

The role of the ‘Suthasinobon’ complex in introgressive hybridization

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ABSTRACT

Introgressive hybridization or introgression is the transfer of gene between two distinct species by the production of viable fertile hybrids. ‘Suthasinobon’ is an introduced day-blooming waterlily identified as *Nymphaea capensis* var. *zanzibariensis*. Together with its selections and hybrids, they are known as ‘Suthasinobon’ complex. Both ‘Suthasinobon’ and its complex are beautiful, aggressive plants and are popular among Thai waterlily growers. They hybridize readily with other *Nymphaea* species in the subgenus *Brachyceras*, including the only native day-blooming species, *Nymphaea nouchali*, known in Thai as ‘Bua Phan’ and ‘Bua Phuean’ which are two forms of *N. nouchali*, and ‘Bua Khap’ - *N. nouchali* var. *cyanea*. Evidences of introgression involving ‘Suthasinobon’ complex have been accumulated in the present study. The consequences of introgression are the breakdown of reproductive isolation, the loss of Thai native species of day-blooming waterlily, and the predominance of mongrels of partially hybrid ancestry closely resemble ‘Suthasinobon’ parent.

What is introgressive hybridization?

Generally, the hybrid individuals produced through interspecific hybridization are sterile, have low viability and soon disappear. This is because gene flow is not expected between two distinct species. However, sometimes the hybrids are apparently normal in every respect, are fertile, and can interbreed with members of both parental species and with other hybrids. In this case, the hybrids may form a genetic bridge through which gene flow can occur between two species. Such process is known as introgressive hybridization or introgression.

Introgressive hybridization is defined as “the transfer of genetic material between two distinct species by the production of fertile viable hybrids and subsequent mating of hybrids with members of the parental species” (Anderson, 1941).

‘Suthasinobon’ and its complex

The history of ‘Suthasinobon’

Accompanying His Majesty King Chulalongkorn (Rama V) to Indonesia in 1897, Her Royal Highness Princess Suthasiminat brought back from Bogor Botanical Garden a day-blooming waterlily plant with blue color. Not long after its

introduction, this plant grew luxuriantly in Thailand condition. In 1957, Kasin Suwatabant, a well-known Thai taxonomist gave it the name of 'Suthasinobon' in honor of the person who introduced it. Since then, 'Suthasinobon' has become popular among Thai waterlily growers (Chomchalow, 2005).

Characteristics of 'Suthasinobon'

'Suthasinobon' is classified as *Nymphaea capensis* var. *zanzibariensis*. It is native to Zanzibar in Tankanyika of South Africa. It is a day-blooming, non-viviparous, very free flowering. Its flowers are quite large, 18–25 cm, and held 20–25 cm above water. The leaf is green on top and underside, nearly round, dentate, serrated, 25–40 cm in size and spread over 1.5–2.4 m; its sinus is usually closed, or partly open. The stem is green. There is no pubescence on peduncle or petiole (Slocum, 2004)

It has two color variants, blue and pink (Fig. 1). The seedlings from a single pod can even display a range of color. The followings are cultivars derived from selections of 'Suthasinobon': 'Azurea', 'Castaliflora', 'Hanry Shaw', 'King of the Blues', 'Purple Zanzibar', 'Jupiter', 'Red Beauty', 'Rosea' and 'Rubra'.

Hybrids of 'Suthasinobon'

'Suthasinobon' hybridizes readily with

other *Nymphaea* species of the *Brachyceras* subgenus. The hybrids show much variation in flower size and color. Many hybrid cultivars have been produced, e.g.:

N. Blue Ampla = *N. ampla* x *N. capensis* var. *zanzibariensis* (infertile?)

N. Blue Beauty = *N. caerulea* x *N. capensis* var. *zanzibariensis*

N. Blue Spider = *N. capensis* var. *zanzibariensis* x unknown

N. Lone Star = *N. ampla* x *N. capensis* var. *zanzibariensis* (infertile)

N. Midnight = *N. colorata* x *N. capensis* var. *zanzibariensis*

N. Ron G. Landon = *N. ampla* x *N. capensis* var. *zanzibariensis* (infertile)

The origin and widespread of the 'Royal Purple'

Until recently, 'Suthasinobon' was also known in Thailand as 'Royal Purple' (Fig. 2). It was Chansilpa (2006) who pointed out that they are not the same. Although they look alike, 'Suthasinobon' is different from 'Royal Purple' in that the latter is viviparous whereas the former is not. The sepals of 'Royal Purple' have purple blotches on the outside whereas those of 'Suthasinobon' are green with no blotch. It was postulated that 'Royal Purple' is a hybrid of an unknown origin of 'Suthasinobon'. Being viviparous, it is anticipated that it is the hybrid



Figure 1 'Suthasinobon' hybrid and 'Suthasinobon'



Figure 2 ‘Royal Purple’

resulting from a cross between ‘Suthasinobon’ and *Nymphaea micrantha*, a related species of the same subgenus (*Brachyceras*) having viviparous habit.

Specimen of ‘Royal Purple’ was introduced under the name of ‘Suthasinobon’ to be grown at Phikun Thong Royal Development Study Center in Narathiwat, Southern of Thailand. It was later spread into “Klai Ban” reservoir near His Majesty’s palace of “Taksin Ratchaniwet” where it quickly occupied the whole area of 1,200 rai (192 ha) and was well known for its most beautiful sight of blue flowers in a vast area (Chomchalow, 2005). Her Majesty the Queen has often enjoyed visiting the reservoir and picked up its flowers for decoration at Taksin Ratchaniwet Palace.

The ‘Suthasinobon’ Complex

‘Suthasinobon’ Complex is the term coined by the authors to mean a group of day-blooming tropical waterlilies which is composed of ‘Suthasinobon’ and its hybrids with other related *Nymphaea* species. They are similar in appearance and behavior with ‘Suthasinobon’ in being easily crossed with other related species of the subgenus *Brachyceras*.

Thai native day-blooming waterlilies

There is only one native species of day-blooming waterlilies in Thailand. It is *Nymphaea*



nouchali. It is non-viviparous, free flowering; its blooms held 30 cm above water. Two botanical varieties exist in Thailand, namely:

***Nymphaea nouchali* (var. *nouchali*)**

Locally known as ‘Bua Phan’ and ‘Bua Phuean’. Both are two distinct forms of *N. nouchali* (Fig. 3).

The followings are their descriptions:

‘Bua Phan’: The leaves are green with faint brownish blotches on top; pink or blue-violet underneath; with the shape of oval to round, sinuate margin; sinus usually open. The size of leaf varies from 13–15 cm and spread to 1.4–1.5 m. There is no pubescence on peduncle or petiole. The petal is pale bluish purple with bluish white sepal. The petal changes its color to pink after the second day



Figure 3 *Nymphaea nouchali*

of blooming. Its anther is pale yellow; its appendage is pale blue similar to the petal. Stamens are pale yellow. The flower has stellate shape with the size of 5-13 cm. It has almost no fragrance. There are 10-16 petals and 4 sepals (Fig. 4a).

'Bua Phuean': It has smaller flower than 'Bua Phan'. It has white petal with pale bluish purple tip and does not change its color after blooming (Fig. 4b).

Figure 5 shows the hybrid of 'Bua Phuean' x 'Suthasinobon'.

Nymphaea nouchali var. *cyannea*

It is locally known as 'Bua Khap' (Fig. 6). It has many other vernacular names in Thailand, viz. 'Nilubon', 'Nilobon', 'Nilottabon', 'Nin Ubon', and 'Pan Sangkon'. Leaves, 20-30 cm in

size, are slightly wavy; margin may or may not be dentate; sinus is deep. Its flowers are of medium-sized, with mauve color, but the color fades after the first day of blooming. It is a day-blooming with slight fragrance.

Belonging to the subgenus *Brachyceras*, the two botanical varieties of *Nymphaea nouchali* are taxonomically related to 'Suthasinobon' and its complex. Thus, it is possible that interspecific hybrids between *N. nouchali* and *N. capensis* can be produced.

The evidences of introgression involving 'Suthasinobon' complex

The evidences of introgression involving 'Suthasinobon' complex are obtained from the following case studies:



Figure 4a 'Bua Phan' and 'Bua Phan' leaf

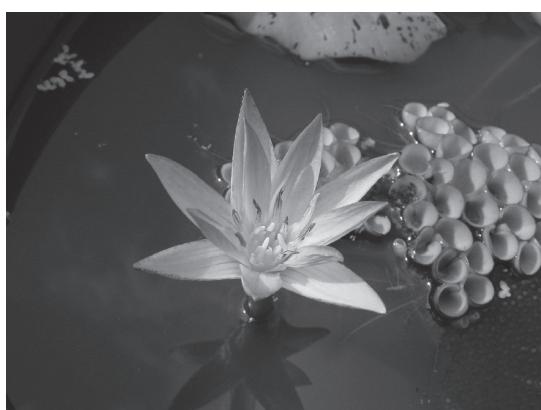


Figure 4b 'Bua Phuean'



Figure 5 The hybrid of 'Bua Phuean' x 'Suthasinobon' and its leaf.



Figure 6 'Bua Khap'

Case Study 1: 'Suthasinobon' planted at Hat Yai Rubber Research Station

Wasuwat (1994) reported that at one time he took 'Sithasinobon' to plant at the Hat Yai Rubber Research Station in Hat Yai, Songkhla Province. When he returned to that site 4-5 years later, he could find only a trace of 'Suthasinobon' with a large population of diverse plants whose flowers were purple, mauve, pink with various shapes of the petals. The person-in-charge notified him that all these diverse plants were not actually planted but originated spontaneously. This suggested that they were mongrels resulting from introgression of 'Suthasinobon' with other plants, possibly *Nymphaea nouchali*, which were also present in proximity.

Case Study 2: Assumption University, Bang Na Campus

Chomchalow (2005) reported a case when 'Suthasinobon' and its complex were planted on the campus of Assumption University at Bang Na in pots placed in a long cement pool of the size 2 × 100 m, having also a few other species of waterlilies planted in the same pool. Within a few years, diverse plants with various colors and forms were observed, many of which had stellate flowers resembling those of *N. nouchali* (Fig. 7). Many plants were viviparous and had variegated leaves of purple color. This suggested, again, that they were the result of introgression involving 'Suthasinobon' and its complex with other plants, including *N. nouchali*, which must have been present in the vicinity.

Case Study 3: Ao. To. Ko. 3 intersection in Nonthaburi

The senior author has witnessed the same situation at Ao. To. Ko. 3 intersection in Nonthaburi Province where waterlilies are grown in large cement pool. Diverse plants of different colors and shapes signifying their hybrid nature resembling that of 'Suthasinobon' have been observed (Fig. 8). It is assumed that they were the result of introgression between other species including Thai native day-blooming waterlilies with 'Suthasinobon' and its complex.



Figure 7 'Suthasinobon' and its hybrids with other *Nymphaea* spp. of the subgenus *Brachyceras*



Figure 8 The hybrids of 'Suthasinobon'

Case study: Conclusion drawn

In all case studies, it is evident that there has been an introgression involving 'Suthasinobon' and its complex with other plants including Thai native day-blooming species of waterlilies, namely *N. nouchali*.

The consequences

The breakdown of reproductive isolation

Evidence from other studies: Several studies have been made which indicated that reproductive isolation among distinct species has been broken down as the result of introgression. In the Gulf Coast area of the United States, two *Iris* species are present. *I. fulva* occupies bottomlands, shaded sites, on heavy soils, and in areas influenced only by fresh water. *I. hexagona* is a species of marshes; it occupies open sunlight, on sandy soils, often in sites influenced by brackish or salt water. Intermediates between the two species were unknown prior to human intervention. When man disturbed the Gulf Coast habitats by cutting forests, building canals, restricting flow by dams, and transporting soils, the two *Iris* species began to interbreed when brought into proximity. Now there are many locations where hybrids of all conceivable intermediates between them are present. This was the result of the breakdown of ecological isolation due to habitat disturbance, which has culminated in introgression of the two species, the end result of which is the breakdown of their reproductive isolation (Anderson, 1941).

Evidence from the present study: All Thai native species of waterlilies are distinct species as they are reproductively isolated. No hybrids have been found in spite of their close proximity with each other. When 'Suthasinobon' and its hybrids were introduced and grown in proximity with day-blooming native waterlilies, hybridization took place between them. Since 'Suthasinobon' is a vigorous plant having fragrant flowers, there is a great chance for the transfer of gene from 'Suthasinobon' to all native waterlilies, resulting

in all conceivable intermediates between them. The F1 hybrids are fertile and usually backcrossing with 'Suthasinobon' and its hybrids, resulting in more and more 'Suthasinonon-like' plants. As a result, there is a predominance of mongrels of partially hybrid ancestry closely resembles 'Suthasinobon' parent.

The loss of Thai *Nymphaea* native species

Since 'Suthasinobon' is a beautiful plant which is highly adaptive to all conditions in Thailand, it has been popularly planted in ponds and ditches almost everywhere. As 'Suthasinobon' flowers have bright color and fragrance they attract a large number of bees to collect nectar. These bees can travel far distant and visit many native waterlilies including 'Bua Phan', 'Bua Phuean' and 'Bua Khap', all of which are in the same species of *Nymphaea nouchli*, which is in the same subgenus with 'Suthasinobon'. As a result, introgression is taking place even in remote natural areas, the end result of which is the loss of Thai *Nymphaea* native species.

Both *N. nouchali* and *N. nouchali* var. *cyanea* occur naturally in the swamp area and natural waterways. As development is taking place at a rapid rate, their population is diminishing every passing day. Although many plants have been cultivated in pond and pots, due to introgression, they are continually disappearing, especially in competition with the vigorous 'Suthasinobon' and its hybrids.

The predominance of mongrels of partially hybrid ancestry closely resembles 'Suthasinobon' parent

By planting 'Suthasinobon' in the proximity of other native *Nymphaea* species, notably *N. nouchali*, the gene of 'Suthasinobon' can be transferred to *N. nouchli*. The resultant hybrids are readily backcrossing with 'Suthasinobon' parent, resulting in the predominance of mongrels of partially hybrid ancestry closely resemble 'Suthasinobon' parent.

DISCUSSION

A lesson to be learned

In natural condition, introgression occurs as the result of habitat destruction as in the case of *Iris fulva* x *I. hexagona*. However, in the present investigation, introgression occurs under domestication.

Plant introduction plays a major role in development. However, there are many cases in which detrimental effect has been recognized as in the case of the widespread of the introduced plants as weeds, or in some case, the occurrence of introgression which results in the loss of native species.

Potential use of Thai *Nymphaea* native species

Both *N. nouchali* and *N. nouchalie* var. *cyanea* are native plants which were once widespread all over the country. Although not as attractive as some of the introduced species and hybrids, they are adaptive to local conditions. Thus, they can be used to cross with other species or hybrids to produce new cultivars adaptive to the local condition.

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