leaf-axils. The inflorescences may be borne from pseudobulbs of the current or previous years growth. Young inflorescence spikes are very similar to young vegetative growths. These spikes eventually thicken and remain closed at the apex while young vegetative shoots remain slender and open at the apex to display the leaf tips. At about half its ultimate length the few to many individual flower buds emerge from the protective sheaths and continue to develop. The inflorescences may be erect, arching, or pendulous but always unbranched (Lohschutz 1973; Swartz in King and Pantling 1898).

Cymbidium plants are usually epiphytic but sometimes terrestrial or lithophytic. Pseudobulbous stems are usually short and stout with few to many long, narrow, usually obviously veined, heavy textured, evergreen leaves. The persistent leaf bases usually encircle and ensheath the pseudobulbs which are held tightly together by heavy short rhizomes. Roots are usually fleshy, thick and plentiful (Lohschutz 1973; Withner 1948).

There are many miniature-flowered Asian and Australian Cymbidium species which thrive under tropical and subtropical conditions (Miller 1965). The miniature-flowered Asian species especially C. pumilum and the C. ensifolium types, impart a high degree of warm-temperature-tolerance, compactness of growth, and floriferousness to their hybrids (Carpenter 1969; Graves 1960; and Menninger 1964). The coriaceous-leaved types, i.e. C. aloifolium, C. canaliculatum, and others, also impart warm blooming tolerance into their hybrids but render them much more difficult to bloom and appear to significantly reduce their floriferousness (De Garmo 1963). Hybrids of these Asian and Australian species with standard cut-flower types are called miniature Cymbidium hybrids. Such hybrids are becoming increasingly popular for commercial cut-flower production. They are more profitable than standard cut-flower types because of their compact growth, free flowering habit (often several times annually), and extremely high yields of some proven varieties (Monkhouse 1972). The ability of the miniature hybrids to flower under warm temperatures makes it possible to select and breed for desirable types that will tolerate the lowland climatic conditions of Hawaii and other tropical and subtropical areas of the world. Crossing 2 miniature hybrid Cymbidium or backcrossing a miniature hybrid to a standard will result in a percentage of large flowered progeny (Menninger 1959); some of which may have a degree of warm-blooming tolerance.

Another source of genes for warm-blooming tolerance may be other tropical genera, related to Cymbidium. Few other genera have been successfully hybridized with Cymbidium to date. The most closely allied genus is Cyperorchis Blume (Anonymous 1956; Holttum 1966). It has been

frequently hybridized with Cymbidium although the proposed generic grex, Cyperocymbidium (Hawkes 1955), has been largely disregarded in favor of Cymbidium because of opposition to the separate generic status of Cyperorchis. Secondary and advanced hybrids involving species of Cyperorchis are not uncommon and appear throughout the hybrid registrations (R.H.S. 1972; Sanders 1946; Sanders and Wreford 1961). Other closely related genera are Grammatophyllum Blume (Hawkes 1963) and Ansellia Lind. (Anonymous 1925 and Cooper 1940). Two registered hybrids, Cymbidium with Grammatophyllum and Cymbidium with Ansellia (Sanders and Wreford 1961; The Royal Hort. Soc. 1972), appear to confirm this close relationship. There is no record that these hybrids have been used for advanced breeding.

Only 1 other alleged intergeneric hybrid of Cymbidium has been registered. Phaiocymbidium Chardwarense, flowered and registered by Moore in 1902 (Sanders 1946), is a supposed bigeneric hybrid of Phaius grandifolius (tankervillae) x C. giganteum. Its hybrid status has never been confirmed by either cytological techniques or progeny testing. There are reports in the literature based on morphological features of the plant and flower that support (Anonymous 1954; Brummitt 1955) and deny (Rolfe 1911) the intergeneric status of this cross.

The genus Cymbidiella Rolfe is considered an ally of Cymbidium (Rolfe 1918) having once been included in that genus. Its separation from Cymbidium is supported by its repeated failure to hybridize with Cymbidium and by the results of cytological investigations by Wimber (1957) that revealed chromosome counts of 54 for Cymbidiella rhodochila, 14 more than the diploid Cymbidium number of 40. He further states

that the karyotype is singularly different from anything seen in Cymbidium. It is highly doubtful whether this plant would cross with any member of the Cymbidium alliance (1957).

A prerequisite to the establishment of a breeding program that would yield commercially acceptable Cymbidium hybrids with warm blooming tolerance is the knowledge of the cross compatibilities of the temperate species and hybrids with the miniature Asian and Australian species and related tropical genera. Compatibility studies with Cymbidium have not been reported in the literature although they have been for various other genera (Moir 1975).

Cytologically, the genus has attracted the efforts of several investigators. Chromosome numbers have been determined for 38 of the approximately 70 known species. Few deviations from the 2n number of 40 have been reported. Menninger (1967) reports that C. insigne 'Bieri' is a triploid with 60 chromosomes...but has not flowered for verification. Sampathkumaran and Seshagiriah (1931) reported C. aloifolium to be n=16 and 2n=32. All subsequent counts for this species have been n=20 and 2n=40. Suessenguth (1921) reported C. lowianum to be n=9-10 and Sharma and Sarkar (1967-68) reported it to be n=22. Other counts for this species report n=20 and 2n=40. Tanaka (1956b) has reported C. nagifolium to be 2n=38 but Mutsuura and Nakahira (1959) reported 2n=40. Godella and Kliphuis (1963) report a tetraploid (2n=80) C. pumilum 'Gesshohen'. There is 1 colchicine-converted tetraploid species, C. parishii var sanderae (Easton 1975).

Primary, secondary, and advanced hybrids have been shown to exist at the diploid, triploid, and tetraploid levels (Tables V, VI and VII).

Two pentaploids are known to exist, C. Flamingo 'Nobilior' (Wells 1956; Wimber 1954 and 1957d) and C. Ilkley (Zuck 1957), and numerous aneuploids have been recorded with chromosome numbers ranging between all of the known euploid levels (Mehlquist 1952; Wells 1956; Wimber and Hernlund 1952). Wimber and Hernlund (1955) demonstrated that aneuploidy can be related to abnormal floral and vegetative characteristics. Triploid and aneuploid plants are known to be poor breeders. When they are not completely sterile, they often produce progeny which are slow to grow and develop and which sometimes never flower even when apparently mature. For these reasons it is important to know the chromosome numbers of all stud plants and potential stud plants in a breeding program.

Sterility barriers to further hybridization are common in the family Orchidaceae. The cytological basis for such sterility, in addition to uneven ploidy levels, is primarily nonhomology of chromosomes due to distant relationships of parental plants (Kamemoto 1950, 1952, 1958; Nakasone and Kamemoto 1961; Sanguthai and Sagawa 1973; Sanguthai et al. 1973; Storey 1952, 1953). Restoration of fertility of hybrids having nonhomologous chromosomes has been demonstrated for numerous non-orchidaceous plants by doubling their chromosomes using colchicine (Eigsti and Dustin 1955).

Artificial induction of polyploidy in orchids using colchicine was first suggested by Jones (1947), MacLeod (1947), and Moore (1947) but 14 years had passed before the first cytologically confirmed report appeared that polyploidy had been achieved via the use of colchicine (Nakasone and Kamemoto 1961). The subject plant was a cutting of a diploid Vanda 'Miss Joaquim', to which an exogenous application of

colchicine was applied. Only 1 plant out of several treated was converted to, and remained, a tetraploid. Menninger (1963) produced the first successful colchicine-induced tetraploid Cymbidium. Her subject material was the diploid primary hybrid C. Conningsbyanum 'Brockhurst', the dormant buds of which she pierced with a find needle and repeatedly soaked in colchicine solutions of 10.4% and 1.0%. Repeated chromosome counts confirmed its tetraploid state. A detailed comparison of the flowers of the diploid and tetraploid forms of this clone showed that the tetraploid had a significantly larger column, sepals, and petals, especially the labellum (Menninger 1963). Orchidists have long recognized the association of increased horticultural qualities with polyploids but never before had the differences been quantified. Wimber and Van Cott (1967) described a method of polyploid induction from Cymbidium protocorms and protocorm-like bodies whereby up to 40% conversion from the diploid to the tetraploid level occurred. Wimber and Wimber (1968) statistically analyzed a seedling population of the normally diploid cross C. Lunagrad, a portion of which were artificially induced tetraploids via the method of Wimber and Van Cott (1967). Their study concluded that both sepals and petals were significantly wider and perhaps longer in the tetraploid forms giving them an overall fuller appearance. Thickness of the sepals and petals was also increased in the tetraploid forms giving them heavier texture and greater substance.

The use of colchicine in a Cymbidium breeding program for warm blooming tolerance should be useful in restoring fertility to sterile hybrids and improving the size and floral qualities of miniature species, primary and secondary hybrids. Today colchicine-induced and

cytologically-confirmed tetraploid Cymbidium are available from a few progressive commercial companies (Dunn and Nicolle 1976). Colchicine-induced hexaploid Cymbidium have not yet been reported.

Meiotic analysis of primary hybrids has been used in various orchid genera to determine chromosomal homologies (Charanasri 1974; Kamemoto 1950; McQuade 1949; Miduno 1954; Storey 1955; Wilfret and Kamemoto 1971). The degree of chromosome homology or non-homology has been used to determine cytogenetic and estimate phylogenetic relationships between the parent species. Wimber (1957c) showed evidence of a striking homology between the genomes of the parents of the primary hybrids C. Gottianum (C. eburneum x C. insigne), C. Eburneo-lowianum (C. eburneum x C. lowianum), and C. Lowio-grandiflorum (C. lowianum x C. grandiflorum). He also presented evidence of an evolutionary divergence of the genomes of the parents of the primary hybrids C. Pauwelsii (C. insigne x C. lowianum), C. Ceres (C. i'ansonii x C. insigne), and C. Lotta (C. i'ansonii x C. lowianum) based on a relatively high percentage of non-homologous chromosomes. Earlier, however, Wimber (1957b) demonstrated that a clone of C. insigne was extremely irregular during meiosis producing an abundance of univalents, fragments, and bridges. The species status of C. i'ansonii is often questioned. Rolfe and Alexander (Crosby 1952) believed that it is a natural primary hybrid of C. lowianum and C. tracyanum. If C. i'ansonii is actually a hybrid and if a meiotically irregular C. insigne was used, it would be expected to find some non-homologous chromosomes in C. Pauwelsii, C. Ceres, and C. Lotta. Wimber's (1957c) work also illustrated that there has been a strong divergence of the genomes in C. pumilum and C. insigne and its allies. This

statement is based on his observations that all 5 of the C. pumilum hybrids he observed had highly disorganized and disrupted meiotic cycles and that his attempts at hybridization with this group met with near total failure. Wimber's results regarding C. pumilum were verified by Yeh (1962) who meiotically analyzed several C. pumilum hybrids and concluded that this species is a very distinct species both morphologically and genetically compared to the large-flowered species such as C. insigne Rolfe, C. lowianum Rchb. f., C. erythrostylum Rolfe, C. parishii Rchb, f., etc. It was also shown that a very close genetic relationship existed between C. insigne and C. parishii and that a fairly close genetic relationship existed between C. insigne and C. lowianum and C. erythrostylum (Yeh 1962).

In the future, meiotic analysis of the primary and intergeneric hybrids produced during this investigation should be undertaken in order to obtain more information about the relationships between the parental species and genera.

MATERIALS AND METHODS

Plant materials available for this investigation included 70 clones of 49 Cymbidium species, 17 Cymbidium primary hybrids, 31 clones of 30 Cymbidium secondary hybrids, 48 clones of 41 Cymbidium advanced hybrids, and 43 species and hybrids of other genera (Table I). The plants were grown in greenhouses at the Lyon Arboretum and the Department of Horticulture, University of Hawaii at Manoa.

To study sexual compatibilities all possible cross combinations were made, including selfings and reciprocals, to the extent that flower production permitted. Pollinia were stored in No. 00 gelatin capsules and placed in glass vials with cork stoppers at about 8° C for later use.

Dates of pollination, flower abscission, and fruit harvest were recorded. Since a preliminary study was made to determine the number of days after pollination required for a mature embryo to develop, this information was used as a standard for collecting fruits. The study showed that mature embryos could be obtained 85 days after pollination when a coriaceous-leaved Cymbidium was used as the female parent. One hundred twenty days were required for all other types of Cymbidium and 75 days for Ansellia, Calanthe, Eulophia, and Phaius. Fruits were not harvested before these critical periods and were sometimes harvested much later due to variations in fruit development. Seeds were sown in 50 ml erlenmeyer flasks containing 20 ml of a modified Vacin and Went liquid medium. Shortly after germination the protocorms were transferred to flasks containing the same medium in solid form. Three to 5 months

later the plants were transferred to community pots and subsequently to individual pots.

The percentage of apparently viable seeds was determined by examining 100 seeds from each fruit harvested that contained seeds. Seeds were spread on a microscope slide stained with 1% aceto-orcein and examined under low power (100X).

For induction of polyploidy protocorms and protocorm-like bodies were treated with a 0.05% aqueous colchicine solution for 7 days. The technique is modified from Sanguthai et al. (1973).

Somatic chromosome numbers were determined from 1-2 mm root tips pretreated in 0.002 M 8-hydroxyquinoline sulfate for 4 to 5 hours at about 8° C, rinsed with tap water, fixed with Carnoy (1:1:2 95% ethyl alcohol, chloroform, glacial acetic acid) for 30 minutes at about 8° C, hydrolyzed with 1 normal hydrochloric acid at 60° C for 5 to 7 minutes, and soaked in 45% acetic acid for approximately 15 minutes. Prior to squashing, the cap was removed from the root tip on a microscope slide in 45% acetic acid under a dissecting microscope. Aceto-orcein stain was added to the preparation which was placed in a petri dish saturated with 45% acetic acid vapor for at least 15 minutes after which it was squashed and sealed with sticky dental wax. Chromosomes were observed and counted using a Leitz Wetzlar microscope at magnifications of 400X and 1,000X.

Photographs in color (Kodachrome II) and black-and-white (Kodak Pan-X) were taken of all species and hybrids which flowered in lieu of herbarium voucher specimens which will remain on file in the Department of Horticulture at the University of Hawaii. Photomicrographs of

chromosomes and seeds containing normal and aborted embryos were taken with a Zeiss photomicroscope at magnifications of 100X and 400X.

Table I

Cymbidium species used in this investigation with authors and sources of material

species	source
C. aliciae Quisumbing	Lloyd De Garmo, Calif.
C. aloifolium Swartz	Everglades Orchids, Florida Hausermann Orchids, Illinois University of Hawaii
var album	Emma Menninger, Calif.
C. aspidistrifolium Fukuyama	Rex van Delden, Calif.
C. bicolor Lindley	Emma Menninger
C. canaliculatum Brown var marginatum	Jones and Scully, Florida
var sparkesii	Jones and Scully Lloyd De Garmo
C. chloranthum Lindley 'Singapore'	Emma Menninger
C. chuen-lan	Ilgenfritz Orchids, Michigan
C. cochlearis Benth. and Hooker	Everglades Orchids Hausermann Orchids
C. cyperifolium Wallich	Everglades Orchids
C. dayanum Reichb.	Stewarts Orchids, Calif.
C. devonianum Lindley	Lloyd De Garmo Ilgenfritz Orchids
C. eburneum Lindley	Lloyd De Garmo Everglades Orchids
C. elegans	Lloyd De Garmo
C. ensifolium Swartz var album	Everglades Orchids Stewarts Orchids
var concolor	Rev. Masao Yamada, Hawaii

Table I (continued)

Cymbidium species used in this investigation with authors and sources of material

species	source
var *niveo-marginatum*	Rex van Delden
C. erythrostylum Rolfe 'Charlesworth'	Lloyd De Garmo
C. faberi Rolfe	Everglades Orchids
C. finlaysonianum Lindley	Lyon Arboretum, Hawaii
C. formosanum Hayata	Stewarts Orchids
C. giganteum	Lloyd De Garmo
C. gracillimum Fukuyama	Everglades Orchids Stewarts Orchids
C. grandiflorum	Everglades Orchids Hausermann Orchids
C. gyokuchin Makino 'Monterey'	Rex van Delden
C. hoosai Makino	Lloyd De Garmo
var *album* 'White Jade'	Rex van Delden
var *kinkwalan* sub var *fayden*	Lloyd De Garmo
C. i'ansonii Rolfe	Santa Barbara Orchid Estate, Calif.
C. illiberale Hayata	Ilgenfritz Orchids
C. insigne Rolfe 'Bierii'	Stewarts Orchids
'Westonbirt'	Emma Menninger
C. kanran Makino	Everglades Orchids
'Taiwan Purple'	Lloyd De Garmo
C. koran Makino var *album*	Stewarts Orchids

Table I (continued)

Cymbidium species used in this investigation
with authors and sources of material

species	source
C. lancifolium Hooker	Rex van Delden
C. longifolium Don	Lloyd De Garmo
'Yellow'	Emma Menninger
C. lowianum Reichb. var concolor	Emma Menninger
'St. Albans'	Stewarts Orchids
C. madidum Lindley	Lloyd De Garmo Emma Menninger Jones and Scully University of Hawaii
'Arcadia'	Emma Menninger
'Leroyi'	Emma Menninger
C. munronianum	Emma Menninger Everglades Orchids
C. oikwakensis	Ilgenfritz Orchids
'Tartar'	Lloyd De Garmo
C. parishii Reichb. var sanderae	Lloyd De Garmo
C. pendulum Swartz	Foster Botanic Garden, Hawaii
C. pumilum Rolfe var album	Lloyd De Garmo
'Chiyoda Nishiki'	Emma Menninger
'Jitzugetzu'	Lloyd De Garmo
var kenruken 'Emerald'	Lloyd De Garmo
'Myosho'	Rex van Delden
'Yashima'	Santa Barbara Orchid Estate

Table I (continued)

Cymbidium species used in this investigation
with authors and sources of material

species	source
C. purpureo-hiemale	Stewarts Orchids
C. rectum Ridley	Emma Menninger
C. roseum Smith	Ilgenfritz Orchids
C. siamense Rolfe	Lloyd De Garmo Emma Menninger University of Hawaii
C. simonsianum K. and P.	Ilgenfritz Orchids
C. sinense Willdenow	Everglades Orchids
var alba 'Jucundissimum'	Lloyd De Garmo
C. soshin	Rev. Masao Yamada
var album	Rev. Masao Yamada
'Tetukotsu'	Lloyd De Garmo
C. suavissimum	Emma Menninger
C. tigrinum Parish	Lloyd De Garmo
C. tracyanum Rolfe	Lloyd De Garmo Everglades Orchids Hausermann Orchids
C. tsukensis	Ilgenfritz Orchids
C. virescens Lindley	Lloyd De Garmo
C. whiteae K. and P.	Lloyd De Garmo

Table II

Cymbidium hybrids used in this investigation
with parents and source of material

Primary hybrids

cross	parents	source
C. Cherry Blossom	C. erythrostylum x C. pumilum	Lloyd De Garmo
C. Cricket	C. devonianum x C. madidum	Lloyd De Garmo
C. Eburneo-Lowianum 'Concolor'	C. eburneum x C. lowianum	Lloyd De Garmo
C. Faridah Hishim	C. ensifolium x C. finlaysonianum	Lloyd De Garmo
C. Ensi-Canal	C. ensifolium x C. canaliculatum var sparkesii	Rex van Delden
C. Little Black Sambo	C. madidum x C. canaliculatum	Lloyd De Garmo
C. Miss Muffit	C. devonianum x C. pumilum	Lloyd De Garmo
C. Pali	C. ensifolium x C. tracyanum	Rev. Masao Yamada

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
C. Pee Wee	*C. pumilum* var *album* x *C. madidum*	Lloyd De Garmo
C. Penguin	*C. pendulum* x *C. canaliculatum* var *sparkesii*	Lloyd De Garmo Emma Menninger
C. Petite	*C. pumilum* x *C. virescens*	Lloyd De Garmo
C. Pied Piper	*C. devonianum* x *C. canaliculatum*	Lloyd De Garmo Emma Menninger
C. Scallywag	*C. pumilum* x *C. suave*	Emma Menninger
C. Vogelsang	*C. devonianum* x *C. insigne*	Lloyd De Garmo
----------	*C. aloifolium* x *C. pumilum*	Lloyd De Garmo
----------	*C. canaliculatum* x *C. pumilum*	Emma Menninger

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
----------	C. chloranthum x C. soshin	Emma Menninger
----------	C. hoosai x C. lancifolium	Lloyd De Garmo
	Cymbidium secondary hybrids	
C. Ayako Tanaka 'Colombia'	C. ensifolium x C. Alexanderi	Alberts and Merkel Bros, Inc., Florida
'Delray'	C. ensifolium x C. Alexanderi	Alberts and Merkel Bros, Inc.
C. Balan 'Chelsea'	C. pumilum x C. Halycon	Stewarts Orchids
C. Blue Smoke 'Green Meadows'	C. lowianum x C. Mirabel	Stewarts Orchids
C. Early Bird 'Pacific'	C. Edward Marshall x C. erythrostylum	Emma Menninger
C. Fair Green	C. pumilum x C. Fanfare 'Sierra Spring'	Loren Johnson, Calif.

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
C. Fairy Wand	*C.* Princess Maria x *C. pumilum*	Emma Menninger
C. Fifi	*C. madidum* x *C.* Argonaut	Alberts and Merkel Bros, Inc.
C. Geraint 'Malibu'	*C. pumilum* x *C.* Jungle	Loren Johnson
C. John-John Fry 'Dos Pueblos'	*C. virescens* x *C.* San Miguel	Loren Johnson
C. Koolau	*C. sinense* x *C.* Swallow	Rev. Masao Yamada
C. Mary Pinchess 'Yellow Cast'	*C. pumilum* x *C.* Pajaro	Loren Johnson
C. Minijenn	*C.* Jean Brummitt x *C. pumilum*	Emma Menninger
C. Nancy Carpenter	*C.* Korintji 'Golden Showers' x *C. chloranthum*	Everglades Orchids
C. Nonna 'Golden Glades'	*C. madidum* x *C.* Alexanderi	Alberts and Merkel Bros, Inc.

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
C. Pat Ann 'Apollo'	C. madidum x C. Apollo	University of Hawaii
C. Peter Pan 'Greensleeves' (2n & 4n)	C. ensifolium x C. Miretta	Alberts and Merkel Bros, Inc. Everglades Orchids
C. Pinafore 'Comet'	C. pumilum x C. Pauwelsii	Wilbur Chang, Hawaii
C. Pipeta 'Chiquita'	C. pumilum x C. Spartan Queen	Florence Crumley, Calif.
C. Starbright	C. pumilum x C. Lyoth	Lloyd De Garmo
C. Sweetheart	C. pumilum x C. Alexanderi	Akatsuka Farms, Hawaii
C. Sweet Lime	C. madidum x C. Esmeralda	Alberts and Merkel Bros, Inc.
C. Tiger Tail 'Canary'	C. tigrinum x C. Alexanderi	Red McLellan Co., Calif.
C. Yellow Scamp	C. madidum x C. Balkis	Alberts and Merkel Bros, Inc.

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
----------	*C. canaliculatum* var *sparkesii* x *C.* Korintji	Rex van Delden
----------	*C. dayanum* x *C.* Alexanderi 'Album'	Lloyd De Garmo
----------	*C. elegans* x *C.* Esmeralda 'AM'	Lloyd De Garmo
----------	*C. formosanum* x *C.* Greenwood	Lloyd De Garmo
----------	*C. hoosai* 'Ireland' x *C.* Carisona 'Glendessa'	Everglades Orchids
----------	*C. parishii* var *sanderae* x *C.* Balkis 'Nevada'	Everglades Orchids
----------	*C. parishii* var *sanderae* x *C.* Babylon 'Castle Hill'	Everglades Orchids
----------	*C. parishii* x *C.* George Lycurgas 'Vivid'	Everglades Orchids

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

Cymbidium advanced hybrids

cross	parents	source
C. Arabian Nights	C. Sussex x C. Balkis	personal collection
C. Artisan '31065'	C. Dorama x C. Babylon	Stewarts Orchids
C. Balkis 'Nevada'	C. Alexanderi x C. Rosanna	Everglades Orchids Red McLellan Co.
C. Barcelona 'Magic Wand'	C. Aureole x C. Peri	personal collection
C. Biak 'Hercules'	C. Fascination x C. Swallow	Stewarts Orchids
C. Bethlehem 'Magi'	C. Frederica x C. Earlyana	personal collection
C. Cleo Sherman '#1'	C. Alexanderi x C. Babylon	personal collection
C. Coral Sea 'Triumph'	C. Swallow x C. Babylon	personal collection

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
C. Edna Cobb 'Spring Aria'	C. Profita x C. Balkis	personal collection
C. Eureka 'Golden Nugget'	C. Esmerella x C. Balkis	personal collection
C. Fred Stewart 'Silver Light'	C. Early Bird x C. Balkis	personal collection
C. Gareth 'Latangor'	C. Sweetheart x C. Nereid	Loren Johnson
C. George Lycurgas 'Vivid'	C. Maya x C. Apollo	personal collection
C. Good News '#1'	C. Earlyana x C. Matana	personal collection
C. Honeyway 'George Off'	C. Swallow x C. Claudona	personal collection
C. Jolity 'Golden Heritage'	C. Eagle x C. Hanburyanum	personal collection
C. Lillian Stewart 'Pink Parfait'	C. Balkis x C. Carisona	personal collection

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
'Treva'	C. Balkis x C. Carisona	personal collection
C. Lump O' Gold 'Glitter'	C. Apollo x C. Pearl	personal collection
'2068'	C. Apollo x C. Pearl	University of Hawaii
C. Madrid 'Forest King'	C. Vale of Kashmir x C. Peri	Loren Johnson
C. Mary Ann 'Sally'	C. Pearl-Easter x C. Rosanna	personal collection
C. Matana 'Maxine'	C. Claudette x C. Rambodia	Rex van Delden
C. New Orleans '#1'	C. Priam x C. Balkis 'Silver Orb'	personal collection
C. Pelleas 'San Diego'	C. Sweetheart x C. Claucis	personal collection
C. Poona	C. Balkis 'Nevada' x C. George Lyeurgus	Everglades Orchids

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
C. Priam 'Gypsy Fire'	C. Ceres x C. President Wilson	Stewarts Orchids
C. San Francisco 'Dos Pueblos Special'	C. Blue Smoke x C. Balkis	personal collection
C. Showgirl 'Copelis'	C. Sweetheart x C. Alexanderi	Jones and Scully
'Kate Hepburn'	C. Sweetheart x C. Alexanderi	Jones and Scully
'Micheline'	C. Sweetheart x C. Alexanderi	Jones and Scully
C. Sicily '2455'	C. Baldur x C. Grand Monarch	University of Hawaii
C. Sound of Music '#1'	C. Coral Sea 'Triumph' x C. Paracel 'Picture'	personal collection
C. Sussex 'Glendessary'	C. Landrail x C. Profusion	personal collection
C. Sussex Dawn 'Chartreuse Lime Alba'	C. Sussex x C. Ramboda	Florence Crumley

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
'Wintergreen Alba'	C. Sussex x C. Rambodia	Florence Crumley
C. Suva 'Lucifer'	C. Volcano x C. Saigon	personal collection
C. Sylvia Miller	C. Mary Pinchess x C. Sussex	Wilbur Chang
----------	C. Balkis 'Nevada' x C. Babylon 'Castle Hill'	Everglades Orchids
----------	C. George Lyeurgus 'Vivid x C. King Arthur 'The King'	Everglades Orchids
----------	C. Paracel 'Picture' x C. Volcana 'Diable	personal collection
----------	C. Pali x (C. soshin x C. Pali)	Rev. Masao Yamada
----------	C. Peter Pan 'Greensleeves' x C. Matana 'Maxine'	Everglades Orchids

Table II (continued)

Cymbidium hybrids used in this investigation
with parents and source of material

cross	parents	source
----------'#1'	*C.* Red Imp x *C.* Babylon 'Castle Hill'	Wilbur Chang
----------'#2'	*C.* Red Imp x *C.* Babylon 'Castle Hill'	Wilbur Chang

Table III

Species and hybrids of genera other than Cymbidium used in this investigation with authors or parents and source of material

species/cross	parents	source
Ansellia africana Lindley		University of Hawaii
Ansellia gigantea Reichb.		Foster Botanic Garden
Ansidium Pasatiempo	C. madidum x A. gigantea	Lloyd De Garmo
Bletia sp		Everglades Orchids
Calanthe vestita rubro-oculatum Lindley		personal collection
Calanthe sp		Foster Botanic Garden
Catasetum oerstedii Reichb.		Foster Botanic Garden
Catasetum thylaciochilum Lem.		Stewarts Orchids
Catasetum Rebecca Northen		Stewarts Orchids
Chysis bractescens Lindley		Stewarts Orchids
Chysis laevis Lindley		personal collection
Coelogyne ochracea Lindley		personal collection
Cycnoches maculatum Lindley		Stewarts Orchids

Table III (continued)

Species and hybrids of genera other than Cymbidium used in this investigation with authors or parents and source of material

species/cross	parents	source
Cycnoches ventricosum var chlorochilon Batem		Stewarts Orchids
Cymbidiella flabellata Rolfe		Jones and Scully
Cyrtopodium poecilum Reichb.		Foster Botanic Garden
Cyrtopodium lyonii		Foster Botanic Garden
Eulophia caffra Reichb.		Foster Botanic Garden
Eulophia kirkii Rolfe		Foster Botanic Garden University of Hawaii
Eulophia nuda Lindley		personal collection
Grammangis ellisii Reichb.		Jones and Scully
Grammatophyllum fenzlianum Reichb.		Jones and Scully
Grammatophyllum measurianum Reichb.		Ilgenfritz Orchids
Grammatophyllum papuanum Smith		Foster Botanic Garden
Grammatophyllum scriptum Blume		Everglades Orchids Hausermann Orchids
Grammatophyllum scriptum Blume 'Lutino'		Jones and Scully

Table III (continued)

Species and hybrids of genera other than *Cymbidium* used in this investigation with authors or parents and source of material

species/cross	parents	source
Grammatophyllum scriptum Blume 'The Governor'		Milton Warne, Hawaii
Grammatophyllum speciosum Blume		Milton Warne
Phaiocalanthe _____	*C. sanderiana* x *P.* Gravesiae	Fennell Orchids, Florida
Phaiocalanthe _____	*P.* Gravesiae x *C.* Lord Rothschild	Fennell Orchids
Phaiocalanthe _____	*P.* Gravesiae x *C.* Veitchi	Fennell Orchids
Phaiocymbidium Chardwarense	*C. giganteum* x *P. grandifolius*	Lloyd De Garmo
Phaius maculatus Lindley		Rex van Delden
Phaius tankervillae Blume		University of Hawaii
Phaius wallichi Lindley		Everglades Orchids
Phaius Ashworthianus	*P. maculatus* x *P. wallichi*	Rex van Delden
Sobralia macrantha Lindley		Foster Botanic Garden

Table III (continued)

Species and hybrids of genera other than Cymbidium used in this investigation with authors or parents and source of material

species/cross	parents	source
Spathoglottis plicata Blume		Lyon Arboretum
Spathoglottis Pacifica		Everglades Orchids
Spathoglottis Primson	S. Parsonii x S. Primrose	Everglades Orchids
Spathoglottis Singapore 'Giant'		Everglades Orchids
Spathoglottis hybrid		Lyon Arboretum
Spathoglottis hybrid 'Kalfred Yee'		Kalfred Yee, Hawaii
_____ _____	Bletilla hzacinthus var alba x Phaius wallichi	Lloyd De Garmo

RESULTS AND DISCUSSION

I. Chromosome numbers

Determinations of chromosome number were made for 119 clones of 88 species and hybrids of Cymbidium. Of the Cymbidium counted there were 89 diploids, 15 triploids, 12 tetraploids, 1 hexaploid, and 2 aneuploids. Counts for 92 clones of 61 species and hybrids of Cymbidium are being reported for the first time. Chromosome number determinations were also made for 44 clones of 33 species, hybrids, and supposed hybrids involving 10 genera other than Cymbidium. On 17 occasions chromosome counts of somatic cells were used to determine the hybrid status of the subject plants. Thirteen plants were determined to be valid intergeneric hybrids while 4 were determined to be false hybrids. Chromosome counts of 21 species and hybrids other than Cymbidium are being reported for the first time.

Nine polyploid plants, including one mixoploid, were recovered from seedlings of 8 hybrid crosses that were treated with colchicine. A portion of the germinated protocorms of these 8 and other crosses were treated with a .05% aqueous colchicine solution for 7 days. The polyploid plants were selected from the treated seedling populations because they showed phenotypic characteristics known to be associated with polyploidy. No attempt was made to determine the success of the colchicine treatments in terms of percent conversion to a polyploid level. It is probable that other polyploids, especially mixoploids, resulted from colchicine treatments but were overlooked because they did not exhibit obvious vegetative characteristics of polyploidy. The

colchicine-converted polyploids appear in the various tables of chromosome numbers and in the discussion with a "C" as part of their clonal epithet.

Chromosome counts of 59 varieties of 42 Cymbidium species were determined (Table IV). Counts for 35 varieties of 19 species are being reported for the first time. Only 2 deviations from the diploid number of 40 were found. Cymbidium insigne 'Bierii' and C. pumilum 'Yashima' were both found to be triploid with 60 chromosomes each. These could be progenies of diploid and tetraploid matings or diploid and diploid matings where 1 parent contributed an unreduced gamete. Chromosome counts are now reported for 53 Cymbidium species. Synonyms have been used in the literature for some species, i.e., C. iridifolium, C. madidum, and perhaps others, so the actual number of species whose chromosome numbers are known is something less than 53.

Chromosome counts of 22 clones of 16 Cymbidium primary hybrids, none of which had been previously reported, were determined (Table V). One triploid and 2 tetraploids were found. Cymbidium Faridah Hishim 'UH-2' has 60 chromosomes. The origin of its triploidy is by 1 of the 2 means described for the 2 species above. Cymbidium Little Black Sambo 'UH-10' has 80 chromosomes. Spontaneous doubling of somatic chromosomes or the union of 2 unreduced gametes is probably responsible for the tetraploid nature of this plant. A seedling, 'UH-C-1', of the unnamed cross of C. madidum x C. hoosai var kinkwalan sub var fayden has 80 chromosomes. The seedling was subjected to colchicine treatment while in the protocorm stage. Its tetraploid nature is probably the result of the colchicine treatment.

The chromosome counts of 22 clones of 19 Cymbidium secondary hybrids were determined (Table VI). Counts of 20 clones of 17 of these hybrids had not been previously reported. Six triploids, 4 tetraploids, and 1 aneuploid were found among 22 clones counted. Cymbidium Early Bird 'Pacific' was found to be a tetraploid with 80 chromosomes. Mehlquist (1952) also reported that this plant was a tetraploid. The colchicine-treated plants of C. Blue Smoke 'Green Meadow' (UH-C-1), C. Peter Pan 'Greensleeves' (UH-2), and a seedling, UH-C-1, of the unnamed cross of C. Starbright x C. hoosai var kinkwalan sub var fayden were also found to be tetraploids having 80 chromosomes. Cymbidium Mimi 'Sandalwood' and seedlings of the unnamed crosses of C. parishii var sanderae x C. Babylon 'Castle Hill', C. Korintji 'Golden Showers' x C. canaliculatum var sparkesii, and C. Peter Pan 'Greensleeves' (UH-2) x C. madidum were all found to be triploids with 60 or near 60 chromosomes. A seedling, 'UH-1', of the unnamed cross of C. Starbright x C. canaliculatum var sparkesii is an aneuploid with 48 chromosomes. Uneven reduction of maternal chromosomes during gametogenesis probably accounts for its aneuploid condition. A partially reduced gamete from the hybrid female parent containing 28 chromosomes united with a normally reduced gamete from the species male parent would result in a progeny having 48 somatic chromosomes.

The ploidy levels of the exact clones used to make C. Early Bird 'Pacific' have not been reported. No other tetraploid forms of this cross are known and it is assumed that the paretns were diploids. The tetraploid nature of C. Early Bird 'Pacific' must then be due to the union of 2 unreduced gametes or spontaneous doubling of somatic

chromosomes in the zygotic or later stages of development. The latter is the more likely mode of origin. The other tetraploids reported here are products of apparently effective colchicine treatments. The triploid nature of C. Mimi 'Sandalwood' and the unnamed hybrid of C. Korintji 'Golden Showers' x C. canaliculatum var sparkesii are probably due to the contribution of unreduced gametes by 1 of their parents. None of the parent plants as available for this study but other members of each of these crosses are said to be diploids (personal communication with Menninger, Hetherington 1975). The other 4 triploids reported here are products of tetraploid hybrids crossed with diploid species.

Chromosome counts of 16 clones of 11 Cymbidium advanced hybrids were determined (Table VII). Only 1 of these clones had been previously reported. The plants were selected on a non-random basis choosing those clones which showed atypically coarse and heavy-textured vegetative characteristics in an attempt to identify polyploid clones for future breeding purposes. The subject plants were in various stages of maturity. Some were taken from flasks, community pots, or small individual pots while others were mature or nearly mature plants. Some had been previously treated with colchicine and these are identified with a "C" in the clonal epithet. Of the 16 determinations made only 2 were diploid while 6 were triploid, 6 were tetraploid, 1 was hexaploid, and 1 was aneuploid. The 8 diploid and triploid plants were not unexpected based on their genealogy. Each of the triploids had a tetraploid for 1 parent. Three of the 6 tetraploids were also not unexpected. Cymbidium Balkis 'Nevada' and 'Silver Orb' and Fred Stewart 'Silver Light' are all products of tetraploid by tetraploid breeding. The remaining

tetraploid, hexaploid, and aneuploid plants are polyploids for other reasons.

Cymbidium Little Black Sambo 'UH-1' is a spontaneous tetraploid which appeared in an S_1 population of the diploid primary hybrid C. Little Black Sambo 'UH-2'. It is possible that the pollen and egg both contributed unreduced gametes, but it is more likely that spontaneous somatic doubling of the chromosomes occurred after a diploid zygote had been formed. Cymbidium Little Black Sambo 'UH-C-1' is from the same S_1 population but from a protocorm that had received colchicine treatment. It is a tetraploid probably as a result of an effective colchicine treatment. The unnamed cross of C. Mimi 'Sandalwood' x C. Vogelsang, triploid and diploid respectively, produced a tetraploid offspring, 'UH-1'. This is probably the result of an unreduced gamete from the triploid maternal parent united with a normally reduced gamete from the diploid paternal parent. The ca 120 chromosome count for the hexaploid C. Bethlehem 'Magi' (UH-1) is a confirmation of unpublished data collected by the author's previous studies. At that time a chromosome count of 120 was recorded. The plant was produced by tissue culture and treated with colchicine in the protocorm-like-body stage. The type clone has been counted as a triploid with 60 chromosomes and appears in this work as C. Bethlehem 'Magi' (UH-2). The unnamed cross of C. Fairy Wand x C. Peter Pan 'Greensleeves' (UH-2), diploid and tetraploid respectively, produced an aneuploid offspring, 'UH-1', with ca 90 chromosomes. Although the count is an approximation, it is probably accurate within 1 or 2 chromosomes. Its ploidy level is definitely higher than tetraploid and lower than pentaploid. The

unusual chromosome number is not easily explained. An unreduced gamete from either parent united with a normally reduced gamete from the other parent does not explain this unusual chromosome number. Cymbidium Fairy Wand is a C. pumilum hybrid and C. pumilum hybrids are known to be highly erratic during meiosis (Wimber 1957c). This particular clone, when crossed with other Cymbidium, however, has produced viable crosses and seedlings 5 times in 12 pollinations, 41.7%. As a male parent it has been completely sterile, failing to induce even a seed pod during any of the 11 times its pollen was used on other Cymbidium. Cymbidium Peter Pan 'Greensleeves' (UH-2) is a colchicine-converted tetraploid and has, when crossed onto other Cymbidiums, produced viable crosses and seedlings 14 times in 49 attempts, 28.6%. As a female parent it has shown equal fertility having produced viable crosses and seedlings 6 times in 21 attempts, also 28.6%. The unusual chromosome number of the progeny of this cross can be accounted for in 3 ways: 1) both of the parents could have given partially-reduced gametes totaling ca 90 chromosomes, 2) a normally reduced gamete from C. Fairy Wand could have united with a partially-reduced gamete from C. Peter Pan containing ca 70 chromosomes, or 3) a partially-reduced gamete from C. Fairy Wand containing ca 25 chromosomes could have spontaneously doubled before being united with a normally reduced gamete from C. Peter Pan. Additional cytological work should be undertaken with this and other seedlings of this cross as well as meiotic analysis of both parents.

Chromosome counts were obtained for 28 seedlings of 19 intergeneric pollinations (Table VIII). A positive hybrid status was determined for 13 seedlings of 11 crosses involving 2 intergeneric combinations:

Cymbidium x Ansellia and Cymbidium x Catasetum. No Cymbidium x Catasetum combination has ever been reported while only 2 Cymbidium x Ansellia crosses have been reported (R.H.S. 1972).

A negative hybrid status was determined for 4 seedlings of 3 pollinations involving 3 intergeneric combinations: Bletia x Phaius, Phaius x Ansellia, and Phaius x Spathoglottis. In each of these cases the chromosome numbers of the plants crossed are quite different. The 4 seedlings counted had chromosome numbers identical to that of the female parent. These seedlings were probably apomictically produced from the mother plant.

The hybrid status of 11 plants of 9 pollinations involving 5 intergeneric combinations remains undetermined although 6 of the plants appear to be, and 1 appears not to be, valid hybrids based on morphological features of the plants. These plants of undetermined origin are from the following intergeneric pollinations: Cymbidium x Ansellia, Cymbidium x Grammatophyllum, Calanthe x Phaius, Phaius x Cymbidium, and Spathoglottis x Ansellia.

A somatic chromosome number of 41 was determined for 10 hybrids of Cymbidium and Ansellia. Since the chromosome number of Ansellia is 42, the counts apparently validate the hybrid status of the plants in question. Two tetraploid Ansidium were produced via colchicine treatment. They are C. Little Black Sambo x A. africana and C. Starbright x A. africana, clones 'UH-C-3' and 'UH-C-1' respectively. Two plants of Cymbidium by Ansellia pollinations had ca 41 chromosomes and 1, a spontaneous tetraploid, had ca 82. They all show vegetative characteristics intermediate between the 2 parental genera and appear to be

valid hybrids. One plant, 'UH-2' of the cross C. Fairy Wand x A. africana was determined to have ca 41 chromosomes but shows no influence of its Ansellia parent. It may be an apomictically produced C. Fairy Wand. Another plant 'UH-1', from the same cross was determined to have exactly 41 chromosomes and does have intermediate vegetative characteristics and apparently is a true Ansidium hybrid.

One hybrid cross of Cymbidium x Catasetum was obtained. The female parent was the primary hybrid C. hoosai x C. lancifolium and the male parent was the species Catasetum fimbriatum. The floral and vegetative parts of the 2 parents are morphologically very dissimilar as are their chromosome numbers. The chromosome number of C. fimbriatum is 108 (Jones and Daker 1968). About 100 seedlings of this cross were obtained. The seedlings are very slow growing and very uniform in appearance. Vegetatively, their appearance is much more like Catasetum than Cymbidium. Ten metaphase plates were examined from a single seedling of this cross, 'UH-1'. Four cells were determined to have ca 74 chromosomes while 6 had exactly 74. The seedling is apparently a valid hybrid with one 20 chromosome genome from Cymbidium and one 54 chromosome genome from Catasetum. The balance of this seedling population may also be valid hybrids.

Chromosome counts were made on 4 seedlings of 2 Cymbidium x Grammatophyllum crosses. Because the chromosome number of Grammatophyllum scriptum (the species used in these crosses) is, as for Cymbidium, 40, it is risky to determine the hybrid status of the progeny based on chromosome numbers. Two of these seedlings had been subjected to a colchicine treatment; 'UH-C-1' and 'UH-C-2' of the cross C. Red Star x

G. scriptum 'The Governor'. 'UH-C-1' is a mixoploid with both diploid and tetraploid cells. Of 28 cells counted from 3 different root tips, 18 cells had 40 chromosomes while 10 had 80. Each of the 3 root tips contained diploid and tetraploid cells. 'UH-C-2' is a tetraploid with 80 chromosomes in each cell observed. Two other seedlings, 'UH-3' of the above cross and a seedling of the cross of (C. hoosai x C. lancifolium) x G. scriptum were determined to be diploid with 40 chromosomes.

An unusual chromosome number of ca 56 was obtained for the intergeneric hybrid of Calanthe Lord Rothschild x Phaius Gravesiae. The hybrid Calanthe Lord Rothschild is unregistered and of unknown origin and was unavailable for this work. The origin of the chromosome number of its intergeneric progeny, therefore, remains obscure. No recorded Phaius species or hybrid has a chromosome number greater than 50 and only 1 Calanthe species is reported to have greater than 44 chromosomes. There is a triploid, and perhaps sterile form of C. tricarinata which has 60 chromosomes (Ito and Mutsuura 1958; Mutsuura 1959; and Mutsuura and Nakahira 1958). It is suspected that polyploidy or aneuploidy may be involved at some point in the genealogy of this hybrid.

The supposed intergeneric hybrid Phaiocymbidium Chardwarense, allegedly a hybrid of Phaius grandifolius (tankervillae) x Cymbidium giganteum has 44, 45, or 46 chromosomes. Jones (Withner 1974) states that the number is either 44 or 45. The chromosome numbers that have been determined by the author for the alleged Phaius and Cymbidium parents are 50 and 40, respectively. Others have reported these same numbers previously. Jones (Withner 1974) further states that the chromosome number and highly irregular meiotic behavior confirm that

this plant is a hybrid between chromosomally distinct parents, but he does not identify them. Without additional information it would appear that Phaiocymbidium Chardwarense is in fact a hybrid.

Upon close examination of the alleged hybrid and its parents, however, one finds no contribution from the supposed Cymbidium parent to the vegetative morphology of the hybrid. The hybrid appears to be a pure Phaius for every vegetative characteristic examined: roots, pseudobulbs, leaves, and inflorescence. The only possible contribution of the Cymbidium parent would be the yellow flower color. The floral morphology is very much Phaius but the yellow color could not have come from P. tankervillae. Cymbidium giganteum, although usually green, is a source of genes for yellow in hybrid Cymbidium. Phaius maculatus, a yellow flowered species, is believed by some to be in the parentage of this hybrid.

The chromosome number of P. maculatus has been determined in this work to be ca 42. Phaius flavus is another yellow-flowered species with a chromosome number of 42 (Pancho 1965a,b). It is conceivable that either P. maculatus or P. flavus, if crossed with P. tankervillae, could yield progeny with characteristics similar to those of the Phaiocymbidium Chardwarense. Theoretically, the chromosome numbers of either of these crosses would be 46.

The species P. wallichii is strikingly similar to P. tankervillae and may be just a varietal form of it. It also has ca 50 chromosomes. Phaius wallichii when crossed with P. maculatus makes the hybrid P. Ashworthianus. A plant of P. Ashworthianus was obtained for this work and grown under identical environmental conditions as Phaiocymbidium

Vegetative morphology of Phaiocymbidium Chardwarense and Phaius Ashworthianus

Fig. 1. Phaiocymbidium Chardwarense (0.10X)

Fig. 2. Phaius Ashworthianus (0.13X)

Floral morphology of Phaiocymbidium Chardwarense and Phaius Ashworthianus

Fig. 3. Phaiocymbidium Chardwarense (0.75X)

Fig. 4. Phaius Ashworthianus (0.50X)

Chardwarense. Phaius Ashworthianus has ca 46 chromosomes in its somatic cells.

The 2 plants are remarkably similar for all observable characteristics. All of the vegetative and floral characteristics are almost alike. They both produce new growths, inflorescences, and flowers at the same time. Both of these plants have been used in breeding with each other, and other Phaius and Cymbidium species and hybrids. Both are sterile as both male and female parents. The degree of similarity between these 2 plants makes it difficult to believe that they, as their registrations indicate, do not have in common a single species in their genealogy. The author is of the opinion that Phaiocymbidium Chardwarense is actually a variety of P. Ashworthianus or some very similar Phaius breeding.

Phaiocymbidium Chardwarense has been tissue cultured and treated with colchicine in an attempt to produce a tetraploid with restored fertility. If a fertile plant can be obtained via this means, an S_1 population of it may show enough segregation so that an accurate determination of its origin can be made. In the event that it is a Phaius x Cymbidium hybrid, it may serve as a bridge to incorporating genes for warm temperature tolerance and large flower size from the same source into Cymbidium.

Seedlings from pollinations of Bletia x Phaius, Phaius x Ansellia, and Phaius x Spathoglottis had chromosome counts of 32, 50, and 50 respectively. These counts are identical to those of the female parents and considerably different from the numbers one would expect of hybrids. The seedlings were probably apomictically produced from

the maternal parent. A Spathoglottis x Ansellia mating has produced a seedling with ca 40 chromosomes. The hybrid status of the seedling cannot be determined at this time.

Chromosome number determinations were made for 16 clones of 14 species of 8 genera other than Cymbidium (Table IX). Seven of these species had not been previously reported. Three clones of Ansellia africana, 'UH-5', 'UH-7', and 'UH-10' were determined to have 42 chromosomes each. Ansellia gigantea was found to have 42 chromosomes. Neither of these 2 species had been previously reported, although A. nilotica was reported by Tanaka (1964a) as having 42 chromosomes. Many observers are of the opinion that A. africana, A. gigantea, A. nilotica, and all other supposed species are no more than subspecies or varietal forms of a highly variable monotypic genus Ansellia. The present counts may, therefore, be only confirmations of the previously reported chromosome number for the genus. Calanthe vistata var rubro-oculata was determined to have 40 chromosomes which is consistent with Hoffmann's (1930) report that the species has 20 gametic chromosomes. Eulophia caffra, E. keithii, and E. speciosa were determined to have 48, 40, and 48 chromosomes respectively. Counts for none of these species had been previously reported and only 10 species (including those studied in this investigation) and 1 unknown species of the approximately 200 species in the genus (Withner 1959) have been reported. Of these 11 reports, however, there are 6 different somatic chromosome numbers. The others reported are E. macrostachya, E. squalida, and E. stricta each with 2n=32 (Pancho 1965a), E. sp. with n=16 and 2n=32 (Sampathkumaran and Seshagiriah 1931), E. geniculata with n=19 and 2n=38 (Chatterji 1965),

Table IV

Chromosome numbers of *Cymbidium* species

Species	Present Count 2n	Previous Counts 2n	n	Authority
C. aliciae	40			
C. aloifolium	40		20	Mehra and Vij '70
		40		Sharma and Chatterji '66
		40		Pancho '65 a,b
		40		Naka. and Moro. '64
		40		Mehlquist '52
		32	16	Sampath. and Sesha. '31
var *album*	40			
C. aspidistrifolium	40			
C. atropurpureum		40		Pancho '65a
C. bicolor	40		20	Swamy '41
'Ceylon'	ca 40			
C. canaliculatum var *marginatum*	40			
var *sparkesii*	40			
C. chloranthum	40			
C. chuen-lan	40			
C. cochleare	ca 40	40		Wimber '57a

Table IV (continued)

Chromosome numbers of *Cymbidium* species

Species	Present Count 2n	Previous Counts 2n	n	Authority
C. cyperifolium	40			
C. dayanum	40	40		Tanaka '65a
		40		Mut. and Nakahira '60
		40		Mut. and Nakahira '58
var *austro-japonicum*		40		Tanaka '65
C. devonianum	40		20	Mehra and Vij '70
		40		Wimber '57a
C. eburneum	40	40		Wimber '57a
		40		Mehlquist '52
x self 'UH-1'	40			
x self 'UH-2'	40			
C. ensifolium	40	40		Tanaka '65a, '62
		40		Wimber '57a
var *album*	40			
var *concolor*	ca 40			
C. erythrostylum		40		Wimber '57a
		40		Mehlquist '52, '49
'Charlesworthii'	40			
C. faberi	40	40		Love and Love '69

Table IV (continued)

Chromosome numbers of *Cymbidium* species

Species	Present Count 2n	Previous Counts 2n	n	Authority
C. finlaysonianum	40	40		Pancho '65a,b
		40		Mehlquist '52
C. forestii		40		Wimber '57a
C. formosanum	40			
C. giganteum	40	40		Sharma and Chatterji '66
		40		Wimber '57a
		40		Mehlquist '52
C. gracillimum	40			
C. grandiflorum		40		Wimber '57a
		40		Mehlquist '52
'Westonbirt'		40		Mehlquist '52
C. gyokuchin	40	40		Kamemoto '59b
C. hoosai	40	40		Kamemoto '59b
var *kinkwalan* sub var *fayden*	40			
C. i'ansonii		40		Wimber '57a
		40		Mehlquist '52
C. illiberale	40			

Table IV (continued)

Chromosome numbers of *Cymbidium* species

Species	Present Count 2n	Previous Counts 2n	n	Authority
C. insigne		40		Larsen '66a
		40		Wimber '57a
		40		Mehlquist '52
var *albens*		40		Mehlquist '52
'Album'		40		Mehlquist '52
var *album*			20	Yeh '62
var *atrosanguinea*		40		Tanaka '64, '62
'Bierii'	60			
'Rhodochilum'		40		Mehlquist '52
'Westonbirt'	40	40		Mehlquist '52
C. iridifolium		40		Wimber '57a
		40		Tanaka '65a
		40		Miduno '37
C. kanran	40			
C. koran	40			
var *album*	40			
C. lancifolium	40		20	Chardard '63
		40		Wimber '57a
C. longifolium	40			
C. lowianum			22	Sharma and Sarkar '67-'68
		40		Sharma and Chat. '66, '61

Table IV (continued)

Chromosome numbers of Cymbidium species

Species	Present Count 2n	Previous Counts 2n	n	Authority
		40		Kamemoto '59b
		40		Wimber '57a
		40		Mehlquist '52
		diploid		Mehlquist '49
			20	Hoffmann '30, '29
			9-10	Suessenguth '21
'Concolor'		40		Mehlquist '52
'Fir Grange'		40		Mehlquist '52
'McBeans'		40		Mehlquist '52
'Pitts'		40		Mehlquist '52
'St. Albans'	40			
'St. Denis'		40		Mehlquist '52
C. madidum 'Leroyi'	ca 40			
'UH-1'	40			
'UH-2'	40			
'UH-3'	40			
'UH-5'	40			
C. mastersii		40		Wimber '57a
C. munronianum	40	40		Sharma and Chat. '66, '61
C. nagi-folium		38		Tanaka '65b
		40		Mut. and Nakahira '59
C. oiwakense	ca 40			

Table IV (continued)

Chromosome numbers of *Cymbidium* species

Species	Present Count 2n	Previous Counts 2n	n	Authority
C. parishii var *sanderae*	40	40		Mehlquist '52
C. pendulum	40		20	Mehra and Vij '70
		40		Sharma and Sarkar '67-'68
C. pumilum	40	40		Tanaka '64, '62
		40		Kamemoto '59b
		40		Wimber '57a
		40		Mehlquist '52
var *album*	40			
var *album* x self 'UH-2'	40			
'Folia Albomarginalis'		40		Mehlquist '52
'Gessho'		40		Tanaka '64, '62
'Gesshohen'		80		Godella and Kliphuis '63
'Yashima'	60			
C. rectum	40			
C. roseum	40			
C. schroederi		40		Wimber '57a
		40		Mehlquist '52
C. siamense 'Singapore'	40			
C. sikkimense			19	Chardard '63

Table IV (continued)

Chromosome numbers of *Cymbidium* species

Species	Present Count 2n	Previous Counts 2n	n	Authority
C. simonsianum		40		Wimber, '57a
C. sinense		40		Sharma and Chatterji '66
		40		Tanaka '65b, '64
		40		Wimber '57a
			20	Sugiura '39
var *alba* 'Jucundissimum'	40			
C. soshin var *album*	40			
C. tigrinum	40			
C. tracyanum	40	40		Wimber '57a
		40		Mehlquist '52
		diploid		Mehlquist '49
C. virescens		40		Tanaka '65b
		46		Mut. and Nakahira '60, '58
		40		Kamemoto '59b
		40		Mutsuura '59
		40		Mut. and Nakahira '58
C. whiteae	40	40		Wimber '57a
C. cochleare	ca 40		20	Mehra and Vij '70
C. elegans			20	Mehra and Vij '70

Table IV (continued)

Chromosome numbers of *Cymbidium* species

Species	Present Count	Previous Counts		
	2n	2n	n	Authority
C. eburneum	40		20	Mehra and Vij '70
C. grandiflora			20	Mehra and Vij '70
C. longifolia	40		20	Mehra and Vij '70
C. mastersii			20	Mehra and Vij '70

Table V

Chromosome numbers of Cymbidium primary interspecific hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Albenense	C. erythrostylum x C. insigne		40	Mehlquist '52
C. Cherry Blossom	C. pumilum x C. erythrostylum	40		
C. Conningsbyanum 'Brockhurst'	C. insigne x C. graniflorum		40	Mehlquist '52
C. Doris	C. insigne x C. tracyanum		40	Mehlquist '52
C. Dryad 'Westonbirt'	C. insigne x C. parishii var sanderae		40	Mehlquist '52
C. Eburneo-Lowianum	C. eburneum x C. lowianum		40	Mehlquist '52
'Concolor'	C. eburneum x C. lowianum var concolor		diploid 40	Wimber '57d Mehlquist '52
C. Ensi-canal	C. ensifolium x C. canaliculatum var sparkesii	ca 40		

Table V (continued)

Chromosome numbers of Cymbidium primary interspecific hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Faridah Hishim 'UH-1'	C. ensifolium x C. finlaysonianum	40		
'UH-2'		60		
'UH-3'		40		
C. Garnet	C. lowianum x C. parishii var sanderae		40	Mehlquist '52
C. Gattonense	C. lowianum x C. tracyanum		40	Mehlquist '52
C. Gottianum 'Westonbirt'	C. eburneum x C. insigne 'Westonbirt'		40	Mehlquist '52
C. Little Black Sambo 'UH-2'	C. canaliculatum var sparkesii x C. madidum	40		
'UH-10'		80		
C. Lowio-Grandiflorum	C. lowianum x C. grandiflorum		40	Mehlquist '52
			diploid	Mehlquist '49
'Westonbirt'			diploid	Wimber '57d
			40	Mehlquist '52
C. Minuet	C. pumilum x C. insigne		40	Mehlquist '52

Table V (continued)

Chromosome numbers of Cymbidium primary interspecific hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Pali	C. ensifolium x C. tracyanum	40		
C. Pauwelsii	C. insigne x C. lowianum		40	Mehlquist '52
'Auriga Brockhurst'	C. insigne 'Album' x C. lowianum var concolor		40	Mehlquist '52
'Comte d'Heptinne'	C. insigne 'Bieri' x C. lowianum 'St Denis'		tetraploid	Wimber '57d
			tetraploid	Menninger '54
			80	Mehlquist '52
			tetraploid	Mehlquist '49
'Magnificum'			40	Mehlquist '49
C. Pee Wee	C. pumilum x C. madidum	40		
C. Penguin 'UH-1'	C. canaliculatum var sparkesii x C. pendulum	40		
C. Rosefieldense	C. grandiflorum x C. tracyanum		40	Mehlquist '52
C. Scallywag	C. pumilum x C. suave	ca 40		

Table V (continued)

Chromosome numbers of Cymbidium primary interspecific hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Seamew	C. parishii var sanderae x C. i'ansonii		40	Mehlquist '52
C. Vogelsang	C. insigne x C. devonianum	40		
C. Wiganianum	C. eburneum x C. tracyanum		40	Mehlquist '52
----------	C. aloifolium x C. madidum	40		
----------	C. aloifolium x C. pumilum	40		
----------	C. canaliculatum var sparkesii x C. pumilum var album	40		
---------- 'UH-1'	C. chloranthum x C. soshin 'Tetukotsu'	40		
---------- 'UH-2'		ca 40		
---------- 'UH-1'	C. hoosai var kinkwaian sub var fayden x C. chloranthum	40		

Table V (continued)

Chromosome numbers of *Cymbidium* primary interspecific hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
---------- 'UH-2'		40		
---------- 'UH-3'		40		
----------	*C. hoosai* x *C. lancifolium*	40		
---------- 'UH-C-1'	*C. madidum* x *C. hoosai* var *kinkwaian* sub var *fayden*	80		

Table VI

Chromosome numbers of Cymbidium secondary (species as one parent) hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Alexanderi	C. Eburneo-Lowianum x C. insigne		40	Mehlquist '52
'Album'			diploid	Wimber '57d
			40	Mehlquist '52
'Roseum'			40	Mehlquist '52
C. Alexanderi 'Westonbirt'	C. Eburneo-Lowianum x C. insigne 'Westonbirt'		tetraploid	Wimber '57d
C. Amelia	C. Albanense x C. erythrostylum		40	Mehlquist '52
C. Atlantes	C. erythrostylum x C. Alexanderi 'Westonbirt'		60	Mehlquist '52
C. Atlantes 'Bellevue'	C. Alexanderi 'Westonbirt' x C. erythrostylum		triploid	Wells '56
C. Beryl	C. Pauwelsii x C. lowianum		40	Mehlquist '52
C. Blue Smoke 'Beverly Glen'	C. lowianum x C. Mirabel		diploid	Wimber '57d

Table VI (continued)

Chromosome numbers of Cymbidium secondary (species as one parent) hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
'Green Meadow'			diploid	Wimber '57d
(UH-C-1)		80		
(UH-2)		40		
'Pernod'			diploid	Wimber '57d
'Sea Green'			diploid	Wimber '57d
C. Butterfly	C. Lowio-Grandiflorum x C. insigne		40	Mehlquist '52
'Westonbirt'	C. Lowio-Grandiflorum x C. insigne 'Westonbirt'		40	Mehlquist '52
C. Charm	C. erythrostylum x C. Ceres		40	Mehlquist '52
C. Charmian	C. erythrostylum x C. Flamingo		40	Mehlquist '52
C. Chloris	C. lowianum 'Leyswood' x C. Petrel 'Westonbirt'		40	Mehlquist '52
C. Corona	C. lowianum x C. Schlegelii		40	Mehlquist '52
C. Cygnet 'Elfin'	C. parishii var sanderae x C. Pauwelsii		40	Mehlquist '52

Table VI (continued)

Chromosome numbers of Cymbidium secondary (species as one parent) hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Early Bird 'Pacific'	C. erythrostylum x C. Edward Marshall	80	tetraploid	Mehlquist '52
C. Erica Sander	C. grandiflorum x C. Pauwelsii		diploid	Wimber '57d
			40	Mehlquist '52
C. Fair Green	C. pumilum x C. Fanfare 'Sierra Spring'	40		
C. Fairy Wand	C. pumilum x C. Princess Maria	40		
C. Feronia	C. erythrostylum x C. Erica Sander		40	Mehlquist '52
C. Floryi	C. Eburneo-Lowianum x C. grandiflorum		40	Mehlquist '54
C. Girrahween 'Elaine'	C. lowianum x C. Flamenco		64	Wells '56
'Enid'			76	Wells '56
'Gloria'			69	Wells '56
'Red Star'			68	Wells '56

Table VI (continued)

Chromosome numbers of Cymbidium secondary (species as one parent) hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Grand Monarch 'Exquisitum'	C. grandiflorum x C. Wiganianum		diploid	Wells '56
C. Hugh Evans	C. Curlew x C. lowianum		40	Mehlquist '52
C. Lowville	C. lowianum x C. Susette 'Perfection'		diploid	Wimber '57d
C. Lyoth	C. Ceres x C. insigne		40	Mehlquist '52
C. Madeleine	C. Pauwelsii x C. insigne		40	Mehlquist '52
C. Mimi 'Sandalwood'	C. pumilum x C. Doris Aurea	60		
C. Minijean	C. pumilum x C. Jean Brummitt	ca 40		
C. Moira	C. Pauwelsii x C. tracyanum		40	Mehlquist '52
C. Parsifal 'Roseum'	C. erythrostylum x C. Redshank		40	Mehlquist '52

Table VI (continued)

Chromosome numbers of Cymbidium secondary (species as one parent) hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Pearl 'Magnificum'	C. Alexanderi x C. grandiflorum		diploid	Wimber '57d
			40	Mehlquist '52
'Mastiff'			40	Mehlquist '52
C. Peter Pan 'Greensleeves' (UH-1)	C. ensifolium x C. Mirette	40		
(UH-2)		80		
C. President Wilson	C. Alexanderi x C. lowianum		40	Mehlquist '52
'Westonbirt'			40	Mehlquist '52
'Concolor'	C. Alexanderi x C. lowianum var concolor		40	Mehlquist '52
'Democrat'	C. Alexanderi 'Westonbirt' x C. lowianum		triploid	Wells '56
C. Prince Charming 'Charmer'	C. Charm 'Elegance' x C. erythrostylum 'Magnificum'		diploid	Wells '56
C. Pumander	C. pumilum x C. Louis Sander		40	Mehlquist '52

Table VI (continued)

Chromosome numbers of Cymbidium secondary (species as one parent) hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Red Star	C. hoosai x C. Rio Rita	40		
C. Romeo	C. grandiflorum x C. Pearl 'Magnificum'		diploid	Wimber '57d
C. Rosalita 'Dos Pueblos'	C. Delysia x C. insigne		diploid	Wimber '57d
C. Solent	C. insigne x C. Doris		40	Mehlquist '52
C. Solon	C. insigne x C. Schlegelii		40	Mehlquist '52
C. Starbright	C. pumilum x C. Lyoth	40		
C. Windsor 'Christmas Star'	C. erythrostylum x C. Louis Sander 'Cusson'		40	Mehlquist '52
C. Zebra	C. Dryad 'Westonbirt' x C. insigne		40	Mehlquist '52

Table VI (continued)

Chromosome numbers of *Cymbidium* secondary (species as one parent) hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
----------	*C. dayanum* x *C.* Alexanderi 'Album'	40		
----------	*C. hoosai* 'Ireland' x *C.* Carisona 'Glendessary'	40		
----------	*C. parishii* var *sanderae* x *C.* Babylon 'Castle Hill'	60		
---------- 'UH-1'	*C.* Fairy Wand x *C. parishii* var *sanderae*	40		
----------	*C.* Korintji 'Golden Showers' x *C. canaliculatum* var *sparkesii*	60		
---------- 'UH-1'	*C.* Peter Pan 'Greensleeves' (UH-2) x *C. aloifolium*	60		

Table VI (continued)

Chromosome numbers of *Cymbidium* secondary (species as one parent) hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
'UH-2'		60		
---------- 'UH-1'	*C.* Peter Pan 'Greensleeves' (UH-2) x *C. madidum*	ca 60		
---------- 'UH-1'	*C.* Starbright x *C. canaliculatum* var *sparkesii*	48		
---------- 'UH-C-1'	*C.* Starbright x *C. hoosai* var *kinkwaian* sub var *fayden*	80		
---------- 'UH-1'	*C.* Vogelsang x *C. madidum*	40		
---------- 'Stewart 1394'	*C.* Zebra '235' x *C. pumilum*		40	Mehlquist and Clovis '57

Table VII

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Adrienne	C. Claudette x C. Shina Black		diploid	Wells '56
C. Alexanderi 'Perfection'	C. Alexanderi 'Albens' x C. Alexanderi 'Westonbirt'		diploid	Wells '56
C. Alexanderi	C. Alexanderi 'Westonbirt' x C. Alexanderi 'Westonbirt'		tetraploid	Menninger '54
			80	Mehlquist '52
			tetraploid	Mehlquist '49
			tetraploid	Wells '56
C. Alexette	C. Alexanderi 'Westonbirt' x C. Janette		triploid	Wells '56
C. Alexfrida	C. Alexanderi 'Westonbirt' x C. Elfrida		triploid	Wells '56
C. Altair 'Luath'	C. Pauwelsii 'Comte d'Hemptinne' x C. Pipit		triploid	Wells '56
C. Anthony Evans	C. Alexanderi 'Westonbirt' x C. Bodmin Moor		triploid	Wells '56
C. Apollo 'Exbury'	C. Curlew x C. Miranda		diploid	Wimber '57d

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Arabella 'Bexley'	C. Eburneo-Lowianum x C. Schlegelii		triploid	Wells '56
'Waverly'			tetraploid	Wells '56
C. Arabella II	C. Alexanderi 'Westonbirt' x C. Swallow		60	Mehlquist '52
C. Arabian Nights	C. Balkis 'Siver Orb' x C. Sussex		triploid	Wells '56
C. Ayot St. Peter	C. Pauwelsii 'Comte d'Hemptinne x C. Lyoth		triploid	Wells '56
C. Babylon 'Carpentier'	C. Olympus x C. Pauwelsii 'Comte d'Hemptinne		tetraploid	Wimber '57d
			tetraploid	Menninger '54
'Castle Hill'	C. Olympus 'Monarch' x C. Pauwelsii 'Comte d'Hemptinne'		tetraploid	Wimber '57d
			tetraploid	Menninger '54
C. Bali	C. Sussex 'A454' x C. Babylon 'Castle Hill'		60	Mehlquist and Clovis '57

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Balkis	C. Alexanderi 'Westonbirt' x C. Rosanna 'Pinkie'		tetraploid	Menninger '54
'Luath'			tetraploid	Wells '56
'Nevada'		80		
'Perfection'			tetraploid	Wimber '57d
'Silver Orb'		80		
			tetraploid	Wimber '57d
			tetraploid	Wells '56
C. Beatrice	_____ x _____		40	Mehlquist '52
C. Bengal Bay	C. Alexanderi 'Westonbirt' x C. Profita 'Mardi Gras'		60	Mehlquist and Clovis '57
C. Bethlehem 'Magi' (UH-1)	C. Frederica x C. Earlyana	ca 120		
(UH-2)		60		
C. Bodmin Moor	C. Alexanderi 'Westonbirt' x C. Erica Sander		triploid	Wells '56
			triploid	Mehlquist '52
C. Brissie	C. Lucy x C. Pixie		diploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Calcutta	C. Pauwelsii 'Comte d'Hemptinne' F.C.C. x C. Babylon 'Castle Hill'		80	Mehlquist and Clovis '57
C. Carisbrook 'Bexley'	C. Ceres x C. Ralph Sander		diploid	Wells '56
'Florence'			diploid	Wells '56
C. Carisona 'Glendessary'	C. Carisbrook 'Brilliance' x C. Cremona 'Indian Prince'		diploid	Wimber '57d
C. Cassandra 'Bellevue'	C. Alexanderi 'Westonbirt' x C. Goosander		triploid	Wells '56
'Jennifer'			triploid	Wells '56
'Karangah'			triploid	Wells '56
'Pastel Queen'			triploid	Wells '56
'Toxteth'			triploid	Wells '56
'Warringal'			triploid	Wells '56
'Waverly'			triploid	Wells '56
C. Charmant	C. Charm x C. Pauwelsii 'Comte d'Hemptinne'		60	Mehlquist '52
C. Chesham 'Green Valley'	C. Saracen x C. Saxon		diploid	Wimber '57d

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Chough	C. Alexanderi 'Westonbirt' x C. Virgo		triploid	Wells '56
C. Christmas Cheer	C. Schlegelii x C. Doris		40	Mehlquist '52
C. Clare Armstrong	C. Alexanderi 'Westonbirt' x C. Mirella		triploid	Wells '56
			60	Mehlquist '52
'Robin Hood'			triploid	Wells '56
C. Clasina de Wit	C. Pauwelsii 'Comte d'Hemptinne' x C. Senator		triploid	Wells '56
C. Claudona 'Glendessary'	C. Claudette 'Invicta' x C. Cremona		diploid	Wimber '57d
C. Cleo Sherman	C. Alexanderi 'Westonbirt' x C. Babylon 'Carpentier'		80	Mehlquist and Clovis '57
C. Cornelia	C. Charmian x C. Nancy Harte		40	Mehlquist '52
C. Cremona 'Black Prince'	C. Cooperi x C. Elfin		diploid	Wimber '57d

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Cygnus 'The Bride'	C. Alexanderi 'Westonbirt' x C. Coningsbyanum		triploid	Wells '56
C. Cyzara	C. Albanense x C. Ceres		40	Mehlquist '52
C. Dante	C. Bullfinch x C. Goosander		diploid	Wimber '57d
C. December Green 'Early Ireland'	C. Doris x C. Venus		diploid	Wells '56
C. Delysia	C. Petrel x C. Ceres		40	Mehlquist '52
C. Diana	C. Eburneo-Lowianum x C. Pauwelsii		40	Mehlquist '52
C. Dorchester	C. Alexanderi 'Westonbirt' x C. Tityus		diploid	Wells '56
'Alpha'			triploid	Wimber '57d
'Manuka'			66	Wells '56
C. Doreen	C. Doris x C. Pauwelsii		40	Mehlquist '52
C. Doris Aurea 'F.J. Noonan'	C. Chiron x C. Lysander		diploid	Wimber '57d

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrids	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Eagle 'Arctic'	C. Alexanderi 'Westonbirt' x C. Gottianum		triploid	Wells '56
'Elizabeth Ann'			triploid	Wells '56
'Mt. Shasta'			triploid	Wimber '57d
'Snow Queen'			triploid	Wells '56
C. Eaglet 'Rosy Dawn'	C. Eagle x C. Pauwelsii 'Comte d'Hemptinne'		triploid	Wells '56
C. Edna Cobb	C. Balkis 'Silver Orb' x C. Profita	60	triploid	Wells '56
C. Edna Cobb	C. Profita 'Mardi Gras' x C. Balkis 'Silver Orb'		60	Mehlquist and Clovis '57
C. Elouera	C. Alexanderi 'Westonbirt' x C. Girrahween 'Enid'		tetraploid	Wells '56
C. Ethel Ward	C. Alexanderi 'Westonbirt' x C. Lysander		triploid	Wells '56
C. Europa 'Wells'	C. Goldfinch 'Exquista' x C. Pearl 'Magnificum'		diploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Felicity	C. Delise x C. Swallow		40	Mehlquist '52
C. Fieldfare	C. Alexanderi 'Albens' x C. Egret		diploid	Wells '56
C. Flamingo 'Allambie'	C. Alexanderi 'Westonbirt' x C. Merlin		88	Wells '56
C. Flamingo 'Nobilior'	C. Alexanderi 'Westonbirt' x C. Merlin 'Westonbirt'		pentaploid 94 ca 100	Wimber '57d Wells '56 Wimber '54
C. Fred Stewart 'Silver Light'	C. Early Bird 'Pacific' x C. Balkis 'Silver Orb'	80		
C. Frivolity 'Alba'	C. Ceres x C. Wheatear		40 diploid	Mehlquist '52 Wimber '57d
C. Goldcrest 'Wondabah'	C. Erica Sander x C. Pauwelsii 'Comte d'Hemptinne'		triploid	Wells '56
C. Golden Eagle 'Robinson'	C. Pauwelsii 'Comte d'Hemptinne x C. Rosefieldense		triploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Golden Oriole	C. Plover x C. Woodhamsianum		40	Mehlquist '52
C. Guelda	C. Coningsbyanum x C. Doris		40	Mehlquist '52
C. Heathrow 'Mary Bea'	C. Claudette x C. Erica Sanders		diploid	Wimber '57d
C. Hera 'Giganteum'	C. Queen Elizabeth x C. Flamingo 'Nobilior'		75	Wimber and Hernlund '55
C. Herod	C. Ceres x C. Curlew		diploid	Wells '56
C. Historian 'Linfield'	C. Alexanderi 'Westonbirt' x C. Glasgow		tetraploid	Wells '56
C. Icarus 'Roberts'	C. Pauwelsii 'Comte d'Hemptinne' x C. Apollo		triploid	Wells '56
C. Ilkley Moor	C. Bodmin Moor x C. Pauwelsii 'Comte d'Hemptinne'		100	Zuck '57
			triploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Irina 'Celeste'	C. Adastra x C. Adelma		diploid	Wimber '57d
C. Ispahan 'Mascot'	C. Lowio-Grandiflorum x C. Rosanna 'Pinkie'		triploid	Wells '56
C. Janette	C. Joy Sander x C. Alexanderi 'Westonbirt'		60	Mehlquist '52
C. Janette 'Golden Crown'	C. Alexanderi 'Westonbirt' x C. Joy Sander		triploid	Wells '56
'A.A. McBean'			triploid	Wimber '57d
			triploid	Wells '56
C. Jason 'Marblethorpe'	C. Alexanderi 'Westonbirt' x C. Miranda		triploid	Wells '56
C. Jolity	C. Eagle 'Heritage' x C. Hanburyanum 'Magnificum'		40	Mehlquist and Clovis '57
C. Joy Sander	C. Ceres x C. Pauwelsii		40	Mehlquist '52
C. Jungfrau	C. Alexanderi 'Westonbirt' x C. Eagle		60	Mehlquist '52

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Kangar 'McBean'	C. Joy Sander x C. Ruby		diploid	Wimber '57d
C. Khyber Pass	C. Profita 'Mardi Gras' x C. Carisona 'Abundance'		40	Mehlquist and Clovis '57
C. Kittiwake	C. Dryad x C. Gottianum		40	Mehlquist '52
C. Laelia Sasso	C. President Wilson x C. Iris		triploid	Wells '56
C. Lillian Stewart 'Pink Parfait'	C. Balkis 'Silver Orb' x C. Carisona 'Glendessary'	60		
'Treva'		60		
C. Linnet 'Olive'	C. Alexanderi x C. Holfordianum		40	Mehlquist '52
C. Little Black Sambo 'UH-1'	C. Little Black Sambo x C. Little Black Sambo	80		
'UH-C-1'		80		
C. Louis Sander 'Regal'	C. Alexanderi 'Westonbirt' x C. Ceres		triploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Louis Sander 'Kirribilli'	C. Alexanderi 'Westonbirt' x C. Ceres 'F.J. Hanbury'		triploid	Wells '56
C. Lutescens	C. Auriga x C. Miranda		40	Mehlquist '52
C. Madonna	C. Alexanderi 'Westonbirt' x C. Memoria P.W. Janssen		60	Mehlquist '52
C. Marmie Kingsford	C. Pauwelsii 'Comte d'Hemptinne' x C. Pearl 'Magnificum'		triploid	Wells '56
C. Memoria Albertii 'Albert'	_____ x _____		triploid	Wells '56
C. Midlothian 'Greensleeves'	C. Enchantress x C. Erica Sander		diploid	Wells '56
C. Minstrel 'Oakley Court'	C. Brugense x C. Miranda		diploid	Wells '56
C. Miranda	C. Alexanderi x C. Lowio-Grandiflorum		40	Mehlquist '52
C. Miretta 'Dos Pueblos'	C. Claudette 'Invicta' x C. Mirabel		diploid	Wimber '57d
'Glendessary'			diploid	Wimber '57d

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Montecito	C. Joy Sander 'Omega' x C. Sparta		diploid	Wimber '57d
C. Muse	C. Euterpe 'Churchill' x C. Ruanda		diploid	Wells '56
C. Nadina	C. Nada x C. Alexanderi 'Westonbirt'		triploid 40	Wells '56 Mehlquist '52
C. Nam Khan 'Verulam'	C. Pauwelsii 'Comte d'Hemptinne' x C. Rosanna 'Pinkie'		tetraploid tetraploid	Wimber '57d Menninger '54
C. Nell Gwynne	C. Myrna x C. Mandarin		40	Mehlquist '52
C. Nirvana 'Warringal'	C. Pauwelsii x C. Swallow		triploid	Wells '56
C. Nitocris	C. Schlegelii x C. Pearl		40	Mehlquist '52
C. Northern Lights 'Daybreak'	C. Giant Rose x C. North		66	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Nymph	C. Ceres x C. Dryad		40	Mehlquist '52
C. Occident	C. Lyoth x C. Sunset		diploid	Wells '56
C. Omega 'Dos Pueblos'	C. Joy Sander 'Omega' x C. Bodmin Moor 'Golden Glow'		triploid	Wimber '57d
C. Pearl-Amber	C. Pearl 'Magnificum' x C. Ramboda 'Caprice'		72	Wells '56
C. Pedregosa	C. Blue Smoke x C. President Wilson		46,49,51,54	Wimber and Hennlund '52
C. Peri	C. President Wilson 'Westonbirt' x C. Pauwelsii 'Comte d'Hemptinne'		60	Mehlquist '52
(Runts)			57,58	Mehlquist '52
C. Peri 'Beefeater'	C. Pauwelsii 'Comte d'Hemptinne' x C. President Wilson		68	Wells '56
'Fiesta'			64	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Peri 'Imperial'	C. Pauwelsii 'Comte d'Hemptinne' x C. President Wilson		64	Wells '56
'Ironclad'			66	Wells '56
'The King'			66	Wells '56
C. Persian Carpet	C. Verona 'Ruby 850' x C. Babylon 'Castle Hill' F.C.C.		60	Mehlquist and Clovis '57
C. Peter Grimes	C. Albion x C. Lilian Sander		40	Mehlquist '52
C. Plover	C. Lowio-Grandiflorum x C. Pauwelsii		40	Mehlquist '52
'Fuchsia'			diploid	Wimber '57d
C. Priam 'Ada Meech'	C. Ceres x C. President Wilson		diploid	Wells '56
C. Princesse Astrid	C. Eagle x C. Vesta		40	Mehlquist '52
C. Princess Elizabeth 'Iris'	C. Alexanderi 'Westonbirt' x C. Princesse Astrid		triploid	Wells '56
'Maisie'			triploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
'Reece'			triploid	Wells '56
'Taylor'			triploid	Wells '56
C. Profusion 'Violaceum'	C. Ceres 'F.J. Hanbury' x C. Vesta		diploid	Wells '56
C. Ramley 'McBean's'	C. Ramboda 'Neptune' x C. Shirley		tetraploid	Wells '56
C. Redstart 'Radiance'	C. Dryad x C. Pauwelsii		40	Mehlquist '52
C. Remus 'Vivid'	C. Regulus x C. Joyful		diploid	Wimber '57d
C. Riga	C. Swallow x C. Pearl 'Magnificum'		40	Mehlquist '52
C. Roger Sander	C. Gottianum x C. Sybil		40	Mehlquist '52
C. Rosanna	C. Kittiwake x C. Alexanderi 'Westonbirt'		60	Mehlquist '52
C. Rosanna 'Pinkie'	C. Alexanderi 'Westonbirt' x C. Kittiwake		tetraploid	Wimber '57d
'Warringal'			tetraploid	Mehlquist '54
			tetraploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Roxette	C. Claudette x C. Roxana		triploid	Wells '56
C. Ruanda 'The Finest'	C. Pearl x C. Redstart		diploid	Wells '56
C. Samarkand	C. Heathrow 'Mary Bea' x C. Alexanderi 'Westonbirt'		triploid	Wells '56
C. Sandpiper 'Dorothy'	C. Alexanderi 'Westonbirt' x C. Seamew		triploid	Wells '56
C. Sanrita	C. Louis Sander x C. Rio Rita 'Radiance'		diploid	Wells '56
C. Shina Black	C. Curlew x C. Edzell 'John Linford'		diploid	Wimber '57d
C. Shiraz 'Mary Bea'	C. Alexanderi 'Westonbirt' x C. Shirley		tetraploid tetraploid	Wells '56 Wimber '57d
C. Shirley	C. Fearnley Sander x C. Floryi		tetraploid	Mehlquist '52
C. Sierra	C. Nell Gwynne 'Phantasy' x C. Alexanderi 'Westonbirt'		60	Mehlquist and Clovis '57

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. Spartan Queen 'Mrs. Ireland'	C. Regina x C. Sparta		diploid	Wimber '57d
C. Sussex	C. Landrail 'Ophir' x C. Profusion		tetraploid 40	Wells '56 Mehlquist '52
C. Swallow	C. Alexanderi 'Westonbirt' x C. Pauwelsii 'Comte d'Hemptinne'		tetraploid 40	Menninger '54 Mehlquist '52
C. Swallow 'Hebe'	C. Alexanderi x C. Pauwelsii		triploid triploid	Wells '56 Wells '56
C. Swallow	C. Alexanderi 'Roseum' x C. Pauwelsii 'Comte d'Hemptinne'		triploid	Wells '56
C. Swallow 'Jill' 'Magnolia' 'Pastel'	C. Alexanderi x C. Pauwelsii		triploid triploid triploid	Wells '56 Wells '56 Wells '56
C. Swallow 'Rainbow'	C. Alexanderi 'Westonbirt' x C. Pauwelsii 'Comte d'Hemptinne'		tetraploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
'Ronnoc'			tetraploid	Wells '56
'Soulangeana'			tetraploid	Wells '56
C. Swallow	C. Pauwelsii x C. Alexanderi 'Westonbirt'		60	Mehlquist '52
C. Swallow	C. Alexanderi 'Westonbirt' x C. Pauwelsii 'Comte d'Hemptinne'		80	Mehlquist '54
C. Thelma	C. Alexanderi 'Westonbirt' x C. Redshank		60	Mehlquist '52
C. Tinsel (Fine)	C. Babylon 'Castle Hill' x C. Pearl 'Magnificum'		triploid	Wells '56
C. Tityus	C. Alexanderi x C. Woodhamsianum		40	Mehlquist '52
C. Vashti	C. Veronique x C. President Wilson 'Westonbirt'		40	Mehlquist '52
C. Woodpigeon 'Yellow Gem'	C. Erica Sander x C. Ringdove		diploid	Wells '56

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
C. York	C. Alexanderi 'Westonbirt' x C. Shina Black		triploid	Wells '56
'Carpentier'			66	Wells '56
---------- 'Stewart 1383'	C. Alexanderi 'Westonbirt' x C. Eagle 'Heritage'		60	Mehlquist and Clovis '57
---------- 'Stewart 1480'	C. Balkis 'Silver Orb' x C. Carisona 'Glendessary		60	Mehlquist and Clovis '57
---------- 'Stewart 1477'	C. Balkis 'Silver Orb' x C. Swallow 'Green Mist'		80	Mehlquist and Clovis '57
---------- 'Stewart 1506'	C. Carisona 'Abundance' x C. Balkis 'Silver Orb'		60	Mehlquist and Clovis '57
---------- 'Stewart 1400'	C. Esmeralda 'A.M.' x C. Apollo 'Exbury'		40	Mehlquist and Clovis '57
---------- 'UH-1'	C. Fairy Wand x C. Peter Pan 'Greensleeves' (UH-2)	ca 90		

Table VII (continued)

Chromosome numbers of Cymbidium advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
---------- 'UH-1'	C. Mimi 'Sandalwood' x C. Vogelsang	80		
----------	C. Nell Gwynne 'White Throat' x C. Esmeralda 'A.M.'		40	Mehlquist and Clovis '57
----------	C. Northern Lights x C. Rosanna 'Pinkie'		triploid	Wells '56
----------	C. Orcades x C. Tinsel		triploid	Wells '56
----------	C. Pali x (C. Pali x C. soshin var alba)	40		
----------	C. Pauwelsii 'Comte d'Hemptinne' x C. President Wilson 'Westonbirt'		triploid	Mehlquist '49
----------			65,70,80,81,85	Wimber and Hernlund '52
----------	C. Shirley x C. Alexander 'Westonbirt'		triploid	Menninger '54

Table VII (continued)

Chromosome numbers of *Cymbidium* advanced hybrids

Hybrid	Parents	Present Count 2n	Previous Count 2n	Previous Count Authority
----------	*C.* Sicily x *C.* San Miguel	40		
---------- 'Stewart 1501'	*C.* Verona 'Ruby' x *C.* Alexanderi 'Westonbirt'		60	Mehlquist and Clovis '57
---------- 'UH-1'	*C.* Vogelsang x *C.* Peter Pan 'Greensleeves' (UH-2)	60		
---------- 'UH-2'		60		

Table VIII

Chromosome numbers of intergeneric hybrids

Hybrid	Parents	Present Count 2n	Hybrid Status
Ansidium Pasatiempo	Ansellia gigantea x C. madidum	41	+
Ansidium _____'UH-1'	C. hoosai var kinkwaian sub var fayden x Ansellia africana	41	+
_____'UH-2'		ca 41	?[1]
_____'UH-5'		41	+
Ansidium _____'UH-1'	C. madidum x Ansellia africana	ca 41	?[1]
_____'UH-3'		41	+
Ansidium _____'UH-1'	C. Fairy Wand x Ansellia africana	41	+
_____'UH-2'		ca 41	?
Ansidium _____ 'UH-1'	C. Little Black Sambo x Ansellia africana	41	+
_____'UH-C-3'		82	+
Ansidium _____'UH-1'	C. Penguin x Ansellia africana	41	+
Ansidium _____'UH-1'	C. Starbright x Ansellia africana	ca 82	?[1]
_____'UH-C-1'		82	+
Ansidium _____'UH-1'	C. Vogelsang x Ansellia	41	+
Ansidium	(C. hoosai x C. lancifolium) x Ansellia africana	41	+
Ansidium _____'UH-1'	(C. Pali x C. soshin var album) x Ansellia africana	41	+

Table VIII (continued)

Chromosome numbers of intergeneric hybrids

Hybrid	Parents	Present Count 2n	Hybrid Status
Catacymbidium[3] _____'UH-1'	C. hoosai x C. lancifolium x Catesetum fimbriatum	74	+
Grammatocymbidium _____'UH-3'	C. Red Star x Grammatophyllum scriptum 'The Governor'	40	?[1]
_____'UH-C-1'		40/80	?
_____'UH-C-2'		80	?
_____	C. hoosai x C. lancifolium x Grammatophyllum scriptum	40	?[1]
Phaiocalanthe _____	Calanthe Lord Rothschild x Phaius Gravesiae	ca 56	?[1]
Phaiocymbidium Chardwerense	Phaius tankervillae x C. giganteum	44,45,or 46	?[2]
_____	Bletia hyacinthina var alba x Phaius wallichii	32	–
_____	Phaius tankervillae x Ansellia africana	50	–
_____'UH-1'	Phaius tankervillae x Spathoglottis plicata	50	–
_____'UH-2'		50	
_____	Spathoglottis plicata x Ansellia africana	ca 40	?

[1]hybrid status unconfirmed by chromosome counts, however, morphological features are intermediate between the two parents. Believed to be a true hybrid.

[2]hybrid status unconfirmed by chromosome counts, however, morphological features are not intermediate between the two parents. Believed not to be a true hybrid.

[3]proposed generic name for new intergeneric hybrid.

Table IX

Chromosome numbers of species and hybrids of genera other than Cymbidium

Species	Present Count 2n	Previous Count 2n	Previous Count n	Authority
Ansellia nilotica		42		Tanaka '64
africana 'UH-5'	42			
'UH-7'	42			
'UH-10'	42			
gigantea	42			
Calanthe vestita			20	Hoffmann '30
var rubro-oculata	40			
Cymbidiella flabellata	54			
Eulophia caffra	48			
keithii	40			
nuda		54		Chatterji '65
speciosa	48			
Grammangis ellisii	54	54		Chardard '63
Grammatophyllum scriptum	40	40		Pancho '65a,b
		40		Wimber '57a
speciosum	40	40		Pancho 65a,b
		40		Wimber '57a
Phaius maculatus	ca 42			
mishemsis			31	Sharma and Sarkar '67,'68
tankervillae	50	38		Arcra '68
		50		Tanaka '65b

Table IX (continued)

Chromosome numbers of species and hybrids
of genera other than *Cymbidium*

Species	Present Count	Previous Counts		
	2n	2n	n	Authority
Phaius wallichii	ca 50		21	Mehra and Vij '70
		48		Sharma and Sarkar '67-68
var *assamica*			21	Sharma and Sarkar '67-68
Spathoglottis plicata	ca 40	40		Tanaka '65b
Hybrid				
Phaius Ashworthianus (*P. maculatus* x *P. wallichii*)	46±4			

E. gusukumai with 2n=56 (Tanaka 1962a), E. hormustii with n=27 (Mehra and Vij 1970), and E. nuda with 2n=54 (Chatterji 1965). Phaius maculatus is being reported for the first time and has approximately 42 chromosomes. Phaius tankervillae was determined to have 50 chromosomes which is identical to the count of Tanaka (1965b) but inconsistent with the more recent count of 38 by Arcra (1968). Phaius wallichii was determined to have approximately 50 chromosomes which is not inconsistent with the count of 48 by Sharma and Sarkar (1967-68) but is inconsistent with the gametic count of 21 by Mehra and Vij (1970). The latter also determined that P. wallichii var assamica also has a gametic chromosome number of 21. Spathoglottis plicata has ca 40 chromosomes which agrees with the count by Tanaka (1965b).

II. Cross Compatibility

Twenty-one species flowered during this investigation. Several of them escaped the sectional classifications of the botanists mentioned and others were not yet described at those times. For these reasons new groups are described to accomodate all of the species that flowered during this investigation. Few floral differences other than size, fragrance, and color, the last of which is known to be variable depending on environmental influences, were observed. The groups are, therefore, based on vegetative morphological features examined and descriptions of the same and growth habit from the literature. The author's description of each group followed by the species assigned to it are as follows:

Group I. Plants small. Pseudobulbs absent, obscure or small. Leaves 1 to 1.5 (2.5) cm wide, usually less than 50 cm long and usually less than 6 per pseudobulb or growth. Leaves grass-like with narrowly to broadly acute apices and sometimes with fine serations on margins near apex. Inflorescences usually erect, 15 to 25 cm long. Flowers 1 to many, 2.5 to 4.5 cm across and usually fragrant. Usually terrestrial in habit.

aspidistrifolium, dayanum, ensifolium, formosanum, gracillimum, hoosai, kanran, koran, lancifolium, munronianum, pumilum, sinense, soshin, and suavissimum.

Group II. Plants large and robust. Pseudobulbs medium to large. Leaves 2 to 3.5 cm wide, often longer than 75 cm and usually less than 10 per pseudobulb. Leaves hard and coriaceous with rounded, retuse or acute apices; margins entire. Inflorescences usually pendent, 45 to 100 cm long. Flowers many, 2.5 to 4.5 cm across and usually unscented but sometimes mildly or strongly scented. Epiphytic in habit.

aloifolium, canaliculatum, chloranthum, madidum, and pendulum.

Group III. Plants medium to large. Pseudobulbs medium to large. Leaves 1.3 to 2.5 cm wide, 50 to 90 cm long and often more than 12 per pseudobulb. Leaves grass-like with medium to narrowly acute apices; margins entire. Inflorescences erect to arching, 60 to 90 cm long. Flowers one to many, 6.5 to 9 cm across, usually unscented but sometimes mildly scented. Usually

epiphytic in habit.

eburneum and parishii.

Each of the Tables X through XV and Table XVII is a summary of the results of pollination studies for a specific group of plants used as females in crossings with plants of the same and other groups used as males. Tables X, XI, and XII show Cymbidium species groups as females. Tables XIII and XIV show Cymbidium intergroup hybrids as females. Table XV shows the accumulated Cymbidium inter- and intragroup hybrids that do not fit the criteria of other tables as females. Table XVII shows the accumulated species and hybrids of genera other than Cymbidium as females. The accumulation of plants in the latter two tables is merely for convenience and is not necessarily meant to imply a common relationship. The only common relationship among these plants may be that none are members of the groups identified in the prior tables.

In analyzing the species inter- and intragroup compatibilities the following four percentage figures are logically the most useful: 1) percentage of fruits yielded, 2) percentage of fruits with apparently normal embryos, 3) embryo percentage per fruit and 4) percentage of fruits with seeds that germinated.

Species from Group I when used as females and hybridized with species of the same Group gave a fruit yield percentage of 43.9 (Table X). When hybridized with species from Group II the fruit yield percentage was 29.6. Crosses of Groups I x I appeared to be more successful than crosses of Groups I x II for the percentage of fruits with seeds containing embryos, 84.0% to 62.5%, and for percentage of fruits with seeds containing embryos that had germination, 76.2% to

Fig. 5. C. dayanum (0.11X)

Fig. 6. C. lancifolium (0.18X)

Fig. 7. C. hoosai var kinkwalan sub var fayden (0.17X)

Fig. 8 C. soshin 'Tetukotsu' (0.18X)

Vegetative and floral morphology of Cymbidium species

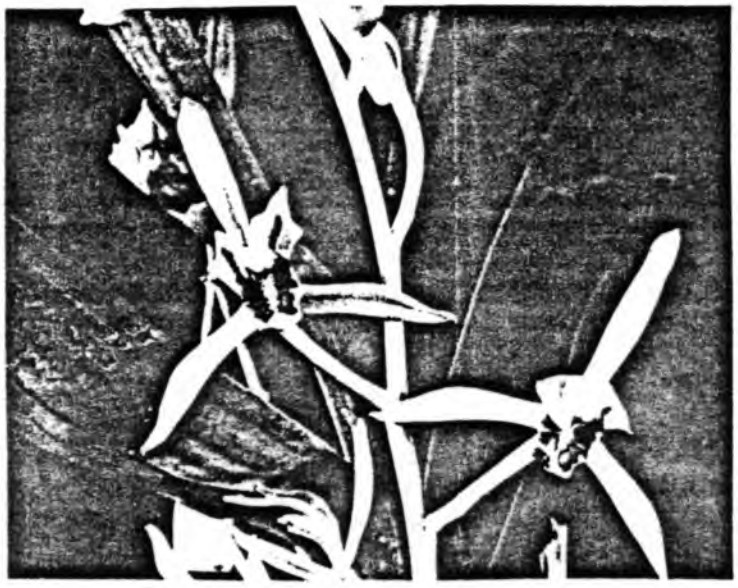

Fig. 9. C. lancifolium (1.75X)

Fig. 10. C. pumilum var album (0.88X)

Vegetative and floral morphology of Cymbidium species

Fig. 11. C. formosanum (1.06X)

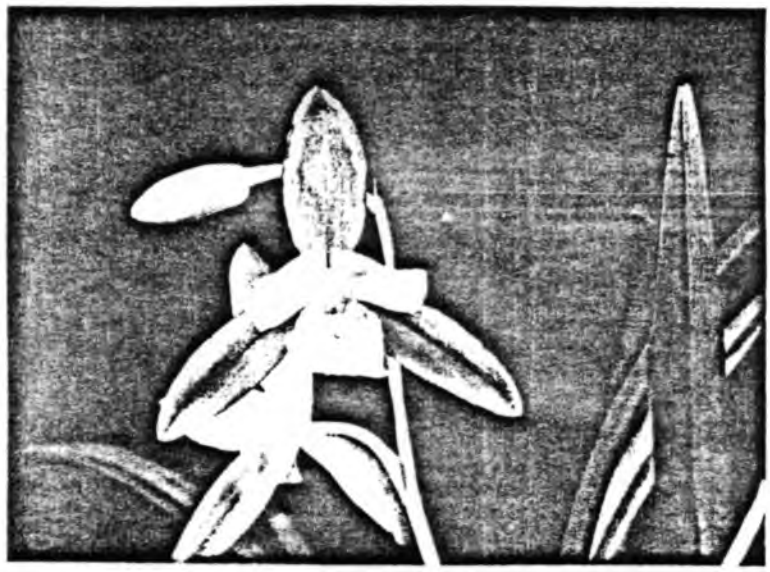

Fig. 12. C. ensifolium var album (1.88X)

Vegetative and floral morphology of Cymbidium species

Fig. 13. C. aloifolium (0.11X)

Fig. 14. C. aloifolium (0.19X)

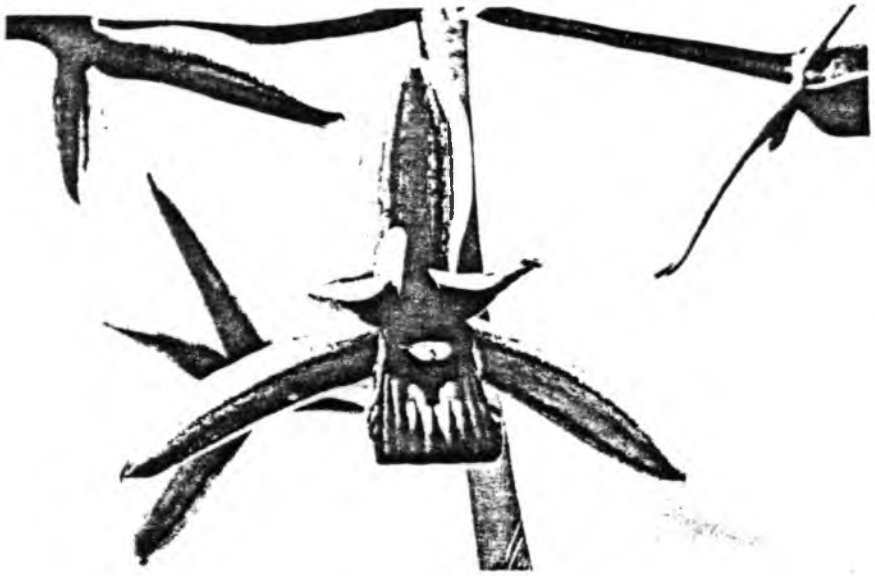

Fig. 15. C. aloifolium (1.44X)

Vegetative and floral morphology of Cymbidium species

Fig. 16. C. canaliculatum var sparkesii (0.17X)

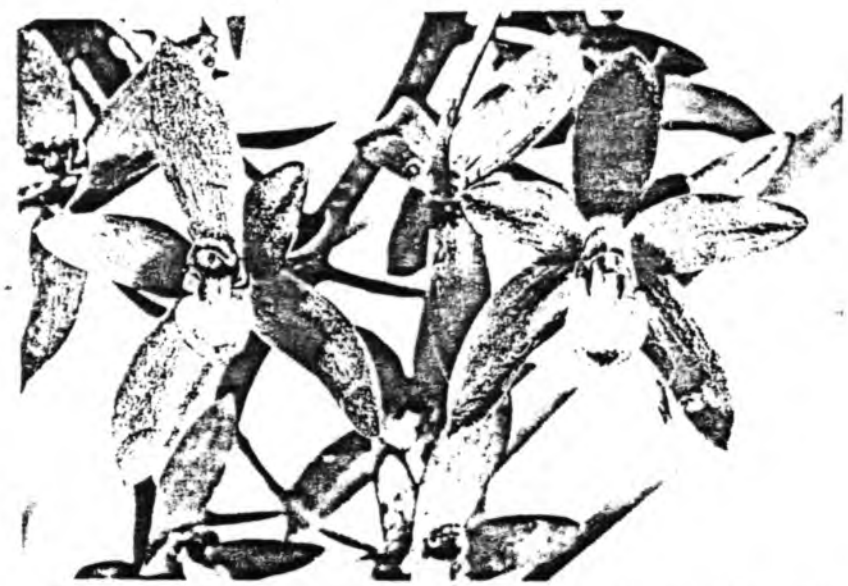

Fig. 17. C. canaliculatum var sparkesii (2.33X)

Vegetative and floral morphology of Cymbidium species

Fig. 18. C. eburneum (0.20X)

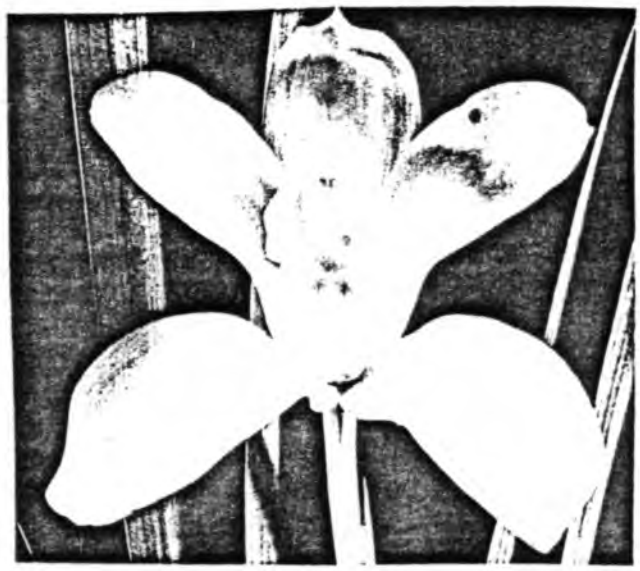

Fig. 19. C. eburneum (1.10X)

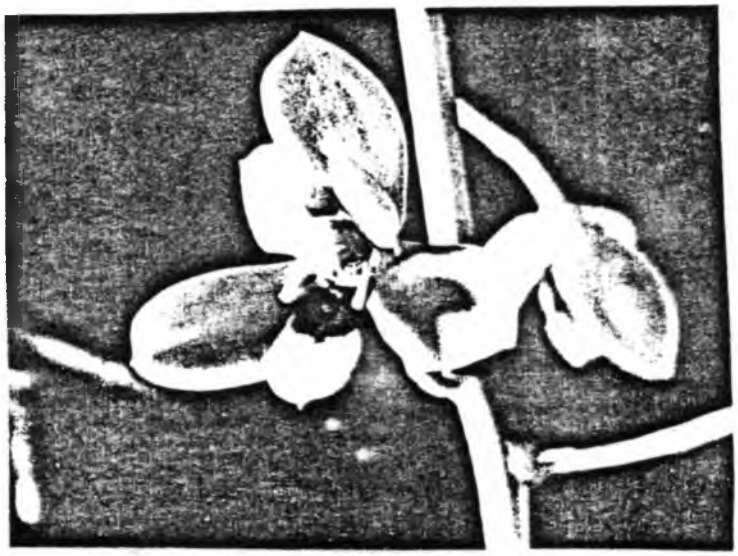

Fig. 20. C. madidum (2.00X)

Vegetative and floral morphology of Cymbidium species

Fig. 21. C. parishii var sanderae (0.18X)

Fig. 22. C. parishii var sanderae (0.46X)

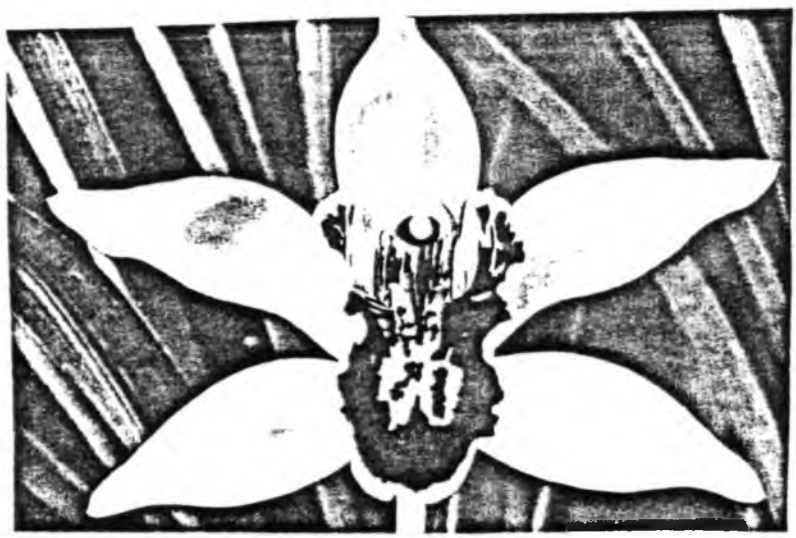

Fig. 23. C. parishii var sanderae (1.07X)

60.0%. The average percentages of seeds containing embryos in those fruits that had embryos was higher in the intergroup crosses than in the intragroup crosses which contradicted the trend of the other data. Insufficient data were obtained from the intergroup combination I x III to evaluate its possible relationship to the others.

Species of Group I when pollinated with pollen from I x III intergroup hybrids gave a 13.3% fruit set of which 16.7% of the fruits had 49% seeds containing embryos. When pollinated with pollen from III x III intragroup hybrids, there was 7.1% fruit set of which 66.7% of the fruits had 6.0% seeds containing embryos. Little can be said from these data because of the inconsistency and because so few fruits resulted. It is important to note, however, that although only 1 fruit contained embryos when the intergroup pollen was used, it did give seedlings; whereas, the 2 fruits containing embryos from crosses with the intragroup pollen did not.

Species from Group II, when used as females and hybridized with species from Group II, gave a fruit set percentage of 43.5 (Table XI). A fruit set percentage of 18.8 was obtained when these were pollinated by species of Group I. The percentage of fruits with embryos and the average embryo percentage of those fruits with embryos were also greater for this intragroup combination, but the percentage of fruits with embryos that germinated was greater for the intergroup crosses. Data for intergroup combinations with species of Group III are lacking although 1 fruit was produced which had 4% embryos and produced seedlings.

Group II species showed limited success when pollinated by I x III intergroup hybrids and complete failure when pollinated by III x III intergroup hybrids.

Limited data were collected for species of Group III when used as female parents (Table XII). At least 2 pollinations each were made with Groups I, II, and III pollen and pollen from I x III and III x III inter- and intragroup hybrids. Seedlings were produced using pollen from a Group III species and an intergroup I x III hybrid. It may be significant that all of the fruits produced from these crossings had very high embryo percentages and germinated.

Species from Groups I, II, and III were each used as pollen parents in crossings with Groups I x III hybrids (Table XIII). The data do not show a dramatic difference in the performances of these 3 cross combinations. Species of Group II gave the highest fruit yield of 31.6% followed by Group III of 28.6% and Group I of 19.2%. The balance of the data from these crossings should be compared with caution. It is obvious that viable embryos in 1 fruit escaped the author's detection. Assuming the embryo percentage of this fruit was relatively low, the average embryo percentage of the crosses involving Group II is probably much closer to the percentage for the crosses involving Group III. The other percentages would likewise be adjusted accordingly.

Two crosses each were made with Group I and II pollen onto Group III x III intergroup hybrids. No fruits were produced. From the unidirectional cross pollination data so far discussed, it is apparent that a variety of inter- and intragroup combinations can be obtained. Because of fluctuations and apparent contradictions in the data, the

Table X

Summary of results of intergroup and intergeneric crosses attempted using group I species as females

	No. of pollinations	No. of fruits harvested	% of pollinations that yielded fruits	No. of fruits with embryos	% of fruits with embryos	Avg. embryo %	No. of fruits that had germination	% of fruits that had germination	% of fruits with embryos that had germination
species I	57	25	43.9	21	84.0	44.8	16	64.0	76.2
species II	27	8	29.6	5	62.5	62.0	3	37.5	60.0
species III	3	--	----	--	----	----	--	----	----
all species	87	33	37.9	26	78.8	48.1	19	57.6	73.1
hybrids I x III	45	6	13.3	1	16.7	49.0	1	16.7	100.0
hybrids III x III	42	3	7.1	2	66.7	6.0	--	----	----
other hybrids	20	1	5.0	1	100.0	12.0	1	100.0	100.0
all hybrids	107	10	9.3	4	40.0	18.3	2	20.0	50.0
all cymbidiums	194	43	22.2	30	69.8	44.1	21	48.8	70.0
other genera	134	13	9.7	3	23.1	18.0	3	23.1	100.0
Total all pollinations	328	56	17.1	33	58.9	41.8	24	42.9	72.7

Table XI

Summary of results of intergroup and intergeneric crosses attempted using group II species as females

	No. of pollinations	No. of fruits harvested	% of pollinations that yielded fruits	No. of fruits with embryos	% of fruits with embryos	Avg. embryo %	No. of fruits that had germination	% of fruits that had germination	% of fruits with embryos that had germination
species I	48	9	18.8	7	77.8	39.7	6	66.7	85.7
species II	46	20	43.5	18	90.0	42.7	14	70.0	77.8
species III	11	1	9.1	1	100.0	4.0	1	100.0	100.0
all species	105	30	28.6	26	86.7	40.4	21	70.0	80.8
hybrids I x III	58	2	3.4	1	50.0	2.0	1	50.0	100.0
hybrids III x III	36	--	----	--	----	----	--	----	----
other hybrids	19	--	----	--	----	----	--	----	----
all hybrids	113	2	1.8	1	50.0	2.0	1	50.0	100.0
all cymbidiums	218	32	14.7	27	84.4	39.0	22	68.8	81.5
other genera	122	12	9.8	9	75.0	23.6	5	41.7	55.6
Total all pollinations	340	44	12.9	36	81.8	35.1	27	61.4	75.0

Table XII

Summary of results of intergroup and intergeneric crosses attempted using group III species as females

	No. of pollinations	No. of fruits harvested	% of pollinations that yielded fruits	No. of fruits with embryos	% of fruits with embryos	Avg. embryo %	No. of fruits that had germination	% of fruits that had germination	% of fruits with embryos that had germination
species I	2	--	----	--	----	----	--	----	----
species II	2	--	----	--	----	----	--	----	----
species III	2	1	50.0	1	100.0	91.0	1	100.0	100.0
all species	6	1	16.7	1	100.0	91.0	1	100.0	100.0
hybrids I x III	3	2	66.7	2	100.0	93.0	2	100.0	100.0
hybrids III x III	6	--	----	--	----	----	--	----	----
other hybrids	2	--	----	--	----	----	--	----	----
all hybrids	11	2	18.2	2	100.0	93.0	2	100.0	100.0
all cymbidiums	17	3	17.6	3	100.0	92.3	3	100.0	100.0
other genera	8	1	12.5	--	----	----	1	100.0	----
Total all pollinations	25	4	16.0	3	75.0	92.3	4	100.0	100.0

Table XIII

Summary of results of intergroup and intergeneric crosses attempted using group I x III hybrids as females

	No. of pollinations	No. of fruits harvested	% of pollinations that yielded fruits	No. of fruits with embryos	% of fruits with embryos	Avg. embryo %	No. of fruits that had germination	% of fruits that had germination	% of fruits with embryos that had germination
species I	26	5	19.2	4	80.0	21.5	3	60.0	75.0
species II	19	6	31.6	4	66.7	36.8	5	83.3	100.0
species III	7	2	28.6	2	100.0	28.5	2	100.0	100.0
all species	52	13	25.0	10	76.9	27.6	10	76.9	100.0
hybrids I x III	47	11	23.4	10	90.9	21.2	9	81.8	90.0
hybrids III x III	19	3	15.8	3	100.0	36.7	2	66.7	66.7
other hybrids	36	3	8.3	3	100.0	12.0	3	100.0	100.0
all hybrids	102	17	16.7	16	94.1	22.4	14	82.4	87.5
all cymbidiums	154	30	19.5	26	86.7	24.4	24	80.0	92.3
other genera	88	21	23.9	13	61.9	21.9	9	42.9	69.2
Total all pollinations	242	51	21.1	39	76.5	23.4	33	64.7	84.6

Table XIV

Summary of results of intergroup and intergeneric crosses attempted using group III x III hybrids as females

	No. of pollinations	No. of fruits harvested	% of pollinations that yielded fruits	No. of fruits with embryos	% of fruits with embryos	Avg. embryo %	No. of fruits that had germination	% of fruits that had germination	% of fruits with embryos that had germination
species I	2	--	----	--	----	----	--	----	----
species II	2	--	----	--	----	----	--	----	----
species III	--	--	----	--	----	----	--	----	----
all species	4	--	----	--	----	----	--	----	----
hybrids I x III	3	--	----	--	----	----	--	----	----
hybrids III x III	1	--	----	--	----	----	--	----	----
other hybrids	--	--	----	--	----	----	--	----	----
all hybrids	4	--	----	--	----	----	--	----	----
all cymbidiums	8	--	----	--	----	----	--	----	----
other genera	14	1	7.1	--	----	----	--	----	----
Total all pollinations	22	1	4.5	--	----	----	--	----	----

Table XV

Summary of results of intergroup and intergeneric crosses attempted using other hybrids (ungrouped) as females

	No. of pollinations	No. of fruits harvested	% of pollinations that yielded fruits	No. of fruits with embryos	% of fruits with embryos	Avg. embryo %	No. of fruits that had germination	% of fruits that had germination	% of fruits with embryos that had germination
species I	11	2	18.2	2	100.0	13.0	2	100.0	100.0
species II	13	3	23.1	3	100.0	24.0	3	100.0	100.0
species III	7	--	----	--	----	----	--	----	----
all species	31	5	16.1	5	100.0	19.6	5	100.0	100.0
hybrids I x III	53	4	7.5	4	100.0	19.0	3	75.0	75.0
hybrids III x III	69	1	1.4	1	100.0	3.0	--	----	----
other hybrids	38	3	7.9	2	66.7	50.5	2	66.7	100.0
all hybrids	160	8	5.0	7	87.5	25.7	5	62.5	71.4
all cymbidiums	191	13	6.8	12	92.3	23.2	10	76.9	83.3
other genera	99	21	21.2	15	71.4	12.7	14	66.7	93.3
Total all pollinations	290	34	11.7	27	79.4	16.2	24	70.6	88.9

Table XVI

Summary of results of intergroup and intragroup crosses attempted using species and hybrids as males and females

cross combinations including reciprocals	No. of pollinations	% fruit yield	% fruit with embryos	embryo %	% fruit w/embryos that germinated	% pollinations that gave germination
I x I	57	43.9	84.0	44.8	76.2	28.1
II x II	46	43.5	90.0	42.7	77.8	30.4
I x II	75	22.7	72.3	47.7	76.4	12.0
I x (I x III)	71	15.5	45.5	27.0	80.0	5.6
II x (I x III)	77	10.4	62.5	29.8	100.0	7.8
I x (III x III)	44	6.8	66.7	6.0	0	0
II x (III x III)	38	0	0	0	0	0

degree of relationship between the groups cannot be determined with certainty. The hypothesis is made, however, that intragroup crosses may be more compatible than intergroup crosses. It is also hypothesized (although the supporting data are limited) that Group III species and Group III x III hybrids are less compatible with Group I and II species than these latter 2 species groups are within and between each other.

This, if it is true, may be due to physical rather than genetic reasons. The flower sizes of Groups I and II species are similar and comparably smaller than the flowers of Group III species. The reason that no hybrids were obtained using Group III species or III x III hybrids as females with pollen from Group I or II species may be because the pollen tubes did not have the physical capacity to grow down the length of the column to reach the unfertilized ovules.

Combining the unidirectional cross compatibility data for the inter- and intragroup pollinations to include their reciprocals reduces some of the inconsistent variations and provides more support for the hypotheses mentioned above regarding possible relationships.

The data in Table XVI show that each of the 2 intragroup combinations produced almost twice the fruit set percentage and over twice the viable fruits to pollinations percentage than did the I x II intergroup combinations. The data also show that secondary hybrids involving Groups I and II were obtained much less frequently than were either inter- or intragroup primary hybrids. Hybrids of Groups I or II with III x III hybrids were unobtainable in this research.

The consolidated cross compatibility data support the hypothesis that the species comprising each of the Groups I and II, based on

morphological features of the plants and flowers, are more closely related within their designated groups than they are to the species of the other group. The hypothesis that Groups I and II are more closely related to each other than either is to Group III is also supported by these data. In the future meiotic analysis of the hybrids produced from this research will help to determine if these relationships are of a physical, genetic, and/or phylogenetic nature.

Thirty-eight intergeneric pollinations which resulted in fruits with embryos and seedlings are listed below. The female parent is listed first. Footnote number 1 indicates cytologically confirmed hybrids, and footnote number 2 indicates false hybrids. The hybrid status of the balance of the crosses either could not be determined cytologically or have not yet been investigated.

Ansellia africana x *C. canaliculatum* var *sparkesii*

Ansellia africana x *C. hoosai* var *kinkwalan* sub var *fayden*

C. aloifolium x *Ansellia africana*

C. aloifolium x *Ansellia giganteum*

C. hoosai var *kinkwalan* sub var *fayden* x *Ansellia africana*[1]

C. koran var *alba* x *Ansellia gigantea*

C. madidum x *Ansellia africana*[1]

C. parishii var *sanderae* x *Ansellia africana*

C. soshin 'Tetukotsu' x *Ansellia gigantea*

C. Fairy Wand x *Ansellia africana*[1]

C. Little Black Sambo x *Ansellia africana*[1]

C. Penguin x *Ansellia africana*[1]

C. Penguin x *Ansellia gigantea*

C. Peter Pan 'Greensleeves' (UH-2) x Ansellia africana

C. Peter Pan 'Greensleeves' (UH-2) x Ansellia gigantea

C. Red Star x Ansellia africana

C. Starbright x Ansellia africana[1]

C. Vogelsang x Ansellia africana[1]

(C. hoosai x C. lancifolium) x Ansellia africana[1]

C. Pali x (C. soshin x C. Pali) x Ansellia africana[1]

(C. hoosai x C. lancifolium) x Catasetum fimbriatum[1]

C. Red Star x Grammatophyllum scriptum 'The Governor'

(C. hoosai x C. lancifolium) x Grammatophyllum scriptum

C. Pali x (C. soshin x C. Pali) x Grammatophyllum scriptum

C. madidum x Eulophia kirkii

C. Penguin x Eulophia kirkii

(C. hoosai x C. lancifolium) x Eulophia kirkii

Eulophia caffra x Ansellia africana

Eulophia kirkii x Ansellia africana

Eulophia caffra x C. Peter Pan 'Greensleeves' (UH-2)

Eulophia kirkii x C. hoosai var kinkwalan sub var fayden

Phaius tankervillae x Ansellia africana[2]

Phaius tankervillae x Spathoglottis plicata[2]

Phaiocalanthe (P. Gravesiae x C. Lord Rothschild) x Calanthe vistata var rubro-oculata

Spathoglottis plicata x Ansellia africana

Spathoglottis plicata x Calanthe vistata var rubro-oculata

Spathoglottis Pacifica x Calanthe vistata var rubro-oculata

Spathoglottis plicata x Phaius tankervillae

Table XVII

Summary of results of intergeneric and intrageneric crosses attempted using genera other than Cymbidium as females

	No. of pollinations	No. of fruits harvested	% of pollinations that yielded fruits	No. of fruits with embryos	% of fruits with embryos	Avg. embryo %	No. of fruits that had germination	% of fruits that had germination	% of fruits with embryos that had germination
species I	189	10	5.3	5	50.0	4.8	2	20.0	40.0
species II	156	10	6.4	2	20.0	8.5	1	10.0	50.0
species III	20	--	----	--	----	----	--	----	----
all species	365	20	5.5	7	35.0	4.7	3	15.0	42.9
hybrids I x III	168	3	1.8	1	33.3	4.0	1	33.3	100.0
hybrids III x III	61	--	----	--	----	----	--	----	----
other hybrids	81	--	----	---	----	----	--	----	----
all hybrids	310	3	1.0	1	33.3	4.0	1	33.3	100.0
all cymbidiums	675	23	3.4	8	34.8	4.6	4	17.4	50.0
other genera	544	52	9.6	36	69.2	37.3	26	50.0	72.2
Total all pollinations	1219	75	6.2	44	58.7	32.3	30	40.0	68.2

The origin of the seedlings of many of the intergeneric combinations was not or could not be determined, and the cross pollination data collected for these combinations do not yet contribute to the analysis of their origin. Two exceptions are the crosses of Cymbidium x Catasetum and Cymbidium x Ansellia, wherein the hybrid origin was determined.

The Cymbidium x Catasetum cross is a cytologically confirmed valid cross. A total of 27 pollinations was made with Catasetum fimbriatum pollen on 6 Cymbidium species (2 groups), 6 Cymbidium hybrids and species of Ansellia, Calanthe, Grammatophyllum, Phaius, and Spathoglottis. All of the flowers abscissed within a few days except for a single pollination on C. hoosai x C. lancifolium. Because the fruit was developing slowly, it was left for 180 days. The fruit, which had only 2% non-aborted embryos at the time of harvest, subsequently yielded about 100 Catacymbidium seedlings. Several similar pollinations using pollen from Catasetum intergrinum, C. viridiflarum and C. Sumanii resulted in premature abscission of the ovaries. The pollen used in each case was collected by the author from outside sources and no flowering Catasetum were available for pollination.

The results of 257 intergeneric cross pollinations, involving numerous species and hybrids of Cymbidium and 2 species of Ansellia, demonstrated conclusively that the 2 genera are sexually compatible but almost exclusively in 1 direction (Table XVIII). Two fruits which appeared to have no embryos ultimately yielded a few seedlings each. The results, with or without an adjustment, are nonetheless conclusive. Each of the 6 Cymbidium species and hybrid categories produced at least 20.8% fruits when pollinated with Ansellia pollen, while only 2

Table XVIII

Summary of results of intergeneric crosses attempted between *Ansellia* and *Cymbidium*

♀ ♂	No. of poll.	No. of fruits harv.	% of poll. that yielded fruits	No. of fruits w/embryos	% of fruits w/embryos	Avg. embryo %	No. of fruits that had germ.	% of fruits that had germ.	% of fruits w/embryos that had germ.
species I x *Ansellia*	24	5	20.8	3	60.0	18.0	3	60.0	100.0
Ansellia x species I	33	1	3.0	1	100.0	9.0	1	100.0	100.0
species II x *Ansellia*	15	5	33.3	3	60.0	22.9	4	80.0	100.0
Ansellia x species II	31	2	6.4	1	50.0	13.0	1	50.0	100.0
species III x *Ansellia*	1	1	100.0	-	----	----	-	----	-----
Ansellia x species III	9	-	----	-	----	----	-	----	-----
hybrid I x III x *Ansellia*	12	11	91.7	8	72.7	19.6	7	63.6	87.5
Ansellia x hybrid I x III	52	-	----	-	----	----	-	----	-----
hybrid III x III x *Ansellia*	3	1	33.3	-	----	----	-	----	-----
Ansellia x hybrid III x III	41	-	----	-	----	----	-	----	-----
hybrid, other x *Ansellia*	11	8	72.7	6	75.0	6.0	7	87.5	100.0
Ansellia x hybrid, other	25	-	----	-	----	----	-	----	-----
all Cymbidiums x *Ansellia*	66	31	47.0	20	64.5	15.8	21	67.7	100.0
Ansellia x all Cymbidiums	191	3	1.6	2	66.7	11.0	2	66.7	100.0

Floral morphology of Ansellia africana

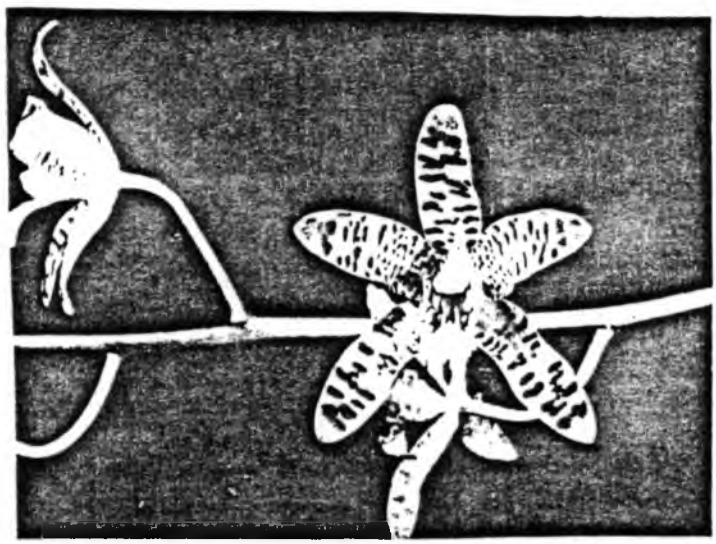

Fig. 24. Ansellia africana 'UH-10' (1.09X)

categories, Groups I and II, produced fruits, the higher being 6.4% with Ansellia as the female parent. The overall average percentage of fruits with embryos and overall average embryo percentage per fruit did not indicate any significant unidirectional differences, but the overall percentages of fruit set were strikingly different depending on which was the seed and pollen parent. Thirty-one fruits were obtained from 66 pollinations, 47.0%, when Cymbidium were used as females; only 3 fruits were obtained from 191 pollinations, 1.6%, when Ansellia were used as females. Further investigation would be necessary to determine the basis for this unidirectional phenomenon.

The data also show that when embryos are present germination is likely to follow given favorable invironmental conditions. Twenty-one of the 22 fruits observed to contain embryos (theoretically 23 of 24) gave seedlings. The data from the Cymbidium intrageneric cross compatibility study indicate that this was not necessarily the case for many of those crosses.

In order to establish an effective Cymbidium breeding program it is important to identify not only group relationships but also to identify individual plants that have demonstrated an ability to hybridize. Tables XIX and XX show in absolute terms, the ranges of pollinations that were made and viable crosses that resulted from each Cymbidium in the collection that gave seedlings. Six species flowered but did not give seedlings. Attempts at hybridizing numerous other Cymbidium hybrids not listed in Table XX all resulted in failure (Appendix A).

In Group I, C. hoosai var kinkwalan sub var fayden showed greater versatility than any other species. It gave viable crosses when

hybridized with 2 species groups, 2 hybrid groups, and 2 other genera. Three species, C. hoosai var kinkwalan sub var fayden, C. soshin 'Tetukotsu', and C. koran var album have the ability to hybridize intergenerically. Only 2 species of this section, C. lancifolium and C. koran var album, hybridized intergroup or intergenerically but failed to hybridize intragroup. It is of interest to note that 2 species, C. hoosai and C. soshin, were represented by 2 clones each. One clone of each species demonstrated excellent versatility in hybridizing while the other clone of each species failed at all attempts.

Four species from Group I, C. aspidistrifolium, C. formosanum, C. koran, and C. soshin, do not appear as parents in the official registration of hybrids but were successful in producing seedlings in this investigation (an unregistered hybrid of C. formosanum x C. Greenwood was obtained from an outside source for this investigation). Three other species from this group, C. dayanum, C. ensifolium, and C. kanran, do appear as parents in the official registration of hybrids but failed to produce seedlings during this research.

In Group II, 5 species flowered and each produced seedlings when hybridized intragroup except C. chloranthum which hybridized only with Group I. Cymbidium pendulum did not hybridize intergroup. Cymbidium aloifolium, C. canaliculatum var sparkesii, and C. madidum produced seedlings when hybridized with Group I and II, intergroup hybrids I x III, and Ansellia. Cymbidium madidum is the only Group II species that produced seedlings with a genus other than Cymbidium or Ansellia. It produced viable seedlings with Eulophia. Cymbidium aloifolium is the only Group II species that hybridized with all 3 Cymbidium groups.

Table XIX

Cymbidium species which flowered and were tested for their crossability with various species groups, intergroup hybrids and genera other than Cymbidium

Species I x	Species			Hybrids			Other Genera			
	I	II	III	IxIII	IIIxIII	Other	Ans	Cat	Eul	Gramm
C. hoosai var kinkwalan sub var fayden	+	+	–	+		+	+	–	+	–
C. soshin 'Tetukotsu'	+	–	–	+	–	+	+	–	–	–
C. gracillimum	+	+					–			–
C. lancifolium	–	+		–	–	+	–	–	–	–
C. pumilum var album	+	+	–				–			
C. aspidistrifolium	+	–				–	–			
C. formosanum	+	–					–			–
C. koran var album	–	–		–		+				
C. sinense var album 'Jucundissimum'	+	–		–	–	–	–	–		–
C. suavissimum	+									
C. soshin var album	–			–	–					
C. ensifolium var album	–			–	–	–	–			

Table XIX (continued)

Cymbidium species which flowered and were tested for their crossability with various species groups, intergroup hybrids and genera other than *Cymbidium*

Species I x	Species			Hybrids			Other Genera			
	I	II	III	IxIII	IIIxIII	Other	Ans	Cat	Eul	Gramm
C. kanran 'Taiwan Purple'	–	–	–	–						–
C. dayanum	–	–		–	–	–	–		–	
C. munronianum	–	–		–	–	–	–		–	
C. hoosai	–	–		–	–	–	–	–	–	–
Species II x										
C. aloifolium	+	+	+	+	–	+	+	–	–	–
C. madidum	+	+	–	+	–	+	+	–	+	–
C. canaliculatum var *sparkesii*	+	+	–	+		–	+		–	–
C. chloranthum	+	–		–	–		–			–
C. pendulum	–	+	–	–	–	–	–	–	–	–

Table XIX (continued)

Cymbidium species which flowered and were tested for their crossability with various species groups, intergroup hybrids and genera other than *Cymbidium*

Species III x	Species			Hybrids			Other Genera			
	I	II	III	IxIII	IIIxIII	Other	Ans	Cat	Eul	Gramm
C. eburneum	–	+	+			–	–			–
C. parishii var *sanderae*	–	–	–	+	–	–	+		–	–

The above table includes reciprocal crosses.

A "+" indicates seedlings were obtained, a "–" indicates pollinations were made but no seedlings were obtained, and no mark indicates the combination was not tested.

In Group III, 2 species flowered and each produced seedlings. Cymbidium eburneum produced seedlings only with Cymbidium species, Groups II and III, while C. parishii var sanderae produced seedlings only with Cymbidium hybrids Group I x III and Ansellia.

Although the cross compatibility data presented throughout this discussion illustrate the relative difficulty in combining species Groups I and III, there are registered hybrids of Group I species C. ensifolium, C. hoosai, C. kanran, and some not used in this research with various Group III species. Other combinations that were not obtained in this research but that appear in the official registration of hybrids are C. eburneum x Group I, C. chloranthum, C. parishii, and C. pendulum x Group III, and C. ensifolium x Groups II and III. It is unknown how many failures there may have been for these and other combinations before and since such hybrids were registered. It is likely that additional breeding will yield yet additional combinations. The lack of registered hybrids between some of the groups do not necessarily indicate a lack of compatibility between these groups.

The registration of Cymbidium hybrids is generally based on 2 criteria. Hybrids registered are often only those considered to have some horticultural merit. Species of Groups I and II generally contribute some inferior horticultural qualities to their hybrids. Secondly, the availability of species material determines the assortment of combinations that can be tested. Cymbidium have been extensively hybridized for nearly a century but the parental species used have come almost exlusively from Group III. It has been only during the last 2

Table XX

Cymbidium hybrids which have crossed with various species groups, intergroup hybrids, and genera other than Cymbidium

Hybrids I x III x	Species			Hybrids			Other Genera			
	I	II	III	IxIII	IIIxIII	Other	Ans	Cat	Eul	Gramm
C. Peter Pan 'Greensleeves' (UH-2)	+	+	+	+	+	+	+	–	+	–
C. Fairy Wand	+	+	+	+		–	+		–	–
C. Red Star	–	+		+	–	–	+		–	+
C. Pali (C. soshin x C. Pali)	+	–		+		–	+		–	+
C. Starbright	+	+			–	–	+			
C. Fair Green	–	–	–	–	–	+	+	–	–	–
C. Mimi 'Sandalwood'	–	–	+	–		+	–	–		–
C. Sylvia Miller	–	+	–	+		–	–	–	–	–
C. Peter Pan 'Greensleeves' (UH-1)	–	–		+		–	–		–	
Hybrids III x III x										
C. Sicily x C. erythrostylum	–	–	–	+	–	–	–			
C. Sicily x C. San Miguel	–			+	–	–	–		–	

Table XX (continued)

Cymbidium hybrids which have crossed with various species groups, intergroup hybrids, and genera other than *Cymbidium*

Hybrids other x	Species			Hybrids			Other Genera			
	I	II	III	IxIII	IIIxIII	Other	Ans	Cat	Eul	Gramm
C. hoosai x *C. lancifolium*	–	–	–	+	–	+	+	+	+	+
C. Penguin	+	+	–	+	–	–	+	–	+	–
C. Little Black Sambo	+	–	–	–		+	+			–
C. Vogelsang	–	+	–	+	–	–	+	–	–	–

The above table includes reciprocal crosses.

A "+" indicates seedlings were obtained, a "–" indicates pollinations were made but no seedlings were obtained, and no mark indicates the combination was not tested.

decades that hybridizers have expressed an interest in the small flowered species of Groups I and II.

Nine Cymbidium intergroup I x III hybrids produced seedlings during this investigation (Table XX). Seven of these hybrids, C. Peter Pan 'Greensleeves' (UH-2), C. Fairy Wand, C. Red Star, C. Pali x (C. soshin x C. Pali), C. Starbright, C. Mimi 'Sandalwood', and C. Sylvia Miller, successfully crossed with at least 1 of the Cymbidium species groups. These hybrids most frequently crossed with other I x III intergroup hybrids and Ansellia, 6 times each. Cymbidium Peter Pan 'Greensleeves' (UH-2), C. Fairy Wand, C. Red Star, and C. Pali x (C. soshin x C. Pali) each produced seedlings with other intergroup I x III hybrids and Ansellia while C. Sylvia Miller and C. Peter Pan 'Greensleeves' (UH-1) produced seedlings with intergroup hybrids I x III, and C. Starbright and C. Fair Green produced seedlings with Ansellia. Three of these plants that bred with Ansellia also produced seedlings with other genera: C. Peter Pan 'Greensleeves' (UH-2) with Eulophia and C. Red Star and C. Pali x (C. soshin x C. Pali) with Grammatophyllum.

Cymbidium Peter Pan 'Greensleeves' (UH-2), the colchicine converted tetraploid, proved to be one of the most versatile plants in the collection for breeding purposes. It produced seedlings when combined with each of the species groups, intergroup hybrid groups, and the genera Ansellia and Eulophia. The diploid form of this clone, C. Peter Pan 'Greensleeves' (UH-1) was almost completely infertile. Attempts were made to hybridize it with 2 species groups, 2 intergroup hybrid groups, and 2 genera other than Cymbidium. For each of these categories it failed to breed with, its tetraploid counterpart was successful. A

few seedlings produced from the diploid form were from crossing it with the highly fertile tetraploid form of the same clone. These data support the theory that restoration of fertility is associated with induction of polyploidy. If the infertility of the diploid plant is due to irregular pairing of chromosomes during meiosis, doubling the chromosomes would provide 2 sets of chromosomes of each parental plant which would facilitate meiotic pairing.

Of the 9 breedable intergroup hybrids, 5 of them are C. pumilum hybrids although they are notoriously poor breeders. Cymbidium pumilum hybrids generally have much higher horticultural qualities than hybrids of other Group I species, so fertile ones become especially desirable to hybridizers.

Cymbidium Sicily x C. erythrostylum and C. Sicily x C. San Miguel both intragroup III x III hybrids, each hybridized only with intergroup I x III plants. Attempts to hybridize these plants with species of Cymbidium and other genera failed.

Four primary hybrids of combinations other than I x III and III x III produced seedlings. Cymbidium hoosai x C. lancifolium, C. Penguin, C. Little Black Sambo, and C. Vogelsang each produced seedlings with Cymbidium species and/or hybrids and Ansellia. Cymbidium Penguin also produced seedlings with Eulophia and C. hoosai x C. lancifolium produced seedlings with 3 other genera, Catasetum, Eulophia, and Grammatophyllum. The performance of C. hoosai x C. lancifolium was unusual in that repeated attempts to hybridize it with Cymbidium species failed while it produced seedlings with 4 genera other than Cymbidium

Fig. 25. C. hoosai x C. lancifolium (1.25X)

Fig. 26. C. hoosai x C. lancifolium (0.16X)

Vegetative and floral morphology of Cymbidium hybrids

Fig. 27. C. Peter Pan 'Greensleeves' (UH-2) (0.09X)

Fig. 28. C. Peter Pan 'Greensleeves' (UH-2) (0.75X)

Vegetative and floral morphology of Cymbidium hybrids

Fig. 29. C. Vogelsang (0.11X)

Fig. 30. C. Vogelsang (1.11X)

and is the only Cymbidium that produced seedlings with more than 2 other genera.

In all 15 hybrid Cymbidium were identified as breedable. Ten produced seedlings with Cymbidium species, 13 with Cymbidium hybrids, and 10 with other genera.

III. Effects of Polyploidy on Morphology

Fourteen floral and vegetative characters of C. Peter Pan 'Greensleeves' (UH-1), the diploid form, and C. Peter Pan 'Greensleeves' (UH-2), the tetraploid form, were compared using the average percent increase or decrease in floral segment size, leaf size, inflorescence length, and flowers per inflorescence (Table XXI).

The widths of the leaves and flower segments, except for the lateral petals, were much more affected than were the lengths by the higher ploidy level. The characters showing the largest increase in size were column width, labellum width, and leaf width, showing 80.0, 40.0, and 35.3 percent increases, respectively. Lateral sepal length was the only character unaffected by the increased ploidy level. The average number of flowers per inflorescence and the average inflorescence length were slightly reduced in the tetraploid form.

It is often said that tetraploids have increased "fullness" or "shapeliness" over diploids. The following formula was developed to test for increased "fullness" or "shapeliness" or symmetry.

$$\frac{\text{overall flower width}}{\frac{\text{dorsal sepal width} + \text{labellum width} + 2(\text{lateral sepal width} + \text{lateral petal width}}{6}}$$

The ratio of flower width to average floral segment width is, for the

Table XXI

Measurements of diploid and tetraploid forms of Cymbidium Peter Pan 'Greensleeves'

Characters	Measurements (cm) 2n	4n	Percent Differences
Dorsal sepal width	1.3	1.6	23.1+
Dorsal sepal length	2.8	2.9	3.6+
Lateral sepal width	1.1	1.3	18.2+
Lateral sepal length	3.2	3.2	0.0
Lateral petal width	1.1	1.3	18.2+
Lateral petal length	2.9	3.7	27.6+
Labellum width	1.5	2.1	40.0+
Labellum length	1.8	2.1	16.7+
Column width	0.5	0.9	80.0+
Overall flower width	5.6	6.2	10.7+
Leaf width	1.7	2.3	35.3+
Leaf length	56.0	62.0	10.7+
Flowers per inflorescence	9.5[1]	8.4[2]	11.6-
Inflorescence length	47.5[1]	45.0[2]	5.3-

[1]Based on 2 inflorescences; 19 flowers

[2]Based on 7 inflorescences; 59 flowers

Floral morphology of diploid and tetraploid forms of Cymbidium Peter Pan 'Greensleeves'

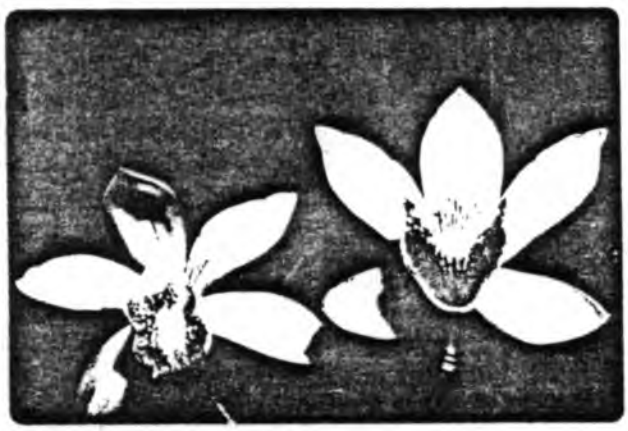

Fig. 31. C. Peter Pan 'Greensleeves' (UH-1), diploid, left; and (UH-2), tetraploid, right (0.63X)

diploid 4.7 and for the tetraploid 4.1. The smaller ratio for the tetraploid indicates that the individual segments, on the average, have increased more in width than the flower has increased in size. The flowers therefore do have increased "fullness" and less space between the floral segments.

The tetraploid C. Peter Pan 'Greensleeves' also appears to have a greater concentration of anthocyanin pigment in the labellum than the diploid form (Figure 31).

It should be pointed out that the diploid form was a 7-bulb plant while the tetraploid form was a 14-bulb plant. This difference undoubtedly accounts for, at least in part, the difference in the number of inflorescences produced. Each plant, however, has produced at least 1 inflorescence on each matured pseudobulb. The plant size difference may also have had an effect on the measurements of the floral characteristics; however, the author's experience with Cymbidium is that flowers of full size and inflorescences of full length and flower number can be obtained on plants with an average minimum of 5 pseudobulbs. Plants were grown under indentical greenhouse and cultural management conditions for over 2 years.

The differences in flower morphology of the diploid and tetraploid forms of C. Peter Pan 'Greensleeves' are consistent with the reports of Menninger (1963) and Wimber and Wimber (1968) on the effect of polyploidy on floral characteristics of Cymbidium.

Menninger reported measurements of 4 floral characteristics of the diploid C. Conningsbyanum 'Brockhurst' and a colchicine derived tetraploid of the same clone. From the measurements she reported, it

was calculated that the greatest gain was in labellum width which increased 50.0%. The overall flower width increased 8.8% while the labellum length and dorsal sepal width increased 15.4 and 16.7%, respectively. Menninger also observed that no marked difference in the 2n and 4n foliage is apparent except that the latter appears somewhat wider (Menninger 1963).

The analysis by Wimber and Wimber (1968) of floral characteristics of diploid and colchicine-derived tetraploid seedling populations of C. Lunagrad is also consistent with the author's results and those of Menninger. The results showed that there is a significant increase in sepal and petal width of the tetraploids. Less obvious differences were slight increases in overall flower width and slight decreases in average number of flowers per inflorescence of the tetraploids. This work also showed that average sepal and petal thickness was also significantly increased in the tetraploids.

Using a slightly different formula than the one described above, it was determined that indeed there is a symmetry change (increased fullness) in the tetraploids (Wimber and Wimber 1968).

The results of these 3 comparative studies show that the most obvious floral difference between diploid and tetraploid forms of like plants is the increased width of floral segments and increased "fullness" of the tetraploids. To a less obvious degree there is an overall increase in flower size and possibly a slight reduction in flower number of the tetraploids.

GENERAL DISCUSSION

Incompatibility systems in the Orchidaceae are of 2 types: exogenous barriers and endogenous barriers to hybridization. Exogenous systems include geographical isolation, pollinator specificity, and seasonal flowering habit. Endogenous systems are of either a genic or chromosomal nature. Exogenous systems can be overcome by the hybridizer under controlled conditions and by storing pollinia for later use. Endogenous systems are not so easily overcome and may offer permanent barriers to hybridization.

Endogenous incompatibilities of a genic origin may be associated with an inability of pollen to germinate on a given stigmatic surface or an inability of pollen tubes to grow down the length of the column and reach the ovules. Such a system may be operative when pollinating Ansellia with Cymbidium pollen but inoperative or absent when the reciprocal is made. Withner (1959) states that the critical factor determining the fate of the pollination is often the direction in which the pollination is made. The cytoplasm in the egg of the maternal parent may have an antagonistic effect on the sperm nucleus of the paternal parent, whereas, the same plants pollinated in the reciprocal way may not result in this phenomenon.

Environmental stimuli in some instances may trigger some of these systems into operation. It may be that under greenhouse cultivation Ansellia does not function well as a female when pollinated by Cymbidium while under other environmental conditions it may. The discovery of this unidirectional phenomenon between Ansellia and Cymbidium

contributes useful practical information to the orchid breeder although additional research will be necessary to determine the exact mechanism responsible for this phenomenon.

The production of non-germinating yet apparently viable embryos by fruits from some intergeneric pollinations is another incompatibility system. Such embryos may be dormant or non-functional due to chemical inhibitors. Burgeff (in Withner 1959) suggests using liquid media for seed sowing in an attempt to leach out chemical inhibitors. The following 11 inter- and intrageneric combinations resulted in some fruits with apparently viable seeds which did not germinate when sown on liquid medium: Bletia x Ansellia, Bletia x Bletia, Cymbidium x Ansellia, Cymbidium x Cymbidium, Cymbidium x Eulophia, Cymbidium x Grammatophyllum, Cymbidium x Phaius, Cymbidium x Spathoglottis, Spathoglottis x Ansellia, Spathoglottis x Calanthe, and Spathoglottis x Cymbidium. Since liquid medium was used for all seeds sown during this research, it is possible that some seeds germinated that would not have on solid medium. Additional research would be required to determine whether chemical inhibitors were actually removed via the method used.

The technique of embryo culture from immature fruits was used throughout this investigation. The technique can sometimes be used to save embryos of intergeneric or other complex crosses which would otherwise abort if the fruit were allowed to terminate naturally (Sagawa and Valmayor 1966). It is possible that some endogenous incompatibility systems may have been overcome in this research by employing this technique, but additional research would be required to

determine with certainty that this has happened.

Progeny of complex hybridizations will often grow to maturity and flower but may be incapable of further hybridization. This is yet another endogenous incompatibility system which is usually the result of chromosomal nonhomology during meiosis. The degree of chromosomal nonhomology will determine the degree of sterility. Chromosomal nonhomology of this type can often be an advantage to the plant breeder if the plant in question can be converted to the tetraploid level. Allotetraploids, unlike autotetraploids, are generally much more fertile than their corresponding diploid counterparts. In the allotetraploid each chromosome has only 1 perfect mate, an exact duplicate of itself, which facilitates pairing and consequently increases fertility. Autotetraploids are less fertile than diploids because each chromosome has 3 homologs with which it can pair (Withner 1974). The result is often an assortment of uni-, bi-, tri-, and quadrivalents which may be nonfunctional or nearly so. It may, therefore, be inadvisable to rely heavily on induced tetraploid species in a breeding program. On the other hand, the greater the infertility of a diploid hybrid, the greater the fertility its tetraploid counterpart is likely to have (Withner 1974). Such is the case with the diploid and tetraploid forms of C. Peter Pan 'Greensleeves' used in this investigation. Since the diploid form is relatively sterile, it can be expected that the tetraploid form will be relatively true breeding and that little segregation will occur in the S_1 population. Hybridizing this tetraploid form with species and other allotetraploids should also produce relatively uniform progeny.

In order to establish a breeding program that will ultimately yield high quality and high yielding Cymbidium varieties for cut-flower purposes at low elevations in Hawaii, a criteria of minimum horticultural standards must be observed. As progenies are selected that meet the criteria, the standards can be advanced and expanded to include additional attributes. It is essential to first select a gene pool comprised of plants with at least some degree of fertility and the ability to flower under the prevailing environmental conditions (further research should be undertaken to correlate the various environmental influences with the flowering response of Cymbidium). Species and hybrids of Cymbidium that flowered at Lyon Arboretum in Manoa and/or at the University of Hawaii Manoa campus and have produced seedlings during this investigation are listed in Table XXII.

The preliminary criteria of horticultural standards should include: 1) a free flowering habit, plants that flower with great difficulty or that flower during alternate years should be avoided; 2) a compact growth habit, plants of ungainly proportions should be avoided; 3) a minimum flower size of 6.5 cm in overall width; 4) a minimum flower number of 16 per inflorescence; and 5) a minimum inflorescence length of 50 cm.

None of the 30 plants listed in Table XXII meets all of these standards, however, 1 species, C. parishii var sanderae, and 3 hybrids, C. Fair Green, C. Fairy Wand, and C. Vogelsang meet 4 of the 5 standards. These 4 plants should be used extensively in the early stages of the breeding program. Seven plants, C. madidum, C. pendulum, C. Mimi 'Sandalwood', C. Penguin, C. Peter Pan 'Greensleeves' (UH-2),

C. Sylvia Miller, and C. hoosai x C. lancifolium meet 3 of the 5 standards and should be used only in combination with plants that do not show the same weaknesses. Other plants should be used only in critical situations where they possess and may contribute 1 or 2 outstanding qualities. Examples of such plants are C. aloifolium and C. canaliculatum var sparkesii with 26 and 38 flowers per inflorescence, respectively, and C. Starbright with 27 flowers on 63.5 cm inflorescences. Ansellia, Catasetum, Grammatophyllum, and perhaps other genera can be used in the same way to introduce additional warm temperature tolerance, branching inflorescence habit or increased flower size. As a general rule, species of Group I and II, the primary sources of warm temperature tolerance, offer few horticultural qualities and should, therefore, be used principally with standard (Group III x III) cut-flower hybrid varieties of proven high quality. Hybrids with warm temperature tolerance that have Group III species in their genealogy and meet certain minimum quality standards, such as C. Fair Green, C. Fairy Wand, C. Mimi 'Sandalwood', C. Peter Pan 'Greensleeves' (UH-2), and C. Sylvia Miller should be intercrossed. If the genes for warm temperature tolerance and the various horticultural qualities segregate independently, a small percentage of individuals possessing a combination of these traits to a high degree may be recovered. The triploid C. Mimi 'Sandalwood' and the tetraploid C. Peter Pan 'Greensleeves' (UH-2) should be used in carefully planned matings to take advantage of their polyploid nature. Polyploidy should be induced on selected individuals to improve flower size and texture and restore fertility if necessary

and on selected lots of germinating seedlings if infertility is anticipated.

Once compact growing, free flowering Cymbidium hybrids with acceptable flower size and number on tall inflorescences are obtained, the criteria may be broadened to include desirable colors, blooming season, fragrance, and multiple inflorescences per pseudobulb. The genes for various colors and blooming seasons may be available from a wide variety of sources while the genes for fragrance and multiple inflorescences are probably available from only a few of the Group I species.

Table XXII

Evaluation of some horticultural qualities of warm temperature tolerant and fertile Cymbidium species and hybrids in the research collection

Species	free flowering habit	compact growth habit	average flower size (cm)	average flower number	average inflorescence length (cm)
C. aloifolium	+	–	5.1	26	45.7
C. aspidistrifolium	–	+	3.8	5	15.2
C. canaliculatum var sparkesii	+	+	1.9	38	27.9
C. chloranthum	+	+	2.5	20	40.6
C. eburneum	–	+	6.5	1	27.9
C. formosanum	–	+	5.7	1	12.7
C. gracillimum	–	+	5.1	2	28.0
C. hoosai var kinkwalan sub var fayden	–	+	3.2	12	50.8
C. koran var album	–	+	2.5	5	20.3
C. lancifolium	+	+	2.5	10	17.8
C. madidum	+	–	2.5	22	51.0

Table XXII (continued)

Evaluation of some horticultural qualities of warm temperature tolerant and fertile Cymbidium species and hybrids in the research collection

Species	free flowering habit	compact growth habit	average flower size (cm)	average flower number	average inflorescence length (cm)
C. parishii var sanderae	+	+	8.9	7	71.0
C. pendulum	+	–	4.4	30	61.0
C. pumilum	–	+		12	13.0
C. sinense var album 'Jucundissimum'	–	+	3.8	8	45.7
C. soshin 'Tetukotsu'	+	+	4.4	4	30.5
C. suavissimum	–	+	2.5	8	35.6
Hybrids					
C. Fair Green	+	+	7.0	16	40.6
C. Fairy Wand	+	+	4.5	24	50.8
C. Little Black Sambo	–	+	2.5	12	27.9
C. Mimi 'Sandalwood'	+	+	7.0	11	43.2
C. Penguin	+	+	3.2	34	40.6

Table XXII (continued)

Evaluation of some horticultural qualities of warm temperature tolerant and fertile Cymbidium species and hybrids in the research collection

Hybrids	free flowering habit	compact growth habit	average flower size (cm)	average flower number	average inflorescence length (cm)
C. Peter Pan 'Greensleeves' (UH-1)	+	+	5.7	10	48.3
C. Peter Pan 'Greensleeves' (UH-2)	+	+	6.5	8	45.7
C. Red Star	+	+	4.4	10	38.1
C. Starbright	–	–	5.7	27	63.5
C. Sylvia Miller	–	–	7.6	16	50.8
C. Vogelsang	+	+	5.7	28	63.5
C. hoosai x C. lancifolium	+	+	5.1	12	58.4
C. Pali x (C. soshin var album x C. Pali)	–	+	5.7	6	38.1

APPENDIX

Appendix A

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium aloifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
aspidistrifolium	1	0	0	0.0	0
formosanum	1	0	0	0.0	0
gracillimum	1	1	0	0.0	0
hoosai	2	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	5	1	1	29.0	1
koran var *album*	2	0	0	0.0	0
lancifolium	3	1	1	5.0	0
pumilum var *album*	1	1	0	0.0	0
sinense var *album* 'Jucundissimum'	2	0	0	0.0	0
soshin 'Tetukotsu'	3	0	0	0.0	0
	21	4	2	17.0	1
Species II					
aloifolium	4	2	2	3.5	0
canaliculatum var *sparkesii*	1	1	1	87.0	1
chloranthum	1	0	0	0.0	0
madidum	1	1	1	12.0	1
pendulum	12	8	8	43.6	8
	19	12	12	37.9	10

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium aloifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species III ♂					
eburneum	1	1	1	4.0	1
parishii var *sanderae*	2	0			
	3	1	1	4.0	1
All Species	43	17	15	32.9	12
Hybrids I x III					
Balan 'Chelsea'	3	0	0	0.0	0
Fair Green	3	0	0	0.0	0
Fairy Wand	2	0	0	0.0	0
Lady Bug	1	0	0	0.0	0
Oriental Legend 'Fantan'	3	0	0	0.0	0
Peter Pan 'Greensleeves' 'UH-2'	6	0	0	0.0	0
Red Star	2	2	1	2.0	1
Sweetheart	1	0	0	0.0	0
Sylvia Miller	5	0	0	0.0	0
Mary Pinchess x Shina Black	1	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	3	0	0	0.0	0
	30	2	1	2.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium aloifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
Ann Green 'Brocade'	1	0	0	0.0	0
Balkis 'Silver Orb'	3	0	0	0.0	0
Baltic Night	1	0	0	0.0	0
Early Bird 'Pacific'	3	0	0	0.0	0
Earlyana 'Egret'	1	0	0	0.0	0
President Wilson	1	0	0	0.0	0
Sensation 'Carlington'	1	0	0	0.0	0
Stanley Fouraker	1	0	0	0.0	0
Valley Gem 'Lodestar'	1	0	0	0.0	0
	13	0			
Other Hybrids					
Penguin	1	0	0	0.0	0
Vogelsang	3	0	0	0.0	0
hoosai x *lancifolium*	2	0	0	0.0	0
madidum x Glasgow	1	0	0	0.0	0
	7	0			
All Hybrids	50	2	1	2.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium aloifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	6	2	2	29.5	2
Ansellia gigantea	3	2	2	11.0	1
Bletia sp.	1	0	0	0.0	0
Calanthe sp.	1	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Cyrtopodium lyonii	2	0	0	0.0	0
Eulophia caffra	1	0	0	0.0	0
Eulophia kirkii	2	1	1	1.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Lord Rothschild)	2	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Veitchii)	1	0	0	0.0	0
Phaius tankervillae	18	2	0	0.0	0
Spathoglottis plicata	5	0	0	0.0	0
Spathoglottis Pacifica	2	0	0	0.0	0
Spathoglottis hyb. 'A'	4	0	0	0.0	0
	50	7	5	16.4	3
All Crosses Attempted	143	26	21	27.5	16

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium aspidistrifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
aspidistrifolium	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	1	0	0	0.0	0
sinense album 'Jucundissimum'	1	0	0	0.0	0
	3	0	0	0.0	0
All Species	3	0	0	0.0	0
All Crosses Attempted	3	0	0	0.0	0
Cymbidium canaliculatum var *sparkesii*					
Species I					
gracillimum	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	1	0	0	0.0	0
pumilum var *album*	1	1	1	34.0	1
sinense var *album* 'Jucundissimum'	1	0			
	4	1	1	34.0	1
Species II					
aloifolium	1	0	0	0.0	0
canaliculatum var *sparkesii*	2	2	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium canaliculatum var *sparkesii* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
chloranthum	1	0	0	0.0	0
madidum	1	0	0	0.0	0
	5	2	0	0.0	0
Species III					
eburneum	1	0	0	0.0	0
	1	0			
All Species	10	3	1	34.0	1
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	2	0	0	0.0	0
	2	0	0	0.0	0
Other Hybrids					
hoosai x *lancifolium*	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	3	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium canaliculatum var *sparkesii* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	2	0	0	0.0	0
Eulophia speciosa	1	0	0	0.0	0
Phaius tankervillae	2	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	6	0	0	0.0	0
All Crosses Attempted	19	3	1	34.0	1
Cymbidium chloranthum					
Species I					
aspidistrifolium	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	1	0	0	0.0	0
sinense var *album* 'Jucundissimum'	1	0	0	0.0	0
	3	0	0	0.0	0
Species II					
chloranthum	2	0	0	0.0	0
	2	0	0	0.0	0
All Species	5	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium dayanum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
dayanum	3	2	1	100.0	0
ensifolium var *album*	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	2	0	0	0.0	0
koran var *album*	1	0	0	0.0	0
lancifolium	1	0	0	0.0	0
	8	2	1	100.0	0
Species II					
madidum	2	1	0	0.0	0
pendulum	1	1	0	0.0	0
	3	2	0	0.0	0
All Species	11	4	1	100.0	0
Hybrids I x III					
Fair Green	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	2	0	0	0.0	0
Red Star	1	0	0	0.0	0
Sylvia Miller	1	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	1	0	0	0.0	0
	6	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium dayanum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
Negrito 'Cherry Ripe'	1	0	0	0.0	0
Sea Foam 'Green Fire'	1	0	0	0.0	0
erythrostylum x Sicily	2	0	0	0.0	0
	4	0	0	0.0	0
Other Hybrids					
Vogelsang	2	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	12	0	0	0.0	0
Related Genera					
Ansellia africana	1	1	0	0.0	0
Ansellia gigantea	1	1	0	0.0	0
Cyrtopodium lyonii	1	0	0	0.0	0
Cyrtopodium punctatum	1	0	0	0.0	0
Eulophia caffra	1	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0
Phaiocymbidium Chardwarense	2	0	0	0.0	0
Phaius tankervillae	3	0	0	0.0	0
Phaius Ashworthiensus	1	0	0	0.0	0
Spathoglottis aurea	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium dayanum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Spathoglottis Pacifica ♂	2	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	16	2	0	0.0	0
All Crosses Attempted	39	6	1	16.7	0
Cymbidium eburneum					
Species III					
eburneum	1	1	1	91.0	1
All Species	1	1	1	91.0	1
Cymbidium ensifolium					
Species I					
koran var album	1	1	0	0.0	0
All Species	1	1	0	0.0	0
Hybrids III x III					
erythrostylum x Sicily	1	1	0	0.0	0
	1	1	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium ensifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrids ♂					
Penguin	1	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	3	0	0	0.0	0
Related Genera					
Ansellia gigantea	1	1	0	0.0	0
Eulophia caffra	1	1	0	0.0	0
Phaiocymbidium Chardwarense	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
	4	2	0	0.0	0
All Crosses Attempted	8	4	0	0.0	0
Cymbidium formosanum					
Species I					
formosanum	1	0	0	0.0	0
sinense var *album* 'Jucundissimum'	1	0	0	0.0	0
	2	0	0	0.0	0
All Species	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium gracillimum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
gracillimum	1	1	1	23.0	1
sinense var *album* 'Jucundissimum'	1	1	1	74.0	1
	2	2	2	48.5	2
All Species	2	2	2	48.5	2
Cymbidium hoosai					
Species I					
formosanum	2	0	0	0.0	0
pumilum var *album*	2	0	0	0.0	0
	4	0	0	0.0	0
Species II					
aloifolium	3	0	0	0.0	0
canaliculatum var *sparkesii*	2	0	0	0.0	0
madidum	2	0	0	0.0	0
	7	0	0	0.0	0
All Species	11	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium hoosai ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids I x III ♂					
Fairy Wand	2	0	0	0.0	0
Mimi 'Sandalwood'	2	0	0	0.0	0
Oriental Legend 'Fantan'	2	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	4	0	0	0.0	0
Starbright	6	0	0	0.0	0
Sylvia Miller	3	0	0	0.0	0
	19	0	0	0.0	0
Hybrids III x III					
Bethlehem 'Caspar'	2	0	0	0.0	0
Bethlehem 'Magi'	2	0	0	0.0	0
Early Bird 'Pacific'	5	0	0	0.0	0
Earlyana 'Egret'	3	0	0	0.0	0
Rincon White	2	0	0	0.0	0
San Miguel 'Christmas Song'	2	0	0	0.0	0
Stanley Fouraker	4	0	0	0.0	0
	20	0	0	0.0	0
Other Hybrids					
Penguin	2	0	0	0.0	0
Tiger Hunt	2	0	0	0.0	0
Vogelsang	3	0	0	0.0	0
hoosai x *lancifolium*	2	0	0	0.0	0
	9	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium hoosai ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Hybrids ♂	48	0	0	0.0	0
Related Genera					
Ansellia africana	10	0	0	0.0	0
Calanthe sp.	3	0	0	0.0	0
Catasetum fimbriatum	2	0	0	0.0	0
Catasetum Sumanii	2	0	0	0.0	0
Eulophia kirkii	3	0	0	0.0	0
Grammatophyllum scriptum	2	0	0	0.0	0
Grammatophyllum scriptum 'The Governor'	3	0	0	0.0	0
Grammatophyllum speciosum	3	0	0	0.0	0
Phaius tankervillae	11	0	0	0.0	0
Phaiocalanthe (*P. Gravesiae* x *C. Veitchii*)	2	0	0	0.0	0
Phaiocymbidium Chardwarense	6	0	0	0.0	0
Spathoglottis plicata	10	0	0	0.0	0
	57	0	0	0.0	0
All Crosses Attempted	116	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium hoosai var *kinkwalan* sub var *fayden* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
aspidistrifolium	1	1	1	69.0	1
formosanum	1	1	1	17.0	1
gracillimum	1	1	1	29.0	1
hoosai	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	3	1	1	6.0	1
sinense var *album* 'Jucundissimum'	1	1	1	70.0	1
	8	5	5	38.2	5
Species II					
aloifolium	1	1	1	16.0	1
chloranthum	1	1	1	71.0	1
madidum	1	1	1	37.0	1
	3	3	3	41.3	3
Species III					
eburneum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	12	8	8	39.4	8
Hybrid I x III					
Mimi 'Sandalwood'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	1	1	49.0	1
	2	1	1	49.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium hoosai var *kinkwalan* sub var *fayden* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrid ♂					
Vogelsang	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	3	1	1	49.0	1
Related Genera					
Ansellia africana	1	1	1	45.0	1
Calanthe sp.	1	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Phaius tankervillae	2	1	0	0.0	0
	7	2	1	45.0	1
All Crosses Attempted	22	11	10	40.9	10
Cymbidium kanran 'Taiwan Purple'					
Species I					
aspidistrifolium	1	0	0	0.0	0
hoosai	1	0	0	0.0	0
soshin 'Tetukotsu'	1	0	0	0.0	0
	3	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium kanran 'Taiwan Purple' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
aloifolium	1	0	0	0.0	0
canaliculatum var *sparkesii*	1	0	0	0.0	0
madidum	1	0	0	0.0	0
	3	0	0	0.0	0
Species III					
parishii var *sanderae*	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	7	0	0	0.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	1	0	0	0.0	0
Related Genera					
Grammatophyllum scriptum	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	3	0	0	0.0	0
All Crosses Attempted	11	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium koran var *album* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
madidum	1	1	1	90.0	0
	1	1	1	90.0	0
All Species	1	1	1	90.0	0
Hybrid I x III					
Red Star	1	1	0	0.0	0
	1	1	0	0.0	0
All Hybrids	1	1	0	0.0	0
Related Genera					
Ansellia gigantea	1	1	1	4.0	1
	1	1	1	4.0	1
All Crosses Attempted	3	3	2	47.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium lancifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
hoosai var kinkwalan sub var fayden	1	1	1	2.0	0
koran var album	1	0	0	0.0	0
lancifolium	3	1	0	0.0	0
	5	2	1	2.0	0
Species II					
aloifolium	2	0	0	0.0	0
madidum	2	0	0	0.0	0
munronianum	1	0	0	0.0	0
pendulum	1	1	0	0.0	0
	6	1	0	0.0	0
All Species	11	3	1	2.0	0
Hybrids I x III					
Lady Bug	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	2	2	0	0.0	0
Red Star	1	0	0	0.0	0
	4	2	0	0.0	0
Hybrids III x III					
Ann Green 'Brocade'	1	0	0	0.0	0
New Moon #2	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium lancifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Vienx Rose 'Del Park' ♂	1	0	0	0.0	0
erythrostylum x Sicily	1	0	0	0.0	0
Sicily x San Miguel	1	0	0	0.0	0
	5	0	0	0.0	0
Other Hybrid					
Vogelsang	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	10	2	0	0.0	0
Related Genera					
Ansellia africana	3	0	0	0.0	0
Ansellia gigantea	3	0	0	0.0	0
Calanthe '2003'	1	0	0	0.0	0
Cyrtopodium lyonii	1	0	0	0.0	0
Cyrtopodium punctatum	1	0	0	0.0	0
Eulophia caffra	1	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Phaius tankervillae	3	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
Spathoglottis Pacifica	1	0	0	0.0	0
	18	0	0	0.0	0
All Crosses Attempted	39	5	1	2.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium madidum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
aspidistrifolium	1	0	0	0.0	0
gracillimum	1	1	1	69.0	1
hoosai	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	1	1	1	8.0	1
lancifolium	1	1	1	73.0	1
pumilum var *album*	1	1	1	60.0	1
sinense var *album* 'Jucundissimum'	2	0	0	0.0	0
	8	4	4	52.5	4
Species II					
aloifolium	2	1	1	98.0	1
canaliculatum var *sparkesii*	1	1	1	65.0	1
chloranthum	1	0	0	0.0	0
madidum	2	2	2	16.0	1
	6	4	4	48.8	3
Species III					
eburneum	2	0	0	0.0	0
parishii var *sanderae*	2	0	0	0.0	0
	4	0	0	0.0	0
All Species	18	8	8	50.7	7

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium madidum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrid I x III ♂					
Fair Green	1	0	0	0.0	0
Fairy Wand	2	0	0	0.0	0
Koolau	1	0	0	0.0	0
Lady Bug	2	0	0	0.0	0
Mimi 'Sandalwood'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-1)	2	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	5	0	0	0.0	0
Sweetheart	2	0	0	0.0	0
formosanum x Greenwood	2	0	0	0.0	0
madidum x *Ansellia africana*	1	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	3	0	0	0.0	0
	22	0	0	0.0	0
Hybrid III x III					
Bethlehem 'Sea Foam'	1	0	0	0.0	0
Carol Cox 'Snow'	1	0	0	0.0	0
Early Bird 'Pacific'	1	0	0	0.0	0
Earlyana 'Egret'	1	0	0	0.0	0
Fred Stewart 'Silver Light'	2	0	0	0.0	0
Matana 'Maxine'	1	0	0	0.0	0
San Miguel 'Christmas Song'	1	0	0	0.0	0
Stanley Fouraker	1	0	0	0.0	0
	9	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium madidum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrids ♂					
Penguin	5	0	0	0.0	0
Vogelsang	3	0	0	0.0	0
hoosai x *lancifolium*	2	0	0	0.0	0
	10	0	0	0.0	0
All Hybrids	41	0	0	0.0	0
Related Genera					
Ansellia africana	1	1	1	28.0	1
Bletia sp.	1	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	1	1	0	0.0	0
Calanthe sp.	2	0	0	0.0	0
Catasetum fimbriatum	3	0	0	0.0	0
Catasetum integrinum	1	0	0	0.0	0
Catasetum Sumanii	4	0	0	0.0	0
Eulophia kirkii	4	3	3	34.0	1
Grammatophyllum scriptum	1	0	0	0.0	0
Grammatophyllum scriptum 'The Governor'	1	0	0	0.0	0
Grammatophyllum speciosum	2	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Veitchii)	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Sanderae)	1	0	0	0.0	0
Phaiocymbidium Chardwarense	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium madidum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Phaius tankervillae ♂	10	0	0	0.0	0
Spathoglottis plicata	9	0	0	0.0	0
	43	5	4	32.5	2
All Crosses Attempted	102	13	12	44.6	9
Cymbidium munronianum 'Singapore'					
Species I					
munronianum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	1	0	0	0.0	0
Hybrids I x III					
Lady Bug	1	0	0	0.0	0
Pali	1	0	0	0.0	0
Sweetheart	1	0	0	0.0	0
	3	0	0	0.0	0
Hybrids III x III					
Ann Green 'Brocade'	1	0	0	0.0	0
President Wilson	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium munroianum 'Singapore' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Swallow 'Soulgeana' ♂	1	0	0	0.0	0
Vieux Rose 'Del Park'	1	0	0	0.0	0
	4	0	0	0.0	0
Other Hybrids					
Penguin	1	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	9	0	0	0.0	0
Related Genera					
Eulophia kirkii	1	0	0	0.0	0
	1	0	0	0.0	0
All Crosses Attempted	11	0	0	0.0	0
Cymbidium parishii var *sanderae*					
Species I					
hoosai var *kinkwalan* sub var *fayden*	1	0	0	0.0	0
soshin 'Tetukotsu'	1	0	0	0.0	0
	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium parishii var *sanderae* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
aloifolium	1	0	0	0.0	0
madidum	1	0	0	0.0	0
	2	0			
Species III					
parishii var *sanderae*	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	5	0	0	0.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	2	2	2	93.0	2
formosanum x Greenwood	1	0	0	0.0	0
	3	2	2	93.0	2
Hybrids III x III					
Bethlehem 'Magi'	1	0	0	0.0	0
Fred Stewart 'Silver Light'	1	0	0	0.0	0
Joan of Arc 'Snowfall'	1	0	0	0.0	0
New Moon '2'	1	0	0	0.0	0
Swallow 'Soulgeang'	1	0	0	0.0	0
erythrostylum x Sicily	1	0	0	0.0	0
	6	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium parishii var *sanderae* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrids ♂					
Penguin	1	0	0	0.0	0
hoosai x *lancifolium*	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	11	2	2	93.0	2
Related Genera					
Ansellia africana	1	1	0	0.0	1
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Phaiocalanthe (*P. Gravesiae* x *C. Veitchii*)	2	0	0	0.0	0
Phaiocymbidium Chardwarense	1	0	0	0.0	0
Spathoglottis sp.	1	0	0	0.0	0
	8	1	0	0.0	1
All Crosses Attempted	24	3	2	93.0	3

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium pendulum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
aspidistrifolium	2	0	0	0.0	0
formosanum	1	0	0	0.0	0
gracillimum	1	0	0	0.0	0
hoosai	2	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	2	0	0	0.0	0
lancifolium	2	0	0	0.0	0
soshin 'Tetukotsu'	2	0	0	0.0	0
	12	0	0	0.0	0
Species II					
aloifolium	2	0	0	0.0	0
canaliculatum var *sparkesii*	1	0	0	0.0	0
chloranthum	1	0	0	0.0	0
pendulum	7	2	2	59.0	1
madidum	3	0	0	0.0	0
	14	2	2	59.0	1
Species III					
eburneum	1	0	0	0.0	0
parishii var *sanderae*	2	0	0	0.0	0
	3	0	0	0.0	0
All Species	29	2	2	59.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium pendulum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids I x III ♂					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
Red Star	2	0	0	0.0	0
Sylvia Miller	1	0	0	0.0	0
	4	0	0	0.0	0
Hybrids III x III					
Balkis 'Silver Orb'	1	0	0	0.0	0
Barcelona 'Magic Wand'	1	0	0	0.0	0
Bethlehem 'Caspar'	1	0	0	0.0	0
Bethlehem 'Magi'	1	0	0	0.0	0
Bethlehem 'Sea Foam'	1	0	0	0.0	0
Bethlehem 'White'	1	0	0	0.0	0
Carol Cox 'Snow'	1	0	0	0.0	0
Early Bird 'Pacific'	1	0	0	0.0	0
Earlyana 'Egret'	1	0	0	0.0	0
Fred Stewart 'Silver Light'	1	0	0	0.0	0
Matana 'Maxine'	1	0	0	0.0	0
Rincon 'White'	1	0	0	0.0	0
San Miguel 'Christmas Song'	1	0	0	0.0	0
Stanley Fouraker	1	0	0	0.0	0
	14	0	0	0.0	0
Other Hybrid					
Vogelsang	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium pendulum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Hybrids ♂	19	0	0	0.0	0
Related Genera					
Ansellia gigantea	3	0	0	0.0	0
Catasetum viridi flavum	3	0	0	0.0	0
Cyrtopodium lyonii	3	0	0	0.0	0
Cyrtopodium punctatum	3	0	0	0.0	0
Eulophia kirkii	3	0	0	0.0	0
Phaius tankervillae	3	0	0	0.0	0
Spathoglottis aurea	2	0	0	0.0	0
Spathoglottis plicata	3	0	0	0.0	0
	23	0	0	0.0	0
All Crosses Attempted	71	2	2	59.0	1
Cymbidium pumilum var *album*					
Species I					
sinense var *album* 'Jucundissimum'	2	0	0	0.0	0
pumilum var *album*	1	1	1	84.0	1
	3	1	1	84.0	1
Species III					
eburneum	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium pumilum var *album* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Species ♂	4	1	1	84.0	1
Related Genera					
Ansellia africana	1	0	0	0.0	0
	1	0	0	0.0	0
All Crosses Attempted	5	1	1	84.0	1
Cymbidium sinense var *album* 'Jucundissimum'					
Species I					
aspidistrifolium	1	0	0	0.0	0
formosanum	1	1	1	38.0	1
gracillimum	1	1	1	55.0	1
hoosai	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	1	1	1	75.0	1
sinense var *album* 'Jucundissimum'	1	1	1	5.0	1
	6	4	4	43.3	4
Species II					
canaliculatum var *sparkesii*	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	7	4	4	43.3	4

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium sinense var *album* 'Jucundissimum' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
Balkis 'Silver Orb'	1	0	0	0.0	0
Bethlehem 'Magi'	1	0	0	0.0	0
Early Bird 'Pacific'	1	0	0	0.0	0
	3	0	0	0.0	0
Other Hybrid					
Mitzi	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	4	0	0	0.0	0
Related Genera					
Ansellia africana	1	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Phaiocymbidium Chardwarense	3	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	3	0	0	0.0	0
	10	0	0	0.0	0
All Crosses Attempted	21	4	4	43.3	4

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium soshin var *album* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
lancifolium	1	0	0	0.0	0
	1	0	0	0.0	0
Hybrid III x III					
Swallow 'Soulangeana'	1	0	0	0.0	0
erythrostylum x Sicily	1	1	1	5.0	0
	2	1	1	5.0	0
Related Genera					
Phaiocymbidium Chardwarense	1	0	0	0.0	0
	1	0	0	0.0	0
All Crosses Attempted	4	1	1	5.0	0
Cymbidium soshin 'Tetukotsu'					
Species I					
dayanum	1	1	0	0.0	0
koran var *album*	1	1	1	37.0	0
lancifolium	1	0	0	0.0	0
soshin var *album*	1	0	0	0.0	0
soshin 'Tetukotsu'	5	5	5	33.2	3
	9	7	6	33.8	3

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium soshin 'Tetukotsu' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
madidum	3	1	1	96.0	0
	3	1	1	96.0	0
All Species	12	8	7	42.7	3
Hybrids I x III					
Balan 'Chelsea'	1	0	0	0.0	0
Fair Green	1	0	0	0.0	0
Mimi 'Sandalwood'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-1)	2	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	2	1	0	0.0	0
Red Star	1	1	0	0.0	0
Sylvia Miller	1	0	0	0.0	0
	9	2	0	0.0	0
Hybrids III x III					
Early Bird 'Pacific'	1	0	0	0.0	0
Hi Rated 'Moonstone'	1	0	0	0.0	0
erythrostylum x Sicily	1	1	1	7.0	0
	3	1	1	7.0	0
Other Hybrids					
Little Black Sambo	1	1	1	12.0	1
madidum x Glasgow	1	0	0	0.0	0
	2	1	1	12.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium soshin 'Tetukotsu' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Hybrids ♂	14	4	2	9.5	1
Related Genera					
Ansellia gigantea	1	1	1	5.0	1
Calanthe vistata var *rubro-oculata*	2	1	0	0.0	0
Catasetum fimbriatum	1	1	0	0.0	0
Cymbidiella rhodochila	1	1	0	0.0	0
Cyrtopodium punctatum	1	1	0	0.0	0
Eulophia caffra	1	1	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Phaiocalanthe (*P. Gravesiae* x *C. Sanderae*)	1	0	0	0.0	0
Phaiocalanthe (*P. Gravesiae* x *C. Veitchii*)	1	0	0	0.0	0
Phaius Ashworthiensus	1	0	0	0.0	0
Spathoglottis aurea	1	0	0	0.0	0
Spathoglottis plicata	2	0	0	0.0	0
	15	6	1	5.0	1
All Crosses Attempted	41	18	10	32.3	5
Cymbidium suavissimum					
Species I					
pumilum var *album*	1	1	1	91.0	1
All Species	1	1	1	91.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Balan 'Chelsea' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
canaliculatum	1	0	0	0.0	0
madidum	1	0	0	0.0	0
	2	0	0	0.0	0
All Species	2	0	0	0.0	0
Hybrids I x III					
Balan 'Chelsea'	1	0	0	0.0	0
	1	0	0	0.0	0
Other Hybrids					
Little Black Sambo	1	0	0	0.0	0
hoosai x *lancifolium*	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	3	0	0	0.0	0
Related Genera					
Ansellia africana	1	1	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
	4	1	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Balan 'Chelsea' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Crosses Attempted ♂	9	1	0	0.0	0
Cymbidium Dag 'Elwood'					
Hybrids I x III					
Red Star	2	0	0	0.0	0
	2	0	0	0.0	0
Hybrids III x III					
Early Bird 'Pacific'	1	0	0	0.0	0
Stanley Fouraker	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	4	0	0	0.0	0
All Crosses Attempted	4	0	0	0.0	0
Cymbidium Edna Cobb					
Species I					
sinense var *album* 'Jucundissimum'	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Edna Cobb ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
chloranthum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	2	0	0	0.0	0
Related Genera					
Ansellia africana	1	1	0	0.0	0
	1	1	0	0.0	0
All Crosses Attempted	3	1	0	0.0	0
Cymbidium Fair Green					
Species I					
ensifolium var *album*	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	4	1	0	0.0	0
lancifolium	1	0	0	0.0	0
soshin 'Tetukotsu'	3	0	0	0.0	0
	9	1	0	0.0	0
Species II					
madidum	2	0	0	0.0	0
	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Fair Green ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species III ♂					
parishii var sanderae	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	12	1	0	0.0	0
Hybrids I x III					
Mimi 'Sandalwood'	2	0	0	0.0	0
Red Star	2	0	0	0.0	0
Sylvia Miller	1	0	0	0.0	0
Pali x (soshin var album x Pali)	2	0	0	0.0	0
	7	0	0	0.0	0
Hybrids III x III					
Ann Green 'Brocade'	1	0	0	0.0	0
Barcelona 'Magic Wand'	1	0	0	0.0	0
Early Bird 'Pacific'	1	1	1	7.0	0
New Moon	1	0	0	0.0	0
Sea Foam 'Green Fire'	1	0	0	0.0	0
Swallow 'Soulangeana'	1	0	0	0.0	0
Valley Gem 'Lodestar'	1	0	0	0.0	0
Vieux Rose 'Del Park'	1	0	0	0.0	0
erythrostylum x Sicily	1	0	0	0.0	0
	9	1	1	7.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Fair Green ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrids ♂					
Penguin	2	0	0	0.0	0
Vogelsang	1	1	1	5.0	1
hoosai x *lancifolium*	1	0	0	0.0	0
madidum x Glasgow	1	0	0	0.0	0
	5	1	1	5.0	1
All Hybrids	21	2	2	6.0	1
Related Genera					
Ansellia africana	1	1	1	6.0	1
Catasetum Sumanii	1	0	0	0.0	0
Eulophia caffra	1	0	0	0.0	0
Eulophia kirkii	1	1	0	0.0	0
Grammatophyllum scriptum 'The Governor'	1	1	1	5.0	0
Grammatophyllum speciosum	2	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Rothschild)	3	0	0	0.0	0
Phaiocymbidium Chardwarense	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	4	0	0	0.0	0
	16	3	2	5.5	1
All Crosses Attempted	49	6	4	5.8	2

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Fairy Wand ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
hoosai var *kinkwalan* sub var *fayden*	3	0	0	0.0	0
soshin 'Tetukotsu'	1	1	1	3.0	1
	4	1	1	3.0	1
Species II					
madidum	1	1	1	5.0	1
	1	1	1	5.0	1
Species III					
parishii var *sanderae*	1	1	1	2.0	1
	1	1	1	2.0	1
All Species	6	3	3	3.3	3
Hybrids I x III					
Fairy Wand	3	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	2	2	2	12.5	2
	5	2	2	12.5	2
Other Hybrid					
Vogelsang	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	6	2	2	12.5	2

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Fairy Wand ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	1	1	1	1.0	1
Grammatophyllum scriptum 'The Governor'	1	0	0	0.0	0
Phaiocalanthe (P. Gravesiae x C. Sanderae)	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	4	1	1	1.0	1
All Crosses Attempted	16	6	6	6.0	6
Cymbidium Green Wings					
Other Hybrids					
Penguin	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	1	0	0	0.0	0
Cymbidium Ian Stewart					
Other Hybrids					
Penguin	1	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Lady Bug ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrids ♂					
Penguin	1	0	0	0.0	0
Vogelsang	2	0	0	0.0	0
hoosai x lancifolium	1	0	0	0.0	0
	4	0	0	0.0	0
All Hybrids	4	0	0	0.0	0
Cymbidium Little Black Sambo					
Species I					
aspidistrifolium	1	0	0	0.0	0
	1	0	0	0.0	0
Species III					
eburneum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	2	0	0	0.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Little Black Sambo ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrid ♂					
Little Black Sambo	1	1	1	70.0	1
	1	1	1	70.0	1
All Hybrids	2	1	1	70.0	1
Related Genera					
Ansellia africana	3	3	3	9.0	3
Grammatophyllum scriptum	2	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	7	3	3	9.0	3
All Crosses Attempted	11	4	4	24.3	4
Cymbidium Mimi 'Sandalwood'					
Species I					
hoosai var *kinkwalan* sub var *fayden*	2	0	0	0.0	0
soshin 'Tetukotsu'	1	0	0	0.0	0
	3	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Mimi 'Sandalwood' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
aloifolium	2	0	0	0.0	0
canaliculatum var *sparkesii*	1	0	0	0.0	0
madidum	3	1	0	0.0	0
	6	1	0	0.0	0
Species III					
parishii var *sanderae*	2	1	1	55.0	1
	2	1	1	55.0	1
All Species	11	2	1	55.0	1
Hybrids I x III					
Fairy Wand	1	0	0	0.0	0
Mimi 'Sandalwood'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	1	1	5.0	0
	3	1	1	5.0	0
Other Hybrids					
Little Black Sambo	1	0	0	0.0	0
Tiger Hunt	1	0	0	0.0	0
Vogelsang	1	1	1	2.0	1
hoosai x *lancifolium*	1	0	0	0.0	0
	4	1	1	2.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Mimi 'Sandalwood' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Hybrids ♂	7	2	2	3.5	1
Related Genera					
Ansellia africana	1	1	0	0.0	0
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Grammatophyllum scriptum 'The Governor'	1	0	0	0.0	0
Grammatophyllum speciosum	2	0	0	0.0	0
Spathoglottis plicata	2	0	0	0.0	0
	8	1	0	0.0	0
All Crosses Attempted	26	5	3	20.7	2
Cymbidium Pali					
Hybrids I x III					
Pali	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	2	0	0	0.0	0
Hybrid III x III					
New Moon '1'	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Pali ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrid ♂					
Vogelsang	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	4	0	0	0.0	0
All Crosses Attempted	4	0	0	0.0	0
Cymbidium Pat Ann 'Apollo'					
Species III					
parishii var sanderae	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	1	0	0	0.0	0
Hybrids I x III					
Lady Bug	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
Sweetheart	1	0	0	0.0	0
	3	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Pat Ann 'Apollo' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
Ann Green 'Brocade'	1	0	0	0.0	0
Bethlehem 'Magi'	1	0	0	0.0	0
Fred Stewart 'Silver Light'	1	0	0	0.0	0
Swallow 'Soulangeana'	1	0	0	0.0	0
Vieux Rose 'Del Park'	1	0	0	0.0	0
erythrostylum x Sicily	1	0	0	0.0	0
formosanum x Greenwood	2	0	0	0.0	0
	8	0	0	0.0	0
Other Hybrids					
Pat Ann 'Apollo'	1	0	0	0.0	0
Penguin	1	0	0	0.0	0
Vogelsang	2	0	0	0.0	0
	4	0	0	0.0	0
All Hybrids	15	0	0	0.0	0
Related Genera					
Ansellia africana	1	1	0	0.0	0
Ansellia gigantea	1	0	0	0.0	0
Calanthe sp.	1	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Pat Ann 'Apollo' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Grammatophyllum scriptum ♂	1	0	0	0.0	0
Phaiocymbidium Chardwarense	1	0	0	0.0	0
Phaius tankervillae	3	0	0	0.0	0
	10	1	0	0.0	0
All Crosses Attempted	26	1	0	0.0	0
Cymbidium Penguin					
Species I					
hoosai var *kinkwalan* sub var *fayden*	1	1	1	9.0	1
lancifolium	1	1	1	17.0	1
	2	2	2	13.0	2
Species II					
aloifolium	1	1	1	10.0	1
madidum	1	1	1	43.0	1
	2	2	2	26.5	2
All Species	4	4	4	19.8	4
Hybrids I x III					
Fair Green	3	0	0	0.0	0
Mimi 'Sandalwood'	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Penguin ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Oriental Legend 'Fantan' ♂	1	0	0	0.0	0
Pali	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-1)	3	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	1	1	57.0	1
Red Star	3	0	0	0.0	0
Sylvia Miller	3	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	4	0	0	0.0	0
	20	1	1	57.0	1
Hybrid III x III					
Balkis 'Silver Orb'	3	0	0	0.0	0
Bethlehem 'Caspar'	2	0	0	0.0	0
Early Bird 'Pacific'	1	0	0	0.0	0
Earlyana 'Egret'	2	0	0	0.0	0
Fred Stewart 'Silver Light'	2	0	0	0.0	0
Joan of Arc 'Snowfall'	4	0	0	0.0	0
Negrito 'Cherry Ripe'	1	0	0	0.0	0
New Moon #1	2	0	0	0.0	0
Sensation 'Carlingford'	1	0	0	0.0	0
Stanley Fouraker	1	0	0	0.0	0
Swallow 'Soulangeana'	2	0	0	0.0	0
Sweetheart	1	0	0	0.0	0
Valley Gem 'Lodestar'	2	0	0	0.0	0
Vieux Rose 'Del Park'	1	0	0	0.0	0
erythrostylum x Sicily	2	0	0	0.0	0
formosanum x Greenwood	1	0	0	0.0	0
Sicily x San Miguel	1	0	0	0.0	0
	29	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrids used as a female

Cymbidium Penguin ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrids ♂					
Penguin	4	0	0	0.0	0
Vogelsang	4	0	0	0.0	0
hoosai x lancifolium	4	0	0	0.0	0
madidum x Glasgow	1	0	0	0.0	0
	13	0	0	0.0	0
All Hybrids	62	1	1	57.0	1
Related Genera					
Ansellia africana	2	2	2	4.0	2
Ansellia gigantea	1	1	1	2.0	1
Calanthe sp.	2	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum intergrinum	1	0	0	0.0	0
Catasetum 'Sumanii'	3	0	0	0.0	0
Eulophia kirkii	6	3	3	10.0	3
Grammatophyllum scriptum	1	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Phaiocalanthe (P. Gravesiae x C. Veitchii)	1	0	0	0.0	0
Phaius tankervillae	4	1	0	0.0	0
Phaius wallichi	1	0	0	0.0	0
Spathoglottis plicata	5	0	0	0.0	0
	29	7	6	6.7	6
All Crosses Attempted	95	12	11	16.0	11

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Peter Pan 'Greensleeves' (UH-2) ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
hoosai	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	1	0	0	0.0	0
	2	0	0	0.0	0
Species II					
aloifolium	1	1	1	100.0	1
madidum	1	1	1	32.0	1
	2	2	2	66.0	2
Species III					
parishii var *sanderae*	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	5	2	2	66.0	2
Hybrids I x III					
Fair Green	1	0	0	0.0	0
Mimi 'Sandalwood'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	1	1	61.0	1
Red Star	1	0	0	0.0	0
Sylvia Miller	1	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	1	0	0	0.0	0
	6	1	1	61.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Peter Pan 'Greensleeves' (UH-2) ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
Fred Stewart 'Silver Light'	1	0	0	0.0	0
erythrostylum x Sicily	1	1	1	81.0	1
Sicily x San Miguel	1	1	1	22.0	1
	3	2	2	51.5	2
Other Hybrids					
Faridah Hishim	1	0	0	0.0	0
Little Black Sambo	1	0	0	0.0	0
Penguin	2	0	0	0.0	0
Tiger Hunt	1	0	0	0.0	0
Vogelsang	1	1	1	29.0	1
hoosai x *lancifolium*	1	0	0	0.0	0
	7	1	1	29.0	1
All Hybrids	16	4	4	48.3	4
Related Genera					
Ansellia africana	1	1	1	4.0	1
Ansellia gigantea	1	1	1	33.0	1
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Peter Pan 'Greensleeves' (UH-2) ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Grammatophyllum scriptum ♂	2	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Lord Rothschild)	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Veitchii)	1	0	0	0.0	0
Phaius tankervillae	3	1	0	0.0	0
Spathoglottis plicata	2	0	0	0.0	0
	16	3	2	18.5	2
All Crosses Attempted	37	9	8	45.3	8
Cymbidium Peter Pan 'Greensleeves' (UH-1)					
Species I					
dayanum	1	1	1	1.0	0
	1	1	1	1.0	0
All Species	1	1	1	1.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-1)	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	1	1	11.0	1
Red Star	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Peter Pan 'Greensleeves' (UH-1) ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Sylvia Miller ♂	1	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	1	0	0	0.0	0
	6	1	1	11.0	1
Other Hybrids					
Penguin	1	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
hoosai x *lancifolium*	1	0	0	0.0	0
	3	0	0	0.0	0
All Hybrids	9	1	1	11.0	1
Related Genera					
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Cymbidiella rhodochila	1	0	0	0.0	0
Cyrtopodium punctatum	1	0	0	0.0	0
Eulophia caffra	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
Spathoglottis Pacifica	1	0	0	0.0	0
	7	0	0	0.0	0
All Crosses Attempted	17	2	2	6.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium President Wilson ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrids ♂					
Penguin	1	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	2	0	0	0.0	0
Cymbidium Red Star					
Hybrid I x III					
Dag 'Elwood'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	3	2	2	4.0	2
Red Star	1	1	1	15.0	1
	5	3	3	7.7	3
All Hybrids	5	3	3	7.7	3
Related Genera					
Ansellia africana	1	1	1	1.0	1
Ansellia gigantea	1	0	0	0.0	0
Cymbidiella rhodochila	1	0	0	0.0	0
Cyrtopodium punctatum	2	2	0	0.0	0
Eulophia kirkii	2	1	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Red Star ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Grammatophyllum scriptum 'The Governor' ♂	1	1	1	8.0	1
Grammatophyllum speciosum	1	0	0	0.0	0
Phaius tankervillae	3	0	0	0.0	0
	12	5	2	4.5	2
All Crosses Attempted	17	8	5	6.4	5
Cymbidium Starbright					
Species I					
hoosai var *kinkwalan* sub var *fayden*	1	1	1	18.0	1
sinense var *album* 'Jucundissimum'	1	0	0	0.0	0
	2	1	1	18.0	1
Species II					
canaliculatum var *sparkesii*	1	1	1	10.0	1
chloranthum	1	0	0	0.0	0
	2	1	1	10.0	1
All Species	4	2	2	14.0	2
Hybrids III x III					
Bethlehem 'Sea Foam'	1	0	0	0.0	0
Early Bird 'Pacific'	1	0	0	0.0	0
	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Starbright ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	1	1	1	20.0	1
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	3	1	1	20.0	1
All Crosses Attempted	9	3	3	16.0	3
Cymbidium Sweetheart					
Other Hybrids					
Penguin	1	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	2	0	0	0.0	0
Cymbidium Sylvia Miller					
Species I					
hoosai var *kinkwalan* sub var *fayden*	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Sylvia Miller ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
aloifolium	1	0	0	0.0	0
madidum	1	1	0	0.0	1
	2	1	0	0.0	1
Species III					
parishii var *sanderae*	2	0	0	0.0	0
	2	0	0	0.0	0
All Species	5	1	0	0.0	1
Hybrids I x III					
Sylvia Miller	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	3	2	1	10.0	1
	4	2	1	10.0	1
Other Hybrids					
Tiger Hunt	1	0	0	0.0	0
hoosai x *lancifolium*	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	6	2	1	10.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Sylvia Miller ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	1	1	0	0.0	0
Calanthe vistata var *rubro-oculata*	2	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Veitchii)	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
	7	1	0	0.0	0
All Crosses Attempted	18	4	1	10.0	2
Cymbidium Vogelsang					
Species I					
hoosai var *kinkwalan* sub var *fayden*	4	0	0	0.0	0
soshin 'Tetukotsu'	2	0	0	0.0	0
	6	0	0	0.0	0
Species II					
aloifolium	4	0	0	0.0	0
canaliculatum var *sparkesii*	1	0	0	0.0	0
madidum	4	1	1	19.0	1
	9	1	1	19.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Vogelsang ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species III ♂					
parishii var *sanderae*	4	0	0	0.0	0
	4	0	0	0.0	0
All Species	19	1	1	19.0	1
Hybrids I x III					
Balan 'Chelsea'	1	0	0	0.0	0
Bletia sp.	1	0	0	0.0	0
Fair Green	1	0	0	0.0	0
Fairy Wand	1	0	0	0.0	0
Lady Bug	1	0	0	0.0	0
Mimi 'Sandalwood'	2	0	0	0.0	0
Oriental Legend 'Fantan'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	1	1	10.0	1
Sweetheart	1	0	0	0.0	0
Sylvia Miller	1	0	0	0.0	0
formasum x Greenwood	2	0	0	0.0	0
	13	1	1	10.0	1
Hybrid III x III					
Bethlehem 'Magi'	1	0	0	0.0	0
Early Bird 'Pacific'	1	0	0	0.0	0
Fred Stewart 'Silver Light'	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Vogelsang ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Valley Gem 'Lodestar' ♂	1	0	0	0.0	0
Vieux Rose 'Del Park'	1	0	0	0.0	0
Sicily x San Miguel	1	0	0	0.0	0
	6	0	0	0.0	0
Other Hybrids					
Vogelsang	1	0	0	0.0	0
Penguin	3	0	0	0.0	0
Tiger Hunt	1	0	0	0.0	0
hoosai x *lancifolium*	2	0	0	0.0	0
	7	0	0	0.0	0
All Hybrids	26	1	1	10.0	1
Related Genera					
Ansellia africana	1	1	0	0.0	1
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Catasetum fimbriatum	2	0	0	0.0	0
Catasetum integrinum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Grammatophyllum scriptum 'The Governor'	1	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Phaiocalanthe (*P. Gravesiae* x *C. Sanderae*)	1	0	0	0.0	0
Phaiocalanthe (*P. Gravesiae* x *C. Veitchii*)	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Vogelsang ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Phaiocymbidium Chardwarense ♂	1	0	0	0.0	0
Phaius tankervillae	2	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	16	1	0	0.0	1
All Crosses Attempted	61	3	2	14.5	3
Cymbidium ensifolium x C. finlaysonianum					
Species I					
hoosai var kinkwalan sub var fayden	1	0	0	0.0	0
lancifolium	1	0	0	0.0	0
	2	0	0	0.0	0
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	3	0	0	0.0	0
Hybrids I x III					
Fair Green	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium ensifolium x *C. finlaysonianum* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
erythrostylum x Sicily	1	0	0	0.0	0
	1	0	0	0.0	0
Other Hybrids					
Vogelsang	1	0	0	0.0	0
hoosai x *lancifolium*	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	5	0	0	0.0	0
Related Genera					
Ansellia africana	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis Pacifica	1	0	0	0.0	0
	3	0	0	0.0	0
All Crosses Attempted	11	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium formosanum x C. Greenwood ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
Swallow 'Soulangeana'	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	1	0	0	0.0	0
Cymbidium hoosai x C. lancifolium					
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
Species III					
eburneum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	2	0	0	0.0	0
Hybrids I x III					
Balan 'Chelsea'	1	0	0	0.0	0
Fair Green	2	0	0	0.0	0
Lady Bug	1	0	0	0.0	0
Oriental Legend 'Fantan'	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium hoosai x *C. lancifolium* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Pali ♂	2	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	1	1	5.0	1
Red Star	1	1	1	4.0	0
Starbright	1	0	0	0.0	0
Sylvia Miller	2	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	1	0	0	0.0	0
	14	2	2	4.5	1
Hybrids III x III					
Ann Green 'Brocade'	2	0	0	0.0	0
Baltic Night	2	0	0	0.0	0
Barcelona 'Magic Wand'	1	0	0	0.0	0
Joan of Arc 'Snowfall'	2	0	0	0.0	0
Negrito 'Cherry Ripe'	1	0	0	0.0	0
New Moon '1'	2	0	0	0.0	0
New Moon '2'	2	0	0	0.0	0
Sea Foam 'Greenfire'	2	0	0	0.0	0
Sensation 'Carlingford'	2	0	0	0.0	0
Swallow 'Soulangeana'	1	0	0	0.0	0
Valley Gem 'Lodestar'	3	0	0	0.0	0
Vieux Rose 'Del Park'	1	0	0	0.0	0
erythrostylum x Sicily	2	1	1	3.0	0
Sicily x San Miguel	2	0	0	0.0	0
	25	1	1	3.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium hoosai x *C. lancifolium* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Other Hybrids					
Faridah Hishim ♂	1	0	0	0.0	0
Little Black Sambo	1	0	0	0.0	0
Mitzi	1	0	0	0.0	0
Penguin	4	0	0	0.0	0
Tiger Hunt	1	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
hoosai x *lancifolium*	2	2	1	1.0	1
	11	2	1	1.0	1
All Hybrids	50	5	4	3.3	2
Related Genera					
Ansellia africana	1	1	1	4.0	1
Catasetum fimbriatum	1	1	1	2.0	1
Catasetum Sumanii	1	0	0	0.0	0
Cymbidiella rhodochila	2	0	0	0.0	0
Cyrtopodium lyonii	1	0	0	0.0	0
Cyrtopodium punctatum	2	1	0	0.0	0
Eulophia caffra	3	2	1	25.0	0
Eulophia kirkii	1	1	1	2.0	1
Grammatophyllum scriptum	2	2	1	5.0	1
Phaiocalanthe (*P. Gravesiae* x *C. Lord Rothschild*)	5	0	0	0.0	0
Phaiocymbidium Chardwarense	3	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium hoosai x C. lancifolium ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Phaius maculatus ♂	1	0	0	0.0	0
Phaius tankervillae	3	0	0	0.0	0
Phaius Ashworthiensus	1	0	0	0.0	0
Spathoglottis aurea	4	0	0	0.0	0
Spathoglottis plicata	3	1	1	85.0	0
	34	9	6	20.5	4
All Crosses Attempted	86	14	10	13.6	6
Cymbidium Esmeralda x C. elegans					
Species II					
aloifolium	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	1	0	0	0.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
Red Star	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	2	0	0	0.0	0
Related Genera					

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Esmeralda x ♀ *C. elegans*	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Ansellia africana ♂	1	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	4	0	0	0.0	0
All Crosses Attempted	7	0	0	0.0	0
Cymbidium Mary Pinchess x Shina Black					
Species I					
ensifolium	1	0	0	0.0	0
hoosai	1	0	0	0.0	0
lancifolium	1	0	0	0.0	0
	3	0	0	0.0	0
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	4	0	0	0.0	0
Hybrids I x III					
Pali	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Mary Pinchess x ♀ Shina Black	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
erythrostylum x Sicily	1	0	0	0.0	0
	1	0	0	0.0	0
Other Hybrids					
Penguin	1	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
hoosai x *lancifolium*	1	0	0	0.0	0
	3	0	0	0.0	0
Related Genera					
Ansellia africana	1	1	1	2.0	0
	1	1	1	2.0	0
All Crosses Attempted	10	1	1	2.0	0
Cymbidium Sicily x *C. erythrostylum*					
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
Hybrids I x III					
Red Star	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Sicily x *C. erythrostylum* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia gigantea	1	0	0	0.0	0
	1	0	0	0.0	0
All Crosses Attempted	3	0	0	0.0	0
Cymbidium Sicily x San Miguel					
Species I					
lancifolium	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	1	0	0	0.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
Red Star	1	0	0	0.0	0
	2	0	0	0.0	0
Hybrids III x III					
Sicily x *erythrostylum*	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Sicily x ♀ San Miguel	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Hybrids ♂	3	0	0	0.0	0
Related Genera					
Ansellia gigantea	1	0	0	0.0	0
Cyrtopodium punctatum	1	0	0	0.0	0
Eulophia caffra	1	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis 'Pacifica'	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Lord Rothschild	1	0	0	0.0	0
	7	0	0	0.0	0
All Crosses Attempted	11	0	0	0.0	0
Cymbidium Pali x (*C. soshin* var *album* x *C.* Pali)					
Species I					
hoosai var *kinkwalan* sub var *fayden*	1	1	1	64.0	1
	1	1	1	64.0	1
All Species	1	1	1	64.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cymbidium Pali x (*C.* *soshin* var *album* x *C.* Pali) ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids I x III ♂					
Fair Green	1	0	0	0.0	0
Mimi 'Sandalwood'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	1	1	77.0	1
	3	1	1	77.0	1
Other Hybrids					
Little Black Sambo	1	0	0	0.0	0
hoosai x *lancifolium*	1	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	5	1	1	77.0	1
Related Genera					
Ansellia africana	1	1	1	90.0	1
Calanthe sp.	1	0	0	0.0	0
Grammatophyllum scriptum	1	1	1	16.0	1
Grammatophyllum speciosum	1	0	0	0.0	0
Phaius tankervillae	2	2	2	49.5	0
	6	4	4	51.3	2
All Crosses Attempted	12	6	6	57.7	4

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Ansellia africana ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
aspidistrifolium	2	0	0	0.0	0
dayanum	2	0	0	0.0	0
formosanum	1	0	0	0.0	0
gracillimum	3	0	0	0.0	0
hoosai	5	0	0	0.0	0
hoosai var kinkwalan sub var fayden	3	1	1	9.0	1
lancifolium	3	0	0	0.0	0
pumilum var alba	5	0	0	0.0	0
sinense var album 'Jucundissimum'	6	0	0	0.0	0
soshin 'Tetukotsu'	3	0	0	0.0	0
	33	1	1	9.0	1
Species II					
aloifolium	12	1	0	0.0	0
canaliculatum var sparkesii	2	1	1	13.0	1
chloranthum	1	0	0	0.0	0
madidum	13	0	0	0.0	0
pendulum	3	0	0	0.0	0
	31	2	1	13.0	1
Species III					
eburneum	6	0	0	0.0	0
parishii var sanderae	3	0	0	0.0	0
	9	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Ansellia africana ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Species ♂	73	3	2	11.0	2
Hybrids I x III					
Balan 'Chelsea'	5	0	0	0.0	0
Fair Green	4	0	0	0.0	0
Fairy Wand	4	0	0	0.0	0
Koolau	2	0	0	0.0	0
Mimi 'Sandalwood'	6	0	0	0.0	0
Oriental Legend 'Fantan'	4	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	8	0	0	0.0	0
Red Star	8	0	0	0.0	0
Starbright	1	0	0	0.0	0
Sylvia Miller	7	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	3	0	0	0.0	0
	52	0	0	0.0	0
Hybrids III x III					
Balkis 'Silver Orb'	6	0	0	0.0	0
Barcelona 'Magic Wand'	4	0	0	0.0	0
Bethlehem 'Caspar'	1	0	0	0.0	0
Bethlehem 'Magi'	3	0	0	0.0	0
Bethlehem 'Sea Foam'	1	0	0	0.0	0
Carol Cox 'Snow'	1	0	0	0.0	0
Early Bird 'Pacific'	6	0	0	0.0	0
Earlyana 'Egret'	3	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Ansellia africana ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Fred Stewart 'Silver Light' ♂	8	0	0	0.0	0
Matana 'Maxine'	2	0	0	0.0	0
Rincon 'White'	2	0	0	0.0	0
San Miguel 'Christmas Song'	3	0	0	0.0	0
Stanley Fouraker	1	0	0	0.0	0
	41	0	0	0.0	0
Other Hybrids					
Little Black Sambo	2	0	0	0.0	0
Mitzi	4	0	0	0.0	0
Penguin	2	0	0	0.0	0
Tiger Hunt	4	0	0	0.0	0
Vogelsang	10	0	0	0.0	0
hoosai x *lancifolium*	3	0	0	0.0	0
	25	0	0	0.0	0
All Hybrids	118	0	0	0.0	0
Related Genera					
Ansellia africana	8	2	1	1.0	1
Ansellia gigantea	2	2	2	83.0	2
Bletia sp.	1	0	0	0.0	0
Calanthe sp.	7	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Catasetum fimbriatum	7	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Ansellia africana ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Catasetum integrinum ♂	3	0	0	0.0	0
Catasetum Sumanii	4	0	0	0.0	0
Chysis laevis	1	0	0	0.0	0
Coelogyne sp.	1	0	0	0.0	0
Cyrtopodium punctatum	2	0	0	0.0	0
Gastorehis humboltii	1	0	0	0.0	0
Grammatophyllum scriptum	8	0	0	0.0	0
Grammatophyllum scriptum 'The Governor'	1	0	0	0.0	0
Grammatophyllum speciosum	4	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Sanderae)	3	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Veitchii)	3	0	0	0.0	0
Phaiocymbidium Chardwarense	5	0	0	0.0	0
Phaius maculatus	3	0	0	0.0	0
Phaius tankervillae	19	0	0	0.0	0
Phaius Wallichi '1'	2	0	0	0.0	0
Phaius Wallichi '2'	2	0	0	0.0	0
Sobralia macrantha	1	0	0	0.0	0
Spathoglottis plicata	13	0	0	0.0	0
Spathoglottis sp.	3	0	0	0.0	0
C. madidum x *Ansellia africana*	1	0	0	0.0	0
	106	4	3	55.7	3
All Crosses Attempted	297	7	5	37.8	5

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Bletia sp. ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	1	0	0	0.0	0
Other Hybrids					
Penguin	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	1	0	0	0.0	0
Related Genera					
Ansellia africana	1	1	1	2.0	0
Bletia sp.	1	1	1	83.0	0
Phaius Wallichi '1'	1	0	0	0.0	0
formosanum x Greenwood	1	0	0	0.0	0
	4	2	2	42.5	0
All Crosses Attempted	6	2	2	42.5	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Calanthe sp. ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
hoosai var kinkwalan sub var fayden	1	0	0	0.0	0
	1	0	0	0.0	0
Species II					
canaliculatum var sparkesii	1	0	0	0.0	0
madidum	1	0	0	0.0	0
	2	0	0	0.0	0
All Species	3	0	0	0.0	0
Other Hybrids					
Little Black Sambo	1	0	0	0.0	0
hoosai x lancifolium	1	0	0	0.0	0
	2	0	0	0.0	0
Related Genera					
Ansellia africana	1	0	0	0.0	0
Calanthe sp.	2	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Grammatophyllum scriptum	2	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	9	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Calanthe sp. ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Crosses Attempted ♂	14	0	0	0.0	0
Calanthe vistata var rubro-oculata					
Species I					
dayanum	2	0	0	0.0	0
hoosai var kinkwalan sub var fayden	1	0	0	0.0	0
soshin 'Tetukotsu'	1	0	0	0.0	0
	4	0	0	0.0	0
Species II					
aloifolium	3	0	0	0.0	0
canaliculatum var sparkesii	1	0	0	0.0	0
madidum	1	0	0	0.0	0
pendulum	2	0	0	0.0	0
	7	0	0	0.0	0
All Species	11	0	0	0.0	0
Hybrids I x III					
Mimi 'Sandalwood'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-1)	3	0	0	0.0	0
	4	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Calanthe vistata var *rubro-oculata* ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
Early Bird 'Pacific'	1	0	0	0.0	0
	1	0	0	0.0	0
Other Hybrids					
hoosai x *lancifolium*	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	6	0	0	0.0	0
Related Genera					
Ansellia africana	6	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	2	2	2	97.5	2
Cyrtopodium lyonii	1	0	0	0.0	0
Eulophia kirkii	2	0	0	0.0	0
Phaiocymbidium Chardwarense	5	0	0	0.0	0
Phaius tankervillae	2	0	0	0.0	0
Phaius Ashworthiensus	5	0	0	0.0	0
Spathoglottis aurea	2	0	0	0.0	0
Spathoglottis plicata	3	0	0	0.0	0
Spathoglottis Pacifica	2	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Lord Rothschild)	4	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Calanthe vistata var rubro-oculata ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Phaiocalanthe (P. Gravesiae x C. Sanderae) ♂	1	0	0	0.0	0
	35	2	2	97.5	2
All Crosses Attempted	52	2	2	97.5	2
Catasetum thybaciochilum					
Species I					
hoosai var kinkwalan sub var fayden	1	0	0	0.0	0
lancifolium	1	0	0	0.0	0
	2	0	0	0.0	0
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	3	0	0	0.0	0
Other Hybrids					
hoosai x lancifolium	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Catasetum thybaciochilum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	1	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
	2	0	0	0.0	0
All Crosses Attempted	6	0	0	0.0	0
Coelogyne sp.					
Hybrid I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	1	0	0	0.0	0
Related Genera					
Bletia sp.	1	0	0	0.0	0
	1	0	0	0.0	0
All Crosses Attempted	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cyrtopodium lyonii ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
hoosai	1	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	2	0	0	0.0	0
lancifolium	1	0	0	0.0	0
soshin 'Tetukotsu'	1	0	0	0.0	0
	5	0	0	0.0	0
Species II					
aloifolium	1	0	0	0.0	0
madidum	1	0	0	0.0	0
	2	0	0	0.0	0
Species III					
pendulum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	8	0	0	0.0	0
Hybrid I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
Red Star	1	0	0	0.0	0
	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cyrtopodium lyonii ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	1	0	0	0.0	0
Ansellia gigantea	1	0	0	0.0	0
Cyrtopodium lyonii	2	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis aurea	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	8	0	0	0.0	0
All Crosses Attempted	18	0	0	0.0	0
Cyrtopodium punctatum					
Species I					
hoosai var *kinkwalan* sub var *fayden*	1	0	0	0.0	0
lancifolium	1	0	0	0.0	0
soshin 'Tetukotsu'	1	0	0	0.0	0
	3	0	0	0.0	0
Species II					
madidum	1	0	0	0.0	0
pendulum	1	0	0	0.0	0
	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Cyrtopodium punctatum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Species ♂	5	0	0	0.0	0
Hybrid I x III					
Fair Green	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	2	0	0	0.0	0
Red Star	1	0	0	0.0	0
	4	0	0	0.0	0
Related Genera					
Ansellia gigantea	1	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Cyrtopodium punctatum	1	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0
Phaius maculatus	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis aurea	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	8	0	0	0.0	0
All Crosses Attempted	17	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Eulophia caffra ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
hoosai	2	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	2	0	0	0.0	0
lancifolium	1	0	0	0.0	0
soshin 'Tetsukotsu'	2	0	0	0.0	0
	7	0	0	0.0	0
Species II					
aloifolium	1	0	0	0.0	0
madidum	3	0	0	0.0	0
	4	0	0	0.0	0
Species III					
parishii var *sanderae*	1	0	0	0.0	0
pendulum	3	0	0	0.0	0
	4	0	0	0.0	0
All Species	15	0	0	0.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	4	1	1	4.0	1
Red Star	3	0	0	0.0	0
	7	1	1	4.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Eulophia caffra ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	4	1	1	19.0	1
Ansellia gigantea	3	0	0	0.0	0
Cyrtopodium lyonii	2	0	0	0.0	0
Cyrtopodium punctatum	2	0	0	0.0	0
Eulophia caffra	6	1	1	83.0	1
Eulophia kirkii	3	1	1	78.0	1
Grammatophyllum scriptum	1	0	0	0.0	0
Phaius tankervillae	3	0	0	0.0	0
Spathoglottis sp.	1	0	0	0.0	0
Spathoglottis plicata	3	0	0	0.0	0
	28	3	3	60.0	3
All Crosses Attempted	50	4	4	55.0	4
Eulophia kirkii					
Species I					
hoosai var *kinkwalan* sub var *fayden*	4	1	1	7.0	1
lancifolium	5	0	0	0.0	0
	9	1	1	7.0	1
Species II					
aloifolium	4	0	0	0.0	0
canaliculatum	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Eulophia kirkii ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
madidum ♂	5	0	0	0.0	0
	10	0	0	0.0	0
All Species	19	1	1	7.0	1
Hybrids I x III					
Fair Green	1	0	0	0.0	0
Fairy Wand	2	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	5	0	0	0.0	0
Sylvia Miller	5	0	0	0.0	0
Pali x (soshin var album x Pali)	4	0	0	0.0	0
	17	0	0	0.0	0
Hybrids III x III					
Balkis 'Silver Orb'	1	0	0	0.0	0
Early Bird 'Pacific'	1	0	0	0.0	0
Fred Stewart 'Silver Light'	1	0	0	0.0	0
	3	0	0	0.0	0
Other Hybrids					
Penguin	4	0	0	0.0	0
Vogelsang	2	0	0	0.0	0
hoosai x lancifolium	4	0	0	0.0	0
	10	0	0	0.0	0
All Hybrids	30	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Eulophia kirkii ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	3	1	1	99.0	1
Ansellia gigantea	1	0	0	0.0	0
Bletia sp.	1	0	0	0.0	0
Calanthe sp.	3	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Eulophia kirkii	1	1	1	28.0	1
Phaius tankervillae	5	0	0	0.0	0
Spathoglottis plicata	6	0	0	0.0	0
	21	2	2	63.5	2
All Crosses Attempted	70	3	3	44.7	3
Grammatophyllum papuanum					
Species I					
formosanum	1	0	0	0.0	0
gracillimum	1	0	0	0.0	0
hoosai	3	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	2	0	0	0.0	0
lancifolium	2	0	0	0.0	0
pumilum var *album*	2	0	0	0.0	0
sinense var *album* 'Jucundissimum'	1	0	0	0.0	0
	12	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Grammatophyllum papuanum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
aloifolium	2	0	0	0.0	0
canaliculatum var sparkesii	2	0	0	0.0	0
chloranthum	2	0	0	0.0	0
madidum	2	0	0	0.0	0
pendulum	2	0	0	0.0	0
	10	0	0	0.0	0
Species III					
eburneum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	23	0	0	0.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	2	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	2	0	0	0.0	0
Related Genera					
Ansellia africana	2	0	0	0.0	0
Ansellia gigantea	2	0	0	0.0	0
Grammatophyllum papuanum	2	2	2	81.5	2

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Grammatophyllum papuanum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Phaius tankervillae ♂	2	0	0	0.0	0
Spathoglottis plicata	3	0	0	0.0	0
	11	2	2	81.5	2
All Crosses Attempted	36	2	2	81.5	2
Grammatophyllum scriptum 'The Governor'					
Species I					
pumilum var *album*	1	0	0	0.0	0
	1	0	0	0.0	0
Species II					
aloifolium	1	0	0	0.0	0
madidum	1	0	0	0.0	0
	2	0	0	0.0	0
All Species	3	0	0	0.0	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
Red Star	1	0	0	0.0	0
	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Grammatophyllum scriptum ♀ 'The Governor'	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	1	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Grammatophyllum scriptum 'The Governor'	1	0	0	0.0	0
	3	0	0	0.0	0
All Crosses Attempted	8	0	0	0.0	0
Grammatophyllum speciosum					
Species I					
hoosai var *kinkwalan* sub var *fayden*	1	0	0	0.0	0
	1	0	0	0.0	0
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	2	0	0	0.0	0
Other Hybrids					
hoosai x *lancifolium*	1	0	0	0.0	0
	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Grammatophyllum speciosum ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
All Hybrids ♂	1	0	0	0.0	0
Related Genera					
Ansellia africana	1	0	0	0.0	0
Ansellia gigantea	1	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
	5	0	0	0.0	0
All Crosses Attempted	8	0	0	0.0	0
Phaiocalanthe (P. Gravesiae x C. Lord Rothschild)					
Species I					
dayanum	1	0	0	0.0	0
soshin 'Tetukotsu'	1	0	0	0.0	0
	2	0	0	0.0	0
Species II					
pendulum	3	0	0	0.0	0
	3	0	0	0.0	0
All Species	5	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaiocalanthe (P. Gravesiae x C. Lord Rothschild ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids I x III ♂					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	1	0	0	0.0	0
Other Hybrids					
hoosai x lancifolium	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	2	0	0	0.0	0
Related Genera					
Ansellia africana	4	0	0	0.0	0
Ansellia gigantea	3	0	0	0.0	0
Calanthe vistata var rubro-oculata	1	1	1	26.0	1
Eulophia kirkii	1	0	0	0.0	0
Phaiocalanthe (P. Gravesiae x C. Lord Rothschild)	1	0	0	0.0	0
Phaiocalanthe (P. Gravesiae x C. Sanderae)	1	0	0	0.0	0
Phaiocymbidium Chardwarense	2	0	0	0.0	0
Phaius Ashworthiensus	1	0	0	0.0	0
Spathoglottis plicata	2	0	0	0.0	0
Spathoglottis Pacific	1	0	0	0.0	0
	17	1	1	26.0	1
All Crosses Attempted	24	1	1	26.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaiocalanthe (P. Gravesiae x C. Sanderae ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
hoosai var kinkwalan sub var fayden	1	0	0	0.0	0
	1	0	0	0.0	0
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	2	0	0	0.0	0
Related Genera					
Ansellia africana	1	0	0	0.0	0
Phaiocalanthe (P. Gravesiae x C. Sanderae)	1	0	0	0.0	0
Phaiocymbidium Chardwarense	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	5	0	0	0.0	0
All Crosses Attempted	7	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaiocalanthe (P. Gravesiae x C. Veitchii) ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	1	0	0	0.0	0
Related Genera					
Phaiocalanthe (P. Gravesiae x C. Veitchii)	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	3	0	0	0.0	0
All Crosses Attempted	4	0	0	0.0	0
Phaiocymbidium Chardwarense					
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	1	0	0	0.0	0
Related Genera					
Ansellia africana	1	0	0	0.0	0
Calanthe vistata var rubro-oculata	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaiocymbidium Chardwarense ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Phaiocymbidium Chardwarense ♂	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Phaius Ashworthiensus	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	6	0	0	0.0	0
All Crosses Attempted	7	0	0	0.0	0
Phaius Ashworthiensus					
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	1	0	0	0.0	0
Related Genera					
Ansellia africana	2	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Phaiocalanthe (*P. Gravesiae* x *C. Lord Rothschild*)	1	0	0	0.0	0
Phaiocymbidium Chardwarense	1	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
Phaius Ashworthiensus	1	0	0	0.0	0
Spathoglottis plicata	1	0	0	0.0	0
	8	0	0	0.0	0
All Crosses Attempted	9	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaius tankervillae ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species I ♂					
aspidistrifolium	1	0	0	0.0	0
gracillimum	1	1	0	0.0	0
hoosai	4	0	0	0.0	0
hoosai var kinkwalan sub var fayden	2	1	0	0.0	0
lancifolium	4	0	0	0.0	0
pumilum var album	1	1	0	0.0	0
sinense var album 'Jucundissimum'	2	0	0	0.0	0
soshin 'Tetukotsu'	4	0	0	0.0	0
	19	3	0	0.0	0
Species II					
aloifolium	3	1	0	0.0	0
canaliculatum var sparkesii	2	1	0	0.0	0
chloranthum	1	0	0	0.0	0
madidum	3	0	0	0.0	0
pendulum	2	0	0	0.0	0
	11	2	0	0.0	0
Species III					
eburneum	1	0	0	0.0	0
parishii var sanderae	3	0	0	0.0	0
	4	0	0	0.0	0
All Species	34	5	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaius tankervillae ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids I x III ♂					
Balan 'Chelsea'	1	0	0	0.0	0
Fair Green	2	0	0	0.0	0
Fairy Wand	1	0	0	0.0	0
Mimi 'Sandalwood'	2	0	0	0.0	0
Oriental Legend 'Fantan'	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	3	1	0	0.0	0
Red Star	2	0	0	0.0	0
Starbright	2	0	0	0.0	0
Sylvia Miller	2	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	2	0	0	0.0	0
	18	1	0	0.0	0
Hybrids III x III					
Balkis 'Silver Orb'	1	0	0	0.0	0
Carol Cox	1	0	0	0.0	0
Early Bird 'Pacific'	2	0	0	0.0	0
Fred Stewart 'Silver Light'	1	0	0	0.0	0
Stanley Fouraker	1	0	0	0.0	0
	6	0	0	0.0	0
Other Hybrids					
Little Black Sambo	2	0	0	0.0	0
Penguin	2	0	0	0.0	0
Tiger Hunt	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaius tankervillae ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Vogelsang ♂	2	0	0	0.0	0
hoosai x *lancifolium*	2	0	0	0.0	0
	10	0	0	0.0	0
All Hybrids	34	0	0	0.0	0
Related Genera					
Ansellia africana	3	1	1	67.0	1
Ansellia gigantea	2	0	0	0.0	0
Bletia sp.	1	0	0	0.0	0
Calanthe sp.	2	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	2	0	0	0.0	0
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum integrinum	1	0	0	0.0	0
Catasetum Sumanii	1	0	0	0.0	0
Eulophia kirkii	3	2	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Grammatophyllum speciosum	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Sanderae)	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Veitchii)	1	0	0	0.0	0
Phaiocymbidium Chardwarense	2	0	0	0.0	0
Phaius maculatus	1	0	0	0.0	0
Phaius tankervillae	1	1	1	41.0	1

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaius tankervillae ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Phaius Ashworthiensus ♂	1	0	0	0.0	0
Spathoglottis plicata	2	2	1	3.0	1
Spathoglottis Singapore Giant	1	1	1	11.0	1
	28	7	4	30.5	4
All Crosses Attempted	96	13	4	30.5	4
Phaius Wallichi					
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
Species III					
parishii var sanderae	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	2	0	0	0.0	0
Hybrids III x III					
New Moon '1'	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Phaius Wallichi ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Bletia sp.	1	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	1	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0
Phaiocymbidium Chardwarense	2	0	0	0.0	0
Phaius tankervillae	1	0	0	0.0	0
	6	0	0	0.0	0
All Crosses Attempted	9	0	0	0.0	0
Sobralia macranthe					
Species II					
madidum	1	0	0	0.0	0
	1	0	0	0.0	0
All Species	1	0	0	0.0	0
Spathoglottis aurea					
Species I					
dayanum	4	0	0	0.0	0
ensifolium var *album*	1	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Spathoglottis aurea ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
lancifolium ♂	1	0	0	0.0	0
soshin 'Tetukotsu'	2	1	0	0.0	0
	8	1	0	0.0	0
Species II					
pendulum	2	1	0	0.0	0
	2	1	0	0.0	0
All Species	10	2	0	0.0	0
Hybrid I x III					
Peter Pan 'Greensleeves' (UH-1)	1	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
	2	0	0	0.0	0
Hybrid III x III					
erythrostylum x Sicily	1	0	0	0.0	0
	1	0	0	0.0	0
Other Hybrids					
hoosai x *lancifolium*	2	0	0	0.0	0
	2	0	0	0.0	0
All Hybrids	5	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Spathoglottis aurea ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	2	1	0	0.0	0
Ansellia gigantea	1	1	0	0.0	0
Calanthe vistata var *rubro-oculata*	2	2	0	0.0	0
Cyrtopodium punctatum	1	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Lord Rothschild)	2	0	0	0.0	0
Phaiocymbidium Chardwarense	2	0	0	0.0	0
Phaius tankervillae	3	0	0	0.0	0
Phaius Ashworthiensus	1	0	0	0.0	0
Spathoglottis aurea	2	0	0	0.0	0
Spathoglottis hyb. 'Kalfred Yee'	1	0	0	0.0	0
	18	4	0	0.0	0
All Crosses Attempted	33	6	0	0.0	0
Spathoglottis plicata					
Species I					
dayanum	29	1	0	0.0	0
hoosai	11	0	0	0.0	0
hoosai var *kinkwalan* sub var *fayden*	6	0	0	0.0	0
koran var *album*	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Spathoglottis plicata ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
lancifolium ♂	4	0	0	0.0	0
pumilum var *album*	1	0	0	0.0	0
soshin 'Tetukotsu'	13	0	0	0.0	0
	66	1	0	0.0	0
Species II					
aloifolium	18	0	0	0.0	0
canaliculatum var *sparkesii*	1	0	0	0.0	0
madidum	12	0	0	0.0	0
pendulum	21	4	1	4.0	0
	52	4	1	4.0	0
All Species	118	5	1	4.0	0
Hybrids I x III					
Fair Green	6	0	0	0.0	0
Oriental Legend 'Fantan'	2	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-1)	8	1	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	19	0	0	0.0	0
Red Star	3	0	0	0.0	0
Sylvia Miller	4	0	0	0.0	0
Pali x (*soshin* var *album* x Pali)	2	0	0	0.0	0
	44	1	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Spathoglottis plicata ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Hybrids III x III ♂					
Balkis 'Silver Orb'	4	0	0	0.0	0
Bethlehem 'Magi'	2	0	0	0.0	0
Sicily x San Miguel	2	0	0	0.0	0
	8	0	0	0.0	0
Other Hybrids					
Faridah Hishim	2	0	0	0.0	0
Little Black Sambo	1	0	0	0.0	0
Penguin	7	0	0	0.0	0
Vogelsang	1	0	0	0.0	0
hoosai x *lancifolium*	15	0	0	0.0	0
	26	0	0	0.0	0
All Hybrids	78	1	0	0.0	0
Related Genera					
Ansellia africana	27	4	2	47.5	1
Ansellia gigantea	8	3	3	1.7	0
Calanthe sp.	1	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	16	3	3	3.0	1
Catasetum fimbriatum	1	0	0	0.0	0
Catasetum Sumanii	2	0	0	0.0	0
Cymbidiella rhodochila	2	0	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Spathoglottis plicata ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Cyrtopodium lyonii ♂	4	0	0	0.0	0
Cyrtopodium punctatum	8	1	0	0.0	0
Eulophia caffra	8	0	0	0.0	0
Eulophia kirkii	2	0	0	0.0	0
Grammatophyllum scriptum	1	0	0	0.0	0
Phaiocalanthe (*P. Gravesiae* x *C.* Lord Rothschild)	17	0	0	0.0	0
Phaiocymbidium Chardwarense	10	0	0	0.0	0
Phaius tankervillae	19	2	1	13.0	2
Phaius Ashworthiensus	15	0	0	0.0	0
Spathoglottis aurea	7	1	0	0.0	0
Spathoglottis plicata	1	1	1	94.0	1
Spathoglottis Pacifica	3	1	1	31.0	1
Spathoglottis hyb. 'Kalfred Yee'	1	1	1	1.0	1
	153	17	12	20.7	7
All Crosses Attempted	349	23	13	19.4	7
Spathoglottis Pacifica					
Species I					
dayanum	11	3	3	2.7	0
hoosai	4	0	0	0.0	0
	15	3	3	2.7	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Spathoglottis Pacifica ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Species II ♂					
aloifolium	1	0	0	0.0	0
madidum	1	0	0	0.0	0
pendulum	9	1	0	0.0	0
	11	1	0	0.0	0
All Species	26	4	3	2.7	0
Hybrids I x III					
Peter Pan 'Greensleeves' (UH-1)	8	0	0	0.0	0
Peter Pan 'Greensleeves' (UH-2)	1	0	0	0.0	0
Red Star	1	0	0	0.0	0
	10	0	0	0.0	0
Other Hybrids					
hoosai x *lancifolium*	1	0	0	0.0	0
	1	0	0	0.0	0
All Hybrids	11	0	0	0.0	0
Related Genera					
Ansellia africana	6	2	1	4.0	0
Ansellia gigantea	1	1	1	10.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Spathoglottis Pacifica ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Bletia sp. ♂	2	0	0	0.0	0
Calanthe vistata var *rubro-oculata*	10	2	2	3.5	2
Cyrtopodium punctatum	1	0	0	0.0	0
Eulophia kirkii	1	0	0	0.0	0
Phaiocalanthe (*P.* Gravesiae x *C.* Lord Rothschild)	6	0	0	0.0	0
Phaiocymbidium Chardwarense	3	0	0	0.0	0
Phaius tankervillae	5	0	0	0.0	0
Phaius Ashworthiensus	6	0	0	0.0	0
Spathoglottis aurea	7	0	0	0.0	0
	48	5	4	5.3	2
All Crosses Attempted	85	9	7	4.2	2
Spathoglottis Singapore Giant					
Related Genera					
Ansellia africana	1	0	0	0.0	0
Bletia sp.	4	1	0	0.0	0
Spathoglottis Singapore Giant	1	0	0	0.0	0
	6	1	0	0.0	0
All Crosses Attempted	6	1	0	0.0	0

Appendix A (continued)

Intra- and intergroup and intergeneric crosses
attempted for each species and hybrid used as a female

Spathoglottis hybrid 'Kalfred Yee' ♀	No. of pollinations	No. of fruits harvested	No. of fruits with embryos	Avg. embryo %	No. of fruits that had germination
Related Genera ♂					
Ansellia africana	2	1	1	7.0	0
Spathoglottis aurea	2	0	0	0.0	0
Spathoglottis hyb. 'Kalfred Yee'	1	1	0	0.0	0
	5	2	1	7.0	0
All Crosses Attempted	5	2	1	7.0	0

Appendix B

Primary Cymbidium hybrids registered through 1976

Parentage	Hybrid	Registrar	Year Registered
aloifolium x bicolor	Burma Star	Limberlost	1961
x finlaysonianum	Hanalei	Hirose	1944
bicolor x aloifolium	Burma Star	Limberlost	1961
canaliculatum x devonianum	Pied Piper	Greenoaks	1968
x ensifolium	Ensi Canal	Stewarts	1969
x finlaysonianum	Iris Banouchie	Black	1973
x madidum	Little Black Sambo	Cooper	1966
x pendulum	Penguin	Greenoaks	1968
x simulans	Alcor	Miller	1971
chloranthum x erythrostylum	Chlorey	Ireland	1971
dayanum x elegans	Elsimon	Andrews	1974
devonianum x canaliculatum	Pied Piper	Greenoaks	1968
x eburneum	Jean Brummitt	Brummitt	1944
x insigne	Vogelsang	Lambeau	1928
x lowianum	Langeyense	Veitch	1911
x madidum	Cricket	Greenoaks	1964
x pumilum	Miss Muffet	Greenoaks	1964
x sinense	Minnehaha	Wyld Court Orchids	1972
eburneum x devonianum	Jean Brummitt	Brummitt	1944
x erythrostylum	Niveum	Hanbury	1926
x giganteum	Eburneo-giganteum	C.	1906
x grandiflorum	Holfordianum	S.	1906
x insigne	Gottianum	S.	1911
x lowianum	Eburneo-lowianum	Veitch	1889
x masterii	Ballianum	Nat. Hyb.	
x pumilum	Naganeb	Nagano	1966
x roseum	Juno	Hamil. Smith	1921
x tracyanum	Wiganianum	Wigan	1902

Appendix B (continued)

Primary *Cymbidium* hybrids registered through 1976

Parentage	Hybrid	Registrar	Year Registered
elegans x *dayanum*	Elsimon	Andrew	1974
x *giganteum*	Maggie Fowler	Fowler	1908
x *longifolium*	Gammieanum	Nat. Hyb.	
ensifolium x *canaliculatum*	Ensi Canal	Stewarts	1969
x *finlaysonianum*	Faridah Hishim	Morgan	1966
x *lowianum*	Lilliput	Dos Pueblos	1961
x *pubescens*	Yin-Chee	Chay Sing Hai	1969
x *tracyanum*	Pali	Yamada	1966
erythrostylum x *chloranthum*	Chlorey	Ireland	1971
x *eburneum*	Niveum	Hansbury	1926
x *giganteum*	Florinda	Edw. Moss	1913
x *i'ansonii*	Radiant	A & B	1923
x *insigne*	Albanese	S.	1915
x *kanran*	Stellina	Ireland	1963
x *lowianum*	Atalanta	Sanders	1918
x *pumilum*	Cherry Blossom	Greenoaks	1963
x *tracyanum*	Hanburyanum	Hanbury	1914
finlaysonianum x *aloifolium*	Hanalei	Hirose	1944
x *canaliculatum*	Iris Bannochie	G. Black	1973
x *ensifolium*	Faridah Hishim	Morgan	1966
x *madidum*	Francis Hunte	G. Black	1973
giganteum x *eburneum*	Eburneo-giganteum	C.	1906
x *elegans*	Maggie Fowler	Fowler	1908
x *erythrostylum*	Florinda	Edw. Moss	1913
x *grandiflorum*	Zaleskianum	Nat. Hyb.	
x *insigne*	Iona	A & B	1914
x *lowianum*	Iris	Edin. Bot. Gard.	
x *masterii*	Winnianum	Winn.	1892
x *tracyanum*	Bennett-Poei	Nat. Hyb.	

Appendix B (continued)

Primary *Cymbidium* hybrids registered through 1976

Parentage	Hybrid	Registrar	Year Registered
grandiflorum x *eburneum*	Holfordianum	S.	1906
x *giganteum*	Zaleskianum	Nat. Hyb.	
x *insigne*	Coningsbyanum	Hamil. Smith	1914
x *lowianum*	Lowio-grandiflorum	Veitch	1902
x *masterii*	Maronii	Maron	1900
x *tracyanum*	Rosefieldense	Crawshay	1908
hoosai x *lowianum*	Loho	Graves	1963
x *pumilum*	Hoosailum	Ireland	1972
i'ansonii x *erythrostylum*	Radiant	A & B	1923
x *insigne*	Ceres	Hamil. Smith	1919
x *lowianum*	Lotta	Colman	1922
x *parishii*	Seamew	H.	1915
x *pendulum*	Faunus		
x *schroderi*	Bacchus	Garbari	1933
insigne x *devonianum*	Vogelsang	Lambeau	1928
x *eburneum*	Gottianum	S.	1911
x *erythrostylum*	Albanense	S.	1915
x *giganteum*	Iona	A & B	1914
x *grandiflorum*	Coningsbyanum	Hamil. Smith	1914
x *i'ansonii*	Ceres	Hamil. Smith	1919
x *lowianum*	Pauwelsii	Pauwels	1911
x *parishii*	Dryad	H.	1914
x *roseum*	Titania	S.	1922
x *schroderi*	J. Davis	Fowler	1911
x *tigrinum*	Insignigrinum	Hamil. Smith	1917
x *tracyanum*	Doris	M.	1912
kanran x *erythrostylum*	Stellina	Ireland	1963
x *lowianum*	Gasper de Portolo	Ireland	1961

Appendix B (continued)

Primary *Cymbidium* hybrids registered through 1976

Parentage	Hybrid	Registrar	Year Registered
lowianum x *devonianum*	Langleyense	Veitch	1911
x *eburneum*	Eburneo-lowianum	Veitch	1889
x *erythrostylum*	Atalanta	S.	1918
x *giganteum*	Iris	Edin. Bot. Gard.	
x *grandiflorum*	Lowio-grandiflorum	Veitch	1902
x *i'ansonii*	Lotta	Colman	1922
x *insigne*	Pauwelsii	Pauwels	1911
x *masterii*	Lowio-masterii	C.	1902
x *parishii*	Garnet	H.	1915
x *tigrinum*	Lowgrinum	Measures	1903
x *tracyanum*	Gattonense	Colman	1930
madidum x *canaliculatum*	Little Black Sambo	Cooper	1966
x *devonianum*	Cricket	Greenoaks	1964
x *finlaysonianum*	Francis Hunte	G. Black	1973
x *pumilum*	Pee Wee	Ireland	1966
x *suave*	Kuranda	Greenaoks	1972
x *virescens*	That's It	Ireland	1968
parishii x *i'ansonii*	Seamew	H.	1915
x *insigne*	Dryad	H.	1914
x *lowianum*	Garnet	H.	1915
pendulum x *canaliculatum*	Penguin	Greenoaks	1968
x *i'ansonii*	Faunus		
x *tracyanum*	Mona	Cowan	1924
pubescens x *ensifolium*	Yin-Chee	Chay Sing Hai	1969
pumilum x *devonianum*	Miss Muffit	Greenoaks	1964
x *eburneum*	Naganeb	Nagano	1966
x *erythrostylum*	Cherry Blossom	Greenoaks	1963
x *hoosai*	Hoosailum	Mary B. Ireland	1972

Appendix B (continued)

Primary *Cymbidium* hybrids registered through 1976

Parentage	Hybrid	Registrar	Year Registered
pumilum x *insigne*	Minuet	A.	1942
x *lowianum*	Pumilow	Andrew Orchids	1967
x *madidum*	Pee Wee	Ireland	1966
x *purpureum*	Bo-Peep	Stewarts	1955
x *suave*	Scallywag	Andrew Orchids	1969
x *tracyanum*	Tiger Baby	Fujita	1965
x *virescens*	Petite	Ireland	1968
roseum x *eburneum*	Juno	Hamil. Smith	1921
x *insigne*	Titania	S.	1922
schroderi x *i'ansonii*	Bacchus	Garbari	1933
x *insigne*	J. Davis	Fowler	1911
simulans x *canaliculatum*	Alcor	Miller	1971
sinense x *devonianum*	Minnehaha	Wyld Court Orchids	1972
suave x *madidum*	Kurunda	Greenoaks	1972
x *pumilum*	Scallywag	Andrew Orchids	1969
tigrinum x *insigne*	Insignigrinum	Hamil. Smith	1917
x *lowianum*	Lowgrinum	R. I. Measures	1903
tracyanum x *eburneum*	Wiganianum	Wigan	1902
x *ensifolium*	Pali	Yamada	1966
x *erythrostylum*	Hanburyanum	Hanbury	1914
x *giganteum*	Bennett-Poei	Nat. Hyb.	
x *grandiflorum*	Rosefieldense	Crawshay	1908
x *insigne*	Doris	M.	1912
x *lowianum*	Gattonense	Colman	1930
x *masterii*	Woodlandense	S.	1904
x *pendulum*	Mona	Cowna	1924
x *pumilum*	Tiger Baby	Fujita	1965
virescens x *madidum*	That's It	Ireland	1968
x *pumilum*	Petite	Ireland	1968

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