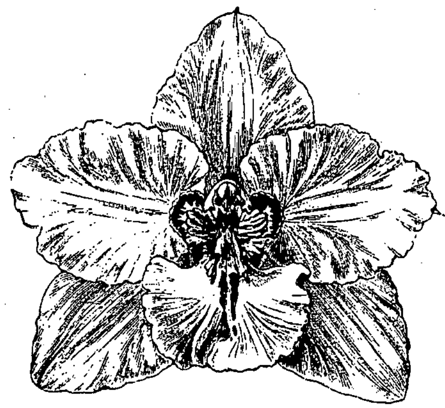
Odontoglossum Alliance Newsletter

Volume 4 May 2002

?In This Issue



Oh Say, Can You See...

How Much Of A Species Is In A Hybrid ?

A Model for Inheritance in Orchid Hybridizing

By Helmut Rohrl
Part II

Let the games begin!

Crosses I through VII with One Chromosome Pair

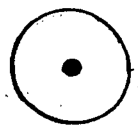
For each cross below we show the zygote matrix for n = 1, followed by a geometric representation of the zygote matrix. Here, a dot stands for a species orchid genotype and a circled dot means a hybrid genotype. If a dot is double-circled, that means it has twice the probability of appearing in the zygote matrix as a single-circled dot.

Cross I: Two cultivars of the same species, [//] with [//], for n = 1

Result: This cross yields 100% identical progeny, a uniform population of the parent species with genotype [//]. The zygote matrix is:

	[/]	[/]
[/]	**[//]**	**[//]**
[/]	**[//]**	**[//]**

Its geometric representation is:

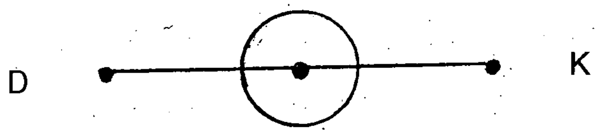


Cross II: Two different species, [KK] with [DD], for n = 1

Result: Again we obtain 100% uniform progeny, but this time a simple primary hybrid population is created that is genetically different from either of the parent species. The zygote matrix is:

	[K]	[K]
[D]	**[DK]**	**[DK]**
[D]	**[DK]**	**[DK]**

Its geometric representation is:

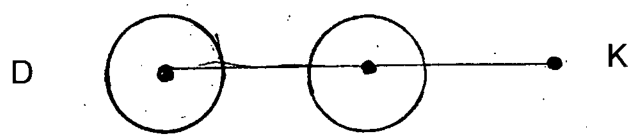


Cross III: Simple primary hybrid [DK] from Cross II with one parent [DD], for n = 1

Result: The progeny of this cross consists of two distinct cultivars; both are species, both appear with a 50% probability. One of the resulting cultivars is the participating species. The zygote matrix is:

	[D]	[K]
[D]	**[DD]**	**[DK]**
[D]	**[DD]**	**[DK]**

Its geometric representation is

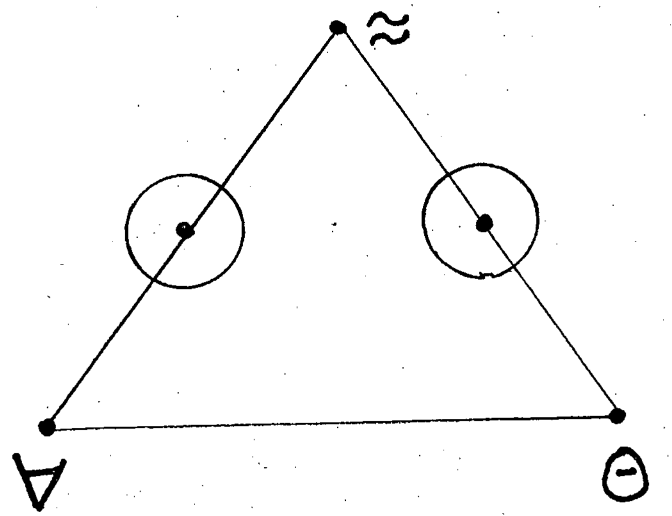


Cross IV: A simple primary hybrid ["q] with a new species [» »] not a parent of the simple primary hybrid, for n = 1

Result: Again, we obtain a population of two distinct cultivars, ["»] and [q »], each of which appears with a probability of 50 %. Neither progeny cultivar is a species. The zygote matrix is:

	[»]	[»]
["]	**["»]**	**["»]**
[q]	**[q »]**	**[q »]**

Its geometric representation is:

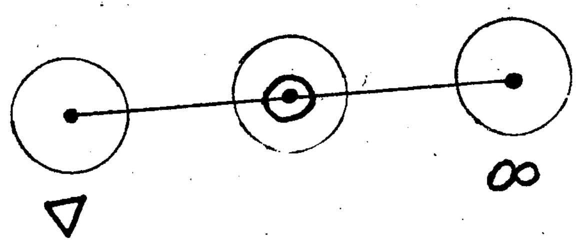


Cross V: Simple primary hybrid [∞∇] with itself, for n = 1

Result: Progeny from this cross consists of three distinct cultivar populations, two species [ÑÑ] and [¥¥] and one simple primary hybrid [Ñ¥]. The species appear with a probability of 25 % each, while the remaining hybrid appears with a 50% probability (Ñ¥ = ¥Ñ). The zygote matrix is:

	[Ñ]	[¥]
[Ñ]	**[ÑÑ]**	**[Ñ¥]**
[¥]	**[¥Ñ]**	**[¥¥]**

Its geometric representation is:



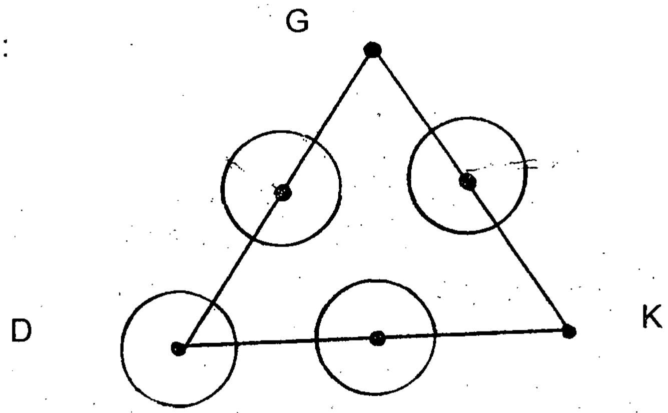
Cross VI: Simple primary hybrid [DK] with a different simple primary hybrid [DG] that shares a species parent, for n = 1

Result: The progeny consists of plants of four distinct cultivars; 3 simple primary hybrids and one species [DD], each of which appears with the same probability of 25%.

The zygote matrix is:

	[D]	[G]
[D]	**[DD]**	**[DG]**
[K]	**[KD]**	**[KG]**

Its geometric representation is:

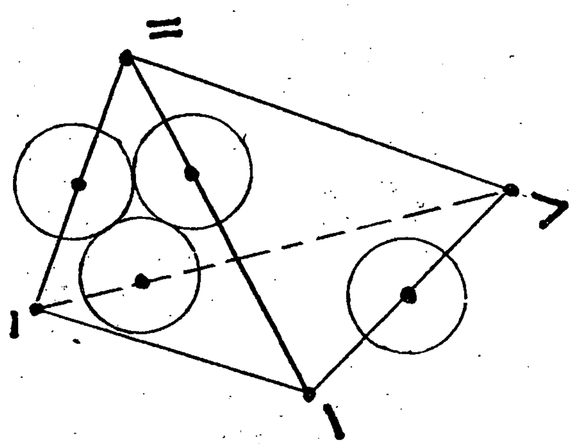


Cross VII: Simple primary hybrid [| \ ] with a different simple primary hybrid [= >] that does not share a species parent, for n = **1**

Result: The description of the population is the same as in Cross VI - four distinct cultivars. The difference is that a species cultivar appeared Cross VI, but none shows up in Cross VII. The zygote matrix is:

<table>
<tr><th></th><th>[=]</th><th>[>]</th></tr>
<tr><td>[|]</td><td>[| =]</td><td>[| >]</td></tr>
<tr><td>[\ ]</td><td>[\ =]</td><td>[\ >]</td></tr>
</table>

Its geometric representation is:



These are all the possible outcomes for hybrids and their crosses in the case of genomes with just one chromosome pair. Progeny of crosses of parents whose somatic genomes have n chromosome pairs can be determined in the same fashion, as is illustrated below.

Crosses I through VII with 'n' Chromosome Pairs

When we work with diploid parents with n pairs - rather than just one pair - of chromosomes, the number of possible progeny genotypes in the zygote matrix increases exponentially. With n pairs, we get 2^n possibilities (2 raised to the power of n, the number of chromosome pairs) for the gametic genomes, some of which may be identical.[1]

As outlined earlier, our model assumes that chromosome pairs in a diploid species consist of two homologous chromosomes. A chromosome pair with the reference number, #4 for example, are identical with chromosome pair # 4 in a different plant of that same species. Therefore, in a species orchid all gametes will have the same genotype. By contrast, the diploid genotype of a hybrid orchid may comprise pairs of chromosomes that are either homologous, (identical), or heterologous, (mutually distinct, or different from one another). It follows, then, that among its 2^n gametic genotypes are several mutually distinct ones. Since each hybrid parent produces 2^n (not necessarily distinct) gametic genotypes, the zygote matrix for cross hybrid x hybrid results in 4^n entries. The probability that a particular genotype, or cultivar, appears in a progeny population is equal to the number of times that this cultivar appears in the zygote matrix, divided by 4^n. For example, crossing two parents, each with 20 heterologous chromosomes, results in 4^{20} =1,000,000,000,000 (one trillion) mutually distinct zygote or progeny genotypes. That means the probability of a particular genotype turning up in the progeny population of such a hybrid can be as little as .000,000,000,001 %.

When the genomes of two gametes fuse to form a zygote, only chromosomes with the same chromosome reference number combine to form a chromosome pair. Single chromosome #4 from the female parent combines only with #4 from the male parent, not with #7, or #2. This means that the general case, where n (the number of chromosome pairs in the nucleus) is more than one, can be described in the same way as when n equals one (a plant with just one pair of chromosomes).

Now we will try out Cross I through VII using parents with *more* than one pair of chromosomes, that is, where n is two or greater, to see what happens to the zygote matrix in each Cross.

Crosses I through VII for n Chromosome Pairs

Cross I: Two cultivars of the same species, [//, //,...] with [//, //,...] for n pairs of chromosomes

Result*:* Whether the parents have two chromosomes, or n chromosomes, the results are the same. The genotypes in the progeny orchids are identical, and the same as the original species.

First, here is the zygote matrix for parents with **two pairs** of chromosomes:

[/, /]   [/, /]   [/, /]   [/, /]

[/, /]	**[//, //]**	**[//, //]**	**[//, //]**	**[//, //]**
[/, /]	**[//, //]**	**[//, //]**	**[//, //]**	**[//, //]**
[/, /]	**[//, //]**	**[//, //]**	**[//, //]**	**[//, //]**
[/, /]	**[//, //]**	**[//, //]**	**[//, //]**	**[//, //]**

The zygote matrix for n **pairs** of chromosomes could be represented as follows:

	[/, /, ...]	[/, /, ...]	[/, /, ...]	...®
[/, /, ...]	**[//, //, ...]**	**[//, //, ...]**	**[//, //, ...]**	**...®**
[/, /, ...]	**[//, //, ...]**	**[//, //, ...]**	**[//, //, ...]**	**...®**
[/, /, ...]	**[//, //, ...]**	**[//, //, ...]**	**[//, //, ...]**	**...®**
⋮	⋮	⋮	⋮	

Cross II: Two different species, [>>, >>,...] with [DD, DD,...], for n pairs of chromosomes

Result: Progeny of this cross are all simple primary hybrids, all appear with equal probability, and all are genetically distinct from either parent species. When n = 2, there are 4^2, or 16 possible genotypes. For general n, there will be 2^n possible genotypes in the progeny, all of which will be identical simple primary hybrids.

Again, here is the zygote matrix for two species parents with two chromosomes:

	[>,>, ...]	[>,>, ...]	[>,>, ...]	[>,>, ...]
[D,D, ...]	**[D>, D>, ...]**	**[D>, D>, ...]**	**[D>, D>, ...]**	**[D>, D>, ...]**
[D,D, ...]	**[D>, D>, ...]**	**[D>, D>, ...]**	**[D>, D>, ...]**	**[D>, D>, ...]**
[D,D, ...]	**[D>, D>, ...]**	**[D>, D>, ...]**	**[D>, D>, ...]**	**[D>, D>, ...]**
[D,D, ...]	**[D>, D>, ...]**	**[D>, D>, ...]**	**[D>, D>, ...]**	**[D>, D>, ...]**

The Cross II – zygote matrix *for **arbitrary*** n looks exactly the same, except that it extends farther downwards and farther to the right.

Cross III: Simple primary hybrid [DK, DK,...] from Cross II with one parent [DD, DD,...], for n pairs of chromosomes

Result: For all values of n, the genotypes of the resulting zygotes are [D,D] and [D,K] The population will have 2^n distinct cultivars. Some cultivars will have a genotype identical with that of the parent species, while other cultivars will have the same genotype as the corresponding simple primary hybrid. Each cultivar is uniquely determined by listing the position of the pairs DD in its somatic genotype symbol. If k is the number of the pairs DD occurring in the progeny genotype, then the number of pairs DK in the genome equals n - k. All cultivars will appear with equal probability of 1/2

^{n}. For example, a cross between a simple primary hybrid and one parent, each with 40 chromosomes, will yield 2^{40}, or one trillion cultivars.

Here is the zygote matrix for Cross III when n = 2:

	[D, D]	[D, D]	[D, D]	[D, D]
[D, D]	**[DD, DD]**	**[DD, DD]**	**[DD, DD]**	**[DD, DD]**
[D, K]	**[DD, KD]**	**[DD, KD]**	**[DD, DD]**	**[DD, KD]**
[K, D]	**[KD, DD]**	**[KD, DD]**	**[KD, DD]**	**[KD, DD]**
[K, K]	**[KD, KD]**	**[KD, KD]**	**[KD, KD]**	**[KD, KD]**

The Cross III – zygote matrix for arbitrary n looks similar in the sense that each row extends farther to the right, with each row having the same, constant, genotype. Moreover there are now 2^n rows, each coming from a different gamete of the simple primary hybrid; the chromosomes in these gametes are either D or K.

Cross IV: Simple primary hybrid [| >, |>...] with a new species [= =, ==...] not used in building the simple primary hybrid, for n pairs of chromosomes

Result: If we code the chromosome pairs of the simple primary hybrid by | > and those of the species by =, then the chromosome pairs of the progeny are |= and >=. The progeny population has 2^n distinct genotypes, each appearing with the same probability of $1/2^{n}$. None of the progeny has the same genotype as any of the parents involved. Each cultivar is uniquely determined by listing the position of the pairs |= in its somatic genome symbol; if k is the number of the pairs |= occurring in the genome, then the number of pairs >= in the genome equals n - k.

Again we show the zygote matrix of Cross IV for n = 2.

<table>
<tr><td></td><td>[=,=]</td><td>[=, =]</td><td>[=, =]</td><td>[=,=]</td></tr>
<tr><td>[|, |]</td><td>[|=, |=]</td><td>[|=, |=]</td><td>[|=, |=]</td><td>[|=, |=]</td></tr>
<tr><td>[|, >]</td><td>[|=,>=]</td><td>[|=,>=]</td><td>[|=,>=]</td><td>[|=,>=]</td></tr>
<tr><td>[>, |]</td><td>[>=,|=]</td><td>[>=,|=]</td><td>[>=,|=]</td><td>[>=,|=]</td></tr>
<tr><td>[>, >]</td><td>[>=, >=]</td><td>[>=, >=]</td><td>[>=, >=]</td><td>[>=, >=]</td></tr>
</table>

The Cross IV –zygote matrix for arbitrary n looks similar in the sense that each row extends farther to the right, with each row having the same, constant, genotype. Moreover, there are now 2^n rows, each coming from a different gamete of the simple primary hybrid.

Cross V: Simple primary hybrid [|/, |/ ...] with itself [|/, |/ ...], for n pairs of chromosomes

Result: If one parent of the simple primary hybrid has genotype [||, ||...] and the other [//, //...], then the chromosome pairs of the progeny cultivars are ||, //, and |/. Each of the progeny's cultivars is uniquely determined by listing the position of the pairs || and the pairs // in its somatic genome symbol; if j is the number of pairs || and k is the number of pairs // occurring in the genome, then the number of pairs |/ in the genome equals n - j - k. The probability that a particular individual will appear in the progeny population equals $1/2^{j+k+n}$.

Next we come to the zygote matrix of Cross V for n = 2.

<table>
<tr><th></th><th>[|, |]</th><th>[|, /]</th><th>[/, |]</th><th>[/, /]</th></tr>
<tr><td>[|, |]</td><td>[||, ||]</td><td>[||, |/]</td><td>[|/, ||]</td><td>[|/, |/]</td></tr>
<tr><td>[|, /]</td><td>[||, |/]</td><td>[||, //]</td><td>[|/, |/]</td><td>[|/, //]</td></tr>
<tr><td>[/, |]</td><td>[|/, ||]</td><td>[|/, |/]</td><td>[//, ||]</td><td>[//, |/]</td></tr>
<tr><td>[/, /]</td><td>[|/, |/]</td><td>[|/, //]</td><td>[//, |/]</td><td>[//, //]</td></tr>
</table>

The Cross V – zygote matrix for arbitrary n extends again in both directions and does not change when it is reflected on ist diagonal.

Cross VI: Simple primary hybrid [|/, |/,...] with a different simple primary hybrid that shares a species parent [|\, |\,...], for n pairs of chromosomes

Result: If the common parent has chromosome pairs ||, then the chromosome pairs in the simple primary hybrids can be written as |/ and |\, respectively. This means that the chromosome pairs in the genotype of the progeny are ||, |/, |\, or Λ. Again, each genotype is uniquely determined by listing the position of the pairs ||, the pairs |/, and the pairs |\ in it.

The zygote matrix of Cross VI for n = 2 looks like this.

<table>
<tr><th></th><th>[|, |]</th><th>[|, /]</th><th>[/, |]</th><th>[/, /]</th></tr>
<tr><td>[|, |]</td><td>[||, ||]</td><td>[||, |/]</td><td>[|/, ||]</td><td>[|/, |/]</td></tr>
<tr><td>[|, \ ]</td><td>[||, |\ ]</td><td>[||, Λ]</td><td>[|/, |\ ]</td><td>[|/, Λ]</td></tr>
<tr><td>[\, |]</td><td>[|\, ||]</td><td>[|\, |/]</td><td>[Λ, ||]</td><td>[Λ, |/]</td></tr>
<tr><td>[\, \ ]</td><td>[|\, |\ ]</td><td>[|\, Λ]</td><td>[Λ, |\ ]</td><td>[Λ, Λ]</td></tr>
</table>

The Cross VI – zygote matrix for arbitrary n extends in both directions and it contains the genotype of the common species.

Cross VII: Simple primary hybrid [|/, |/,...] with a different simple primary hybrid [\?, \?,...] that does <u>not</u> share a species parent, for n pairs of chromosomes

Result: If the chromosome pairs of the four species parents are ||, //, \\, ??, then the chromosome pairs in the genome of the progeny's cultivars are |\, |?, Λ, and /?. Each individual will appear in the progeny with the same probability of $1/4^{n}$. None of the progeny is a species.

And now the zygote matrix of Cross VII for n = 2.

<table>
<tr><td></td><td>[|, |]</td><td>[|, /]</td><td>[/, |]</td><td>[/, /]</td></tr>
<tr><td>[\, \ ]</td><td>[|\, |\ ]</td><td>[|\, /\ ]</td><td>[/\, |\ ]</td><td>[/\, /\ ]</td></tr>
<tr><td>[\,?]</td><td>[|\, |?]</td><td>[|\, /?]</td><td>[/\, |?]</td><td>[/\, /?]</td></tr>
<tr><td>[?,\ ]</td><td>[|?, |\ ]</td><td>[|?, /\ ]</td><td>[/?, |\ ]</td><td>[/?, /\ ]</td></tr>
<tr><td>[?,?]</td><td>[|?, |?]</td><td>[|?, /?]</td><td>[/?, |?]</td><td>[/?, /?]</td></tr>
</table>

The Cross VII –zygote matrix for arbitrary n have 4^n distinct entries, just as the above zygote matrix of Cross VII for n = 2 has 16 distinct entries.

It should be emphasized that for diploids with n chromosome pairs there are many more types of crosses than Cross I through Cross VII. This is due to the existence of highly complex hybrids.

[1] To get an idea of what 2^n is for various values of n: a plant with 10 pairs of chromosomes produces about 1,000 possible genotypes; a plant with 20 pairs results in about 1,000,000 possible genotypes; a plant with 30 pairs results in about 1,000,000,000 (one billion) possible progeny genotypes; and a plant with 40 pairs produces about 1,000,000,000,000 (one trillion) possible genotypes. Recall that the most common orchid chromosome numbers are 28, 38, and 42.

Report on The Odontoglossum Alliance Meeting 12 April 2002

The Odontoglossum Alliance meeting for 2002 was held in Northbrook, Illinois in conjunction with the Illinois Orchid Show and AOS trustees meeting. The meeting was held the afternoon of Friday, 12 April. There were four speakers, Larry Sanford, Norris Williams, Stig Dalström and Milton Carpenter. There was ample attendance with about 40-50 attendees who enjoyed the talks.

Larry Sanford

Some Cultural and Spike Observations for Odonts and Some Warmer Growing Intergenerics in the Ohio Valley

Larry's talk along with a selection of his slides is included in this newsletter

Professor Norris Williams

University of Florida

Molecular Systematics (DNA) of the Odontoglossum Alliance

A synopsis of Professor Williams talk along with a selection of his visual material will be printed in a subsequent newsletter.

Stig Dalström

When One and One Becomes Three, At Least

Stig Dalström talk concerned the confusion existing between taxonomists Eric Christensen and himself over a number of orchid species. Stig has promised to provide a written version of his talk for a future newsletter.

Milton Carpenter

Everglades Orchids, Belle Glade, Florida

Milton has been a pioneer in the development of warmer growing hybrids of the Odontoglossum alliance. He showed a numbered of beautiful hybrids he has produced. He has provided slides of some of these and they will be printed in future newsletters.

The evening dinner was held at Froggy's, a fine French restaurant and attended by 27 people including all our speakers as guests of the Alliance. The food and service, as commented by a number of people, was excellent. Following the dinner, Russ Vernon was our able auctioneer. He was assisted by Mario Ferrusi and Bob Hamilton. (This did not stop them from bidding on the numerous plants and two watercolor prints done by Nellie Roberts.) We had quite a few contributions of some very early alliance hybrids, several of them made in the period before 1910. It is to their growing and survivability that they are still around. It is hoped that the lucky winners of those plants will at some future time, offer divisions for another Alliance auction. The results of the auction is the bank account is now $1273 better off. We covered with that the expenses of the meeting. Hats off to Sue Golan who was our 'on the scene' contact and organizer. When it looked like the dinner might be sparsely attended she rounded up some friends who willingly attended and did some bidding at the auction.

We might have had better attendance at the lectures and dinner if we had done a few things different. First the talks given by our speakers need to be advertised as being open and welcome to registrants at the show. Second we should have had advertising in the registration material of the Alliance dinner. It should have been possible for registrants to pay for the dinner as part of the registration material. Finally we should have had the registration material mailed to our complete membership list. While we described the meeting in our newsletter, you had to request registration material from Illinois. In the future we will try to correct all these items and improve our communication. Next year, 2003, we will have our meeting in Hawaii and you can expect to see it happen there.

Purchase of Odontoglossum Art Works

The Odontoglossum Alliance purchased a collection of Odontoglossum art works from Bruce Cobbledick. Bruce was the first President of the Odontoglossum Alliance but subsequently decided to quite the orchid growing business and hobby. While we miss Bruce and wish he would return to growing, we were pleased to obtain his collection of Odontoglossum art works for a price of $735.00. It is the intention of the Alliance to offer at our auction a few of these each year. Two items were offered at auction at the most recent Odontoglossum Alliance dinner and meeting in Illinois. Listed below are the art works.

Odm. Britomartis 'Glorimundi': painting Artist: MIG 10" x 12" framed
Odm. Clonius Rex: painting Artist: Nellie Roberts 10" x12" framed
Odm. Isolene: painting Artist: MIG 10" x12" framed
Oda. Melina 'Alpha': painting Artist MIG 10" x 12" framed
Odm. Purple Queen 'Eileen' AM-RHS 1934 painting Artist Nellie Roberts 10" x 12" framed.
Odm. Grethus: painting Artist: Nellie Roberts 6.5" x 8" Stuart Low Collection
Odm. Crispum Starlight type painting Artist Alphonse Goosons? 7" x 6.5" Stuart Low Collection
Odm. Gloriette painting 1929: Artist Alphonse Goosons 6" x 8.5" Stuart Low Collection
Odm. Princess Yolande painting: Artist Alphonse Goosons 6" x 8.5" Stuart Low Collection
Odm. Lillian painting: Artist Alphonse Goosons 7" x 10" Stuart Low Collection
Odm. Verulanium Painting: Artist Nellie Roberts 7.5" x 10.5"
Oda, Cordor painting: Artist E. Chard 7.5" x 10.5"
Oda. Breweii 'Viscount Kitchner' FCC/RHS 1917 Artist F. Bolas 9" x 11.5"
Oda. Scarlet Pimpernel painting: Artist Nellie Roberts 7.5" x 10.5"
Odm. Crispum 'Pittiana' painting: Artist Nellie Roberts 7.5" x 10.5" Stuart Low Collection
Oda. Charlesworthii 'Marfield' FCC/RHS 1915 painting: Artist W. Williamson 9" x 11.5" (has crease)
Litho of 5 Vuylsteke's Odonts from Revue Horticole 8" x 11"
Oda. Viscount Lascelles FCC/RHS painting: Unsigned colored lithograph reproduction from P. Petit. 12" x 15"

The next Odontoglossum Alliance meeting will be held in Hilo, Hawaii 22-25 March 2003. The program is in the planning stage at this time. We plan to offer at our regular auction of fine Odontoglossum Alliance material a few of these art works. The auction of two of these paintings at the Illinois meeting produced some very spirited bidding. We will be announcing which ones will be offered for auction as we progress through our planning for the meeting.

Dues Notice

Enclosed with this May issue of The Odontoglossum Alliance Newsletter is the notice for payment of dues. Please note your current status of dues as the Date Paid through. If you are paid through 05/02 you need to send in your dues payment promptly. I urge you to send it in before 1 August 2002. While we have sent reminders in the past, this is time consuming and expensive for your editor. I remind you I am a one-man band here doing this newsletter and dues collection. Please help by cooperating and sending in your payment. If you are paid through 05/03 or later, NO payment is required.

Election of Directors

The terms of three (3) or our Directors expire this year. They are Helmut Rohrl, Chairman, Howard Liebman, and Robert Hamilton. All three have re-nominated to become Directors with terms ending in 2005. On he reverse side of your dues notice is an ability to vote for these nominees or to write in nominees of your choice. Ballots will be counted until 1 August 2002. Results of the election will be announced in the August 2002 Odontoglossum Alliance Newsletter.

Some Cultural and Spike Observations for Odonts and Some Warmer Growing Intergenerics in the Ohio Valley

By Larry Sanford

Introduction

I am flattered and pleased to share my Cultural Observations and Spike Observations with Odonts and some Warmer growing intergenerics in the Ohio valley. For serious Odont growers, much of this will not be new, but it is my hope that in spite of some amateurish photography, it is presented in a memorable manner

For context, my greenhouse is a lean-to on the east side of my house; it has a cool section for Odonts, Sophronitis and Masdevallia and Lycastes and some Cattleya alliance (Figure 1). Each section is about 8' x 15'.

I grow in paper pots with 60% coarse peat, the balance equal parts sponge rock and charcoal, RO water with a conductivity of about 500 microseimens with 3/1/2 fertilizer, "kick start" with HP sodium light every morning at 800-1000footcandles for 2-3 hours (Figure 2), sufficient air movement to require daily misting or watering (most leaves are in movement). In summer 2001, I targeted for 76-82 F° day@ 2000 foot candles through Aluminet shading and Kool Cell evaporative cooling and 54-58 F° night via refrigeration (closed greenhouse vents) and intermittent fogging.

Like many engineers I have a tendency to measure whether I understand what I'm measuring or not. For example I grade each flowering on a 5-10 scale and "keepers" must score 8 or better unless there is some unusual feature. However, I seldom discard on the first bloom.

My basic culture objective is to have fat healthy pseudobulbs and with 75% of the plants with double leads (Figue 3). My spike objectives are good color, shape flowers well spaced and presented. Since the greenhouse is small, I can provide Optimum Growing Conditions *if I really knew what they are.*

What follows is a limited search for optimum growing conditions in the Ohio Valley. At the end, I will very much welcome comments that lead to better understanding of why and be most appreciative of any perspectives on Esser's scientific work of the 70's with Oda Lipperstadt that both Leonore Bockemühl and Carl Withner cite.

I Pseudobulb Growth Observations:

Over the years, I have had sporadic Excellent Growth and Flowering. As cooling capability was added, 'Odont' culture improved. Esser's study indicates maximum temperatures of 72-77 F° and optimum light levels of 1000 foot candles (Figure 4). Yet most growers recommend significantly higher light levels and Bockemühl indicates full morning sun in her habitat descriptions. In Cincinnati, "morning sun" ranges 4000-9000 foot candles. Further, in summer 2000 several high crispum Odonts prospered outside with morning sun and shaded noon onward. Additionally, several Australian cymbidium growers reported success with night watering to keep nighttime temperatures down, and early studies reported that Odonts and Cymbidiums have similar carbon cycles.

To test, three set of reasonably matched trays containing a group of two plants of high (78%) cool growing Odont parentage (Wildcat definition) and a second group of three plants of 25-44% Brassia/Aspasia with only 30-45% cool Odont parentage were repotted and weighed after drying out (Figure 5). One placed inside the cool greenhouse and watered or misted as conditions indicate. Two outside trays, each watered daily, one at normal morning watering and the other early evening. After 86 days each tray was again weighed after drying out and weight gain calculated. The weight gain results are shown in the following Table 1

Table 1

Percentage Weight Gain as Measure of Growth for inside and outside trays (86 days, 5 plants)

Tray	Percent weight gain
Inside cool greenhouse Control	56%
Outside:	
Morning watering	48%
Evening watering	21%

Outside Cultural Conditions:

Day 75-90 F° @ 2000-7000 foot candles AM only, daily watering

Night 65-72 F° but about 50 nights wet bulb temperature greater than 70 F°

This data indicates that the inside cool tray had slightly better weight gain (as percentage) than morning watering outside and much better than outside evening watering. But this is misleading as shown in a comparison of inside and outside growth of high Brassia group (Figure 6) The inside plant on the left shows good growth, but the outside sibling plant on the right demonstrates the kind of growth I seek, so a closer look of the two groups is more revealing as shown in Table 2 where each plant group is subjectively graded for each inside and outside tray.

Table 2

Pseudobulb and growth Subjective Growth Grade average in each tray for high cool growing percentage and high Brs/Asp. Parentage for each tray reported in Table 1

	Group 1* 78% known Cool	Group 2** 45% cool 33% Brs/Asp
Inside Control	7.5	8
Outside:		
Morning watering	6	9
Evening watering	6	8

* Group 1 plants: Odm. Bruce Cobbledick, Oda. Bonne Nuit –78% known Cool by Wildcat
**Group 2 plants: Alex. Amy's Gold, Rcfta. Mem. Jim Asher, Wgfa Cassetta x Odm Coupe Point 45% cool 33% Brs/Asp intermediate/warm crosses based on Mclna and Wgfa.

Outside growth for all plants during the month of June was good but as the 2001 Summer bulb continued, July and August had n excessive numer of high wet bulb temperature nights (about 50 nights of >70 F° wet bulb temperature). The high cool Group1 suffered badly outside with smaller leads and shriveled older pseudobulbs, i.e. only one of four mature blooming size plants subsequently flowered with flowers mini-sized and low count. By contrast, the Group 2 plants (high Brassia/Aspasia) prospered outside growing strong pseudobulbs and 4 of 6 subsequently flowering for the first time. (This included all of the plants watered in the evening- apparently some stress can trigger flowering).

In October, all Odonts in the cool greenhouse experienced a growth surge as the day temperatures dropped into the mid 60's F° except those shriveled by outside summer heat

II Spike Observations:

Spike growth rate Measurements:

Six mixed "Odontoglossums" spikes were measured morning and evening at two light levels in the cool greenhouse. The results are summarized in the following:

	1300 Foot Candles	3000 Foot candles
Day 78-82 F° greenhouse/spike	0.88 mm/hour	0.56 mm/hour
Night 52 F° greenhouse/spike	0.45 mm/hour	0.43 mm/hour
Cumulative 3-day growth/6 spikes	286 mm	254 mm

Winter 58-65 F°, 3 day/6spikes <u>but different plants:</u> 220 mm

Application of spike measurement data:

I have a very nice Odcdm. Tiger Parade with good shape and color that is crowded. Could the spacing be improved by keeping the spike tip in relative darkness? Normal good growth shows a branching spike 83 cm tall with 33 flowers. (Figure 7). Relative darkness was provided at the spike tip by a partially collapsed paper tube suspended over the spike tip and raised as the spike grew. The spike on this flowering attained 93 cm with 28 flowers and (Figure 8) shows a modest reduction in crowding.

Seasonal Flower Color and Shape Variation:
In fall 1999, the lead bulb of an Oda. Bryce Canyon had two spikes one maturing in mid September, the other in mid November. The first spike had flowers that were small, variable form. Light colors, which faded badly. In fact, it was so disappointing, that I trash canned the plant several times- but curiosity about the later spike developing in cooler weather proved to be the right choice. The second spike from the same pseudobulbs was of good shape and substance and a deep non-fading color and received an HCC at a late November show.

When Odm. Mont Fallu was awarded at a late spring show the award slide (Figure 9) indicates a flat flower with very dark raspberry markings with some bleeding on lateral sepals. As shown next, (Figure 10) the next flowering, now in July the following year, the flowers are smaller, cupped and the markings are now carmine without any blush.

Finally, an awarded Odm. Augres flowering in July (Figure 11) and the same plant flowering under cooler conditions with lower flower count but better shape and size. (Figure 12)

A few plants of past and future successes and then onto conclusions and future plans: The earlier awards were limited to the warmer intergenerics: Mclna Pagan Love Song, Wgfa. Cassetta, Sand. Saint Helier and others, as more cooling capability was slowly added, the traditional "Odonts" increasingly succeeded: Oda. Mont Ube, pescatoria, Wils.Lisa Devos and Onc. macranthum and most recently, Oda. Joe's Drum .

The future includes Oda. Burning Bed (which has incredible substance as well as color), Oda.Victoria Village, Odm. Crispum, and Alex. Amy's Gold named for my granddaughter.

Conclusions:
With extended hot weather, high Brassia and Aspasia parentage hybrids thrive outside with direct morning sun and shaded or dappled afternoon. In contrast, high % cool 'Odont' parentage suffer severe shriveling and set-back living on reserves under temperatures excessive by conventional "Odont" wisdom.
Modest spike elongation maybe achieved under some lower light conditions which may be used to slight advantage with crowded spikes
Since cooler growing conditions often produce better shape and colors, for high % cool parentage plants avoid hot weather flowering by removing spike and let the plant save the energy for the next cooler spike.

Future Plans:
Mimic Bockemühl's observed seasonal temperature variation as much as possible in the cool greenhouse:

	Oct-Feb	March-May	June-September
Day	61 F°	64 F°	68-72 F° @ 1300 foot candles
Night	54 F°	59 F°	>49 F° @ 90% Humidity

Summer 2002 will see more Brassia Aspasia hybrids outside enjoying direct morning sum before returning to the intermediate greenhouse.
Continue a modest search for more readily attainable cool growing conditions with perhaps morning and night watering or misting of Odonts in fine fir in paper pots or sphagnum in net pots in the intermediate greenhouse using only cool cell and shade.

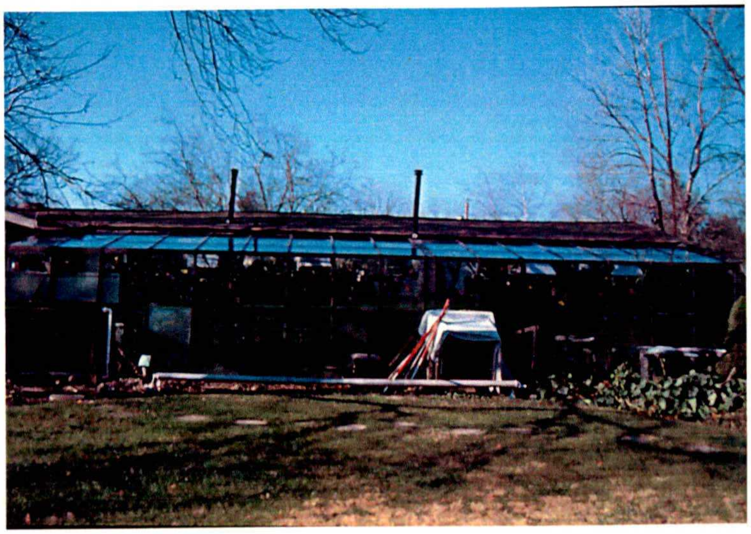


Fig. 1. Lean-to greenhouse

Fig. 2 HP Sodium Lights

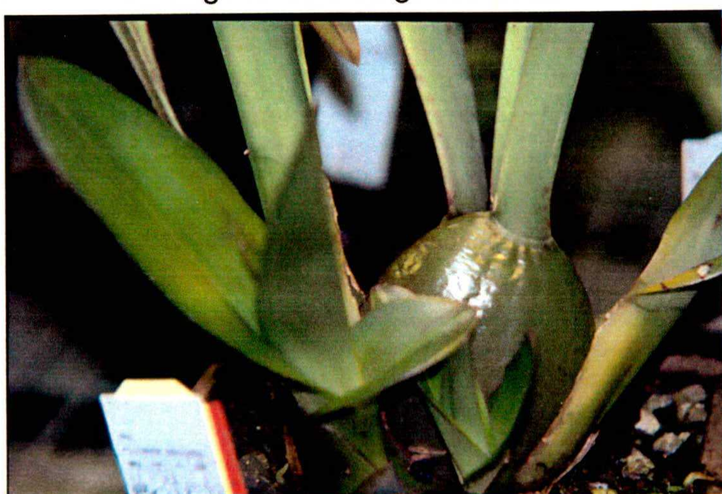


Fig. 3 Psuedobulb Growth

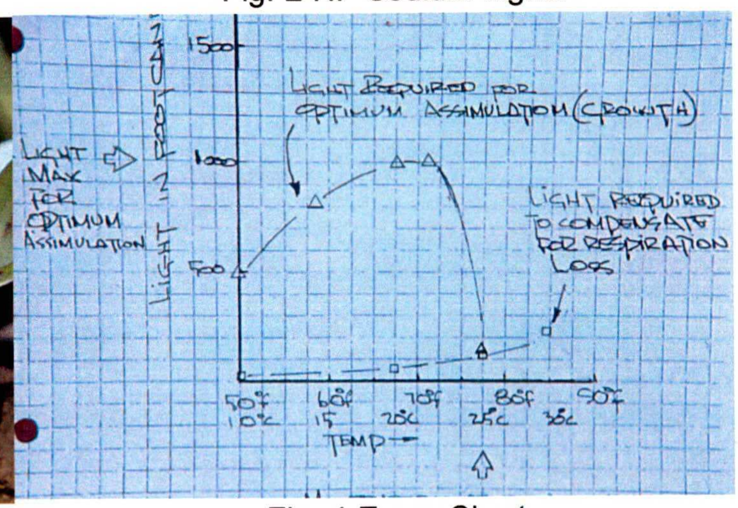


Fig. 4 Esser Chart

Fig. 5 Brassia Group

Fig 6 Inside-Outside Plants

Fig. 7 Odcdm. Tiger Parade

Figure 8 Odcdm. Tiger Parade

Fig. 9 Odm. Mont Falu HCC/AOS

Figure 10 Spring Flowering
Mont Falu HCC/AOS

Fig. 11 Odm. Augres
July Flowering

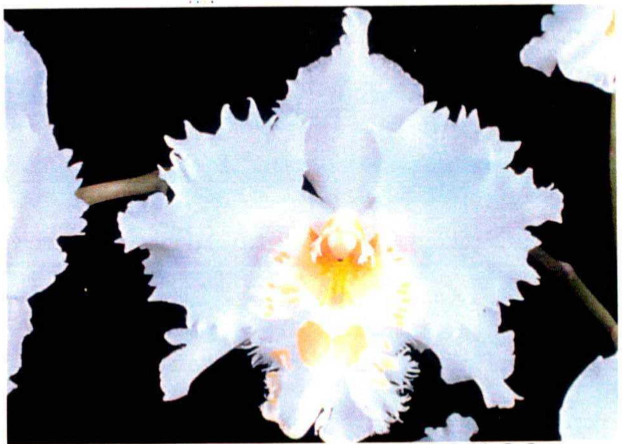


Fig. 12 Odm. Augres HCC/AOS
Cool growing