

I shall speak about the following principal points:

- •Some general remarks on my hybridizing program
- •Why are crosses of standard daffodils and species of special interest?
- •Chromosomes of daffofils and fertility
- •Crosses of different species with standard daffodils



The seeds are collected in June: This year about 10000 seed grains only, in the last 10 years in most cases about 20000. My garden is situated in clima zone 8 with mean maximum and minimum temperatures in January of 4,5/0,2 degrees C. The lowest temperatures in winter can go down to - 14 degrees C. Sowing seeds outdoors is possible, but since 1996, the year I began to cross standard daffodils with species, I sow in heated seed beds. The temperature stays few grades above the freezing point. The seed beds are heated only during the first winter.



The heaters are made from rods of wood with isolated copper wires. The wooden construction rots in the ground which can harm the little bulbs. Therefore I shall use plastic instead of wood in the future.





The seeds are sown in August or September protected by a fungicid and very tight together, because I have only a limited area .The seedlings stay there for three years.



The seed beds are covered with a construction of boards and polycarbonate plates.



For three years the seedlings remain in the seed beds. In the fourth year they are replanted. The first seedlings flower after five years. They stay in the field till they are seven years old. Afterwards they are killed by a herbicide or dug out and given away. The selected seedlings are planted seperately and are observed for three to five years.



In the very best case you get 20 bulbs from a clone of a selected seedling 10 years after sowing. If you want a higher bulb propagation you can use different methods. For example you cut the bulb into 32 pieces each with a part of the base plate and weighing about 1 g. The cutted segments are stored for 3 months at 20 degrees C and develop little bulbs. Three years later the plants come to flower.



There are many excellent standard daffodils which become still better from year to year for crosses with species.



The crosses of standard daffodils with species are in most cases infertile. This is a problem, if you intend to make further crosses. Therefore we must have a short look on the genetics of daffodils.

Plant cells of most daffodil species contain 14 chromosomes, one chromosome set of 7 from the mother and one chromosome set of 7 from the father. To held the number of 14 constant for the next generations it must be halfed for the pollen and egg cells. The process is called reduction division. The functioning of this process is the precondition for fertility.

During the reduction division the chromosomes are combined in a new manner and parts of the homologous chromosomes of the mother and the father are exchanged by `crossing over'. The real process is much more complicated than shown in the simple schematic picture.



In the left picture of the first line you see seven pairs of chromosomes one of these pairs from the mother and one from the father.The petunia hybrid is diploid and each of the two chromosome sets has seven chromosomes as have most daffodil species. In the second picture the pairs divide; each different chromosome from one pair can go upwards or downwards. In the first picture of the second line the division is completed.The number of the chromosomes is reduced from fourteen to seven. A second division begins:Each chromosome builds two equal parts and in the following process four cells develop which grow up to four pollen grains. (The pictures are made by H. Rode).



Most standard daffodils are tetraploid. That means their plant cells contain four chromosome sets of seven chromosomes. They are in most cases fertile because the number of four chromosome sets can be halfed to two chromosome sets for egg cells and pollen.



Hillstar arose by crossing Daydream as a seed parents with N. jonquilla as the pollen parent. The jonquilla pollen grain was unreduced. The plant cell contains two chromosome sets of Daydream (red) and two chromosome sets of N. jonquilla (black), overall four chromosome sets.



If you cross a tetraploid standard daffodil with a diploid species you get plant cells which have two chromosome sets from the standard daffodil and one chromosome set from the species. There is no possibility for halfing the three chromosome sets to get pollen and egg cells and therefore the plants are infertile. Sometimes a reduction division takes place by dividing the two chromosome sets of the standard daffodil and adding the one of the species to form NX- gametes, and in fewer cases you get unreduced pollen and egg cells NNX. That means the gametes have the same number of chomosome as the plant cell. The few fertile gametes are very important for further crosses.



Here you have three different chromosome sets. The chance to get some fertile pollen grains is very low. I got thousands of this type of seedlings and found one fertile plant which produced some unreduced pollen grains. The chances are better for triploid plant cells with two different chromosome sets as in the picture before or with one type of chromosomes only.



To sprout pollen is possible in a sugar solution with some additives. Under the microscope this can be observed. The pollen diameters are about 0,02 to 0,06 mm. The pollen volume of Actaea with two chromosome sets is twice the volume of N. poeticus with one chromosome set. The volume of N. cordubensis pollen is the smallest. The volume of Altruist x N. cordubensis is the sum of the volumes of N. poeticus and N. cordubensis. Or with other words: From the volume of the pollen the chromosomal constitution of the pollen can be determined.



There are clones of N. cordubensis from the Sierra de Grazalema with very nice flowers. I can grow this species outdoors. Crosses of standard daffodils with this species are no problem.





Perhaps 5 to 10 percent of the crosses of standard daffodils with N. cordubensis generate some fertile pollen. If the fertile plant as for example the seedling of Trigonometry x N. cordubensis has a split corona it can be crossed with different other daffodils and a great part of the seedlings too has a split corona. The pollen of Trigonometry x N. cordubensis has one chromosome set of Trigonometry and one of N. cordubensis. Seedlings with many flowers per stem and a split corona can be produced.



All these seedlings have some viable pollen.



This is N. fernandesii from the Sierra Madrona. It belongs to the jonquilla section and is smaller than N. jonquilla. It can be crossed with many standard daffodils and some seedlings, perhaps 5 percent, are pollen fertile.



Altruist x N. fernandesii1

TS 126 x N. fernandesii



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TS 126 is a 2 W-W.



All these seedlings generate some viable NF – pollen. TS 35 is a 2 W-O.



As you know, the clones of one species you find in the wild can be very different. For crosses I choose the pollen from plants with the best flowers and good bulb reproduction. N. assoanus grows from the south of France to the south of Spain. Perhaps a distance of nearly 1000 kilometers. The same species is very different from site to site. The picture on the upper left side is made in the mountains not far from Ejulve. On the lower left side you see N. assoanus from Grazalema and on the right side from near the coast not far from Alcossebre.

Crosses of standard daffodils with assoanus are possible but no so easy as crosses with N. cordubensis and N. fernandesii. They are of special interest if you intend to get little seedlings with small flowers.



TS 108 is a 3 W-R.



TS 124 x N. assoanus develops some fertile pollen grains which have one chromosome set from the standard daffodil and one from N. assoanus. I have 3 years old seedlings of this plant crossed with Regeneration. The pollen grains do successful work not only under the microscope but too on the egg cell. TS 124 is a 2 W-W.

In this group you find not so many pollen fertile plants as in the groups already shown.



Sidley is a 3 W-GYY intermediate. The seed set for crosses with N. assoanus is good and the seedlings are often little plants with flowers of a diameter a little lower than 50 mm.



It is a good idea to use especially the very little N. scaberulus and N. gaditanus for crosses with standard daffodils, but ist seems to be not easy. Till now I found nearly no standard daffodils which set seed with the species in the pictures. An exception are the fertile jonguilla hybrids for example Regeneration from which I have seedlings with N. calcicola, N. scaberulus and N. watieri. They have not yet flowered.



The bulbs of triandrus live for few years only and show no bulb reproduction. Therefore it is useful to make crosses with other species or standard daffodils to get varieties which grow better. Many crosses have been made by other hybridizers especially with the white N. triandrus triandrus. N. triandrus pallidulus and N. triandrus concolor have been used much less.



Most standard daffodils of the NNNN-type are fertile with N. triandrus. Perhaps 5 % of the seedlings show some sprouting pollen under the microscope.



Crosses of N. triandrus pallidulus with fertile jonquilla hybrids as for example Hillstar are easy to make. The seedlings have good vitality and grow well in Germany, but I found no fertile flower under thousands of plants. The only possibility for the daffodil to become fertile is to generate unreduced pollen (NJT) which obviously occurs very seldom.



Some seedlings of the cross were selected. One of them grows in the field of Arno Kroon in Holland.



The chromosome composition of the viridiflorus hybrid 'Emerald Sea' of John Hunter is similar as for jonquilla hybrids. Both have two chromosome sets of standard daffodils and two of the species and are fertile. Species which can be combined with jonquilla hybrids set seeds with viridiflorus hybrids too. But the seedlings don't stand the frosty winters in Germany.



There are many different yellow bulbocodiums. They are diploid , tetraploid and hexaploid. I think the bulbocodiums from the Sierra Madrona in the picture are diploid.



Crosses of standard daffodils (NNNN) with the bulbocodium from the Sierra Madrona are very seldom successful, whereas crosses with fertile jonquilla hybrids (NNJJ) as for example Hillstar are no problem.





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Hillstar x N.
bulbocodium seedlings
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N. hedraeanthus is one of the smallest species. In the pictures you see an especially nice typpe from the Sierra Morena which sometimes is called N. hedraeanthus luteolentus.



To succeed with crosses of standard daffodils and N. hedraenthus is very seldom. This is a fertile seedling with unreduced pollen (NNH). Backcrossed with the species it gives NNHH which is fertile and would be the first of this group. Some of these seedlings I have in the pipeline.



Here too the combination with the fertile jonquilla hybrids is easy. The seedlings are small and grow well.



In the picture on the left you see six years old seedlings. The selected seedling on the right is not suitable for show, but shall be tested for cultivation as a pot plant in the Netherlands. In the best case it will become a successor of Tête á Tête.



The selected seedling shown already in the previous picture.



This diploid form of N. cantabricus can easily be combined with standard daffodils, jonquilla- and viridiflorus – hybrids. This is not possible for the tetraploid cantabricus species from Morocco.



Here you see two seedlings of Broomhill pollinated with N. cantabricus from the Sierra Calatrava. Broomhill is an older but well growing 2 W-W.



Most seedlings are white with different forms. I generated only one with a little red in the cup which lives no more in the real world, but only as a picture on the hard disc. TS 126 is a 2 W-W. I found few fertile seedlings of this type of crosses only.



TS 411 is a is a fertile jonquilla hybrid in white, smaller than Limequilla.





Silver Bells, a triandrus hybrid, which should be infertile because it is triploid develops same fertile egg cells and pollen wih one chromosome set of standard daffodils and one of jonquilla. It can be crossed with N. cantabricus from Spain. Under the triploid seedlings with three different types of chromosomes I found no fertile plant.



This seedling is triploid with three different chromosome sets from a standard daffofil N. viridiflorus and N. cantabricus. It develops some unreduced viable pollen. This is the only seedling from thousands with three different chromosome sets which is fertile. It is grown in the greenhouse.



The flowers of N. cyclamineus have a stove pipe corona or a flanged corona. Many nice crosses with standard daffodils are on the market. A few of these triploids are fertile.



Crosses of N. cyclamineus with fertile jonquilla hybrids are no problem. The seedlings of the upper pictures show excellent vitality und bulb reproduction.



This N. tazetta I can be grown outdoors in my field. It doesn't need high temperatures to set seed which is produced freely by open pollination.



I found only few standard daffodils which set seed pollinated by this tazetta. But from these seedlings perhaps 20 % have some pollen fertile pollen. Crosses with existing fertile tazetta hybrids as for example Matador should be of great interest.



Loch Coire is one of the standard daffodils which sets seeds with N. tazetta; Ufo, Actaea and Symptom are the others. I try to find more seed parents, especially white pinks; perhaps the seed setting is better in warmer climates.



N. elegans is an autumn flowering tazetta. The possibility for crossings with standard daffodils should be similar as for N. tazetta. I tried it, but I have no reliable results till now. The seed set which I saw can be from open pollination.



N. dubius is a very successful pollinator for standard daffodils. There are very nice seedlings from Harold Koopowitz and Brian Duncan. Some of these seedlings have fertile pollen. I found two till now. Harold Koopowitz has some seed fertile plants too. N. dubius is a natural cross of N. assoanus with N. papyraceus which took place long ago. It has four chromosome sets of N. assoanus and two of N. papyraceus.



The seedlings can grow outdoors in Germany. The leafs come up very early and are often a little damaged by frost.



This is the first seedling from pollen of a fertile standard x dubius seedling on Hillstar which flowered this year for the first time. TS 175 is a 2 W-O.



N. tortifolius is a nice little tazetta species with two chromosome sets of N. assoanus and two of N. papyraceus. It has developed in former times from a natural cross between N. assoanus and N. papyraceus.



Very few standard daffodils only can be combined with N. tortifolius. The seedlings need a long time to flower.



In southern Spain and Morocco species of N. papyraceus can be found. N. pannizianus is similar, but more sturdy. It can grow outdoors.



I found only Pontresina, a 2 W-Y, as a seed parent for N. pannazianus. Some of the seedlings are pollen fertile and have a yellow colour of the flower.



N. viridiflorus is an autumn flowering daffodil which lives in the extreme south of Spain and in Morocco. It is tetraploid and interbred with standard daffodils you get fertile NNVV plants.



This is an extremely impressive picture with a nice viridiflorus hybrid. January is no good time for flowering outdoors in Germany. Therefore I dug it out and took it to my greenhouse, where it flowered the next day.



This is the flower of the seedling in the field. Ballygowan is a 3 W-YYR.



I began crossing with N. viridiflorus in 2003 at a time when John Hunter and Bob Spotts used seedlings of the second generation. But I think there are many different good standard daffodils which wait for beeing crossed. The seed set for me is not so good. The seedlings often need seven or eight years to flower in Germany but the remaining seedlings normally stand coldness and frost.



In mixing N. miniatus, an autumn flowering species, with standard daffodils I was not really successful. I got one seedling from Actaea. N. cavanillesii, an autumn flowering species too, can be combined with the fertile jonquilla hybrids as for example Regeneration. I tried it in 2010.