

## A Survey of Biology Research in *Tolumnia* Orchids

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### Summary

*Tolumnia* plants are indigenous to the Caribbean islands, and have extensive habitats in that region. The genus *Tolumnia* was established in 1836. These plants are miniature oncidium that possess variable sympodial epiphyte with triangular succulent leaves that form small fan shaped growths and most appearances show of lack pseudobulb. *Tolumnias* can flowered at anytime, with bloom peaks in autumn or spring meanwhile which offer no reward to their pollinators and flowers are mostly self-incompatible. In addition, the most of them show the number of chromosome ( $2n$ ) is 42. Because of *tolumnias* orchids grow well within an intermediate range and also which exhibit strong growing habitat, short juvenility and higher hybridization compatible. Therefore they have been hybridized for a relative short term to reach flowering. Recently, intragenerics or intergenerics hybrids of *tolumnias* were recorded in the Royal Horticulture Society (RHS) at a number of 1,829. Since *tolumnias* orchid is adaptable to the Taiwan climate, more research on cultivation of the genus, may lead to encourage the commercial and industrial exploitation offered by the distinct characteristics of the various hybrids created using this genus.

### Introduction

*Tolumnia* plants are indigenous to the Caribbean islands (Aldrich, 1986; Ackerman and Galarza-Pérez, 1991; Baker and Baker, 2006). Likewise, Ackerman and Galarza-Pérez (1991) reported a Caribbean orchid genus, *Tolumnia* Raf. in one of their samples, which had the effect

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of generating considerable interests from the field of horticulture and taxonomy. *Tolumnias* are miniature oncidium that form small charming shapes with their triangular succulent leaves (Aldrich, 1994). The hybrids present a surprising array of colors and have been hybridized for a relative short term to reach flowering size which enabled breeders to breed important advances in a few years (Aldrich, 1994).

### Scientific name taxonomy

The nomenclatures of this species evolution were as followed: (Peters, 1989; Nash *et al.*, 2005; Baker and Baker, 2006; Cole, 2012) firstly, it was established in 1800, as *Oncidium* which has catch-all genus for hundreds of species that bear a superficial similarity to another one (Nash, *et al.*, 2005). Olaf Swartz chose *Oncidium variegatum* as the species representing his newly established genus *Oncidium* (Peters, 1989). In 1836, Rafinesque introduced the genus *Tolumnia* and was known as the equitant or variegatum oncidiums for many years (Baker and Baker, 2006). He also proposed the isolation of these species in a separate genus, called *Tolumnia* in 1837. But not long ago it was continued to be grouped within the genus *Oncidium* for hybridizing purposes (Cole, 2012).

In 1922, Fritz Kränzlin classified the equitants in his subsection *Variiegata* of the genus *Oncidium* and then in 1952, when they first encountered *Onc. variegatum* and *Onc. guianense* in the Dominican Republic, the team of Moir and Moir guided the way in recognizing the possibilities presented by this section of the genus *Oncidium*. According to Kränzlin's report, they are still not clearly presented because of several uncorrected errors of Fritz Kränzlin. Consequently, in 1970, Garay reorganized the genus putting the equitants in the section *Oncidium* of the genus *Oncidium* (Peters, 1989). In addition, Moir supported by Rafinesque affirmed that since *Onc. variegatum* was the first species described in this group, not only should they be referred to as the "variegate oncidiums" but they should as well be a separate genus (Peters, 1989). In 1986, the genus *Tolumnia* was reintroduced and Guido Bream transferred the equitant oncidiums into the new genus (Baker and Baker, 2006). Finally, Pridgeon *et al.* (2009) published *Genera Orchidacearum* Volume 5, supported by Rafinesque's, and proposed the separation by numerous independent researchers based on molecular analyses and these Caribbean species have formally been grouped as *Tolumnia* (Cole, 2012).

## Plant morphology and habitat

*Tolumnia* plants are indigenous to the Caribbean islands (Aldrich, 1986; Ackerman and Galarza-Pérez, 1991; Baker and Baker, 2006). Baker and Baker (2006) introduced research on the habitat of *Tolumnia*: several species in this genus demand rather warm weather, while other thrives in dry conditions. Furthermore some may be found in the hot lowlands, while others grow in the cooler and moist, mountain regions. Plants are normally found within the range of Lat. 17.1-26.6°N and Long 61.8-83.7°W. and the temperature records are 40°C ~-3°C. The habitat regions are a variety of thorny shrubs, and small trees and have estimated the habitat elevation at 60~2,000 m. Baker and Baker (2006) introduced and named at one time approximately 40 species and natural hybrids, but nearly 22 species are now in this genus. While, Leitch *et al.* (2009) introduced the numbers of species in this genus is 36 species.

In recent years, several studies have attempted to typify *Tolumnia variegata* (Phang, *et al.*, 1979; Ackerman and Galarza-Pérez, 1991; Calvo, 1993; Melédez and Ackerman, 1993, 1994; Ackerman *et al.*, 1996; Sabat and Ackerman, 1996; Ackerman *et al.*, 1997; Ackerman, 1998; Ackerman and Ward, 1999; Chase *et al.*, 2005; Otero *et al.*, 2005; Leitch *et al.*, 2009; Morales *et al.*, 2010). Firstly, Wilson (1985) showed that many species complexes are characterized by greatly variable populations. In addition, Ackerman and Galarza-Pérez, (1991) and Ackerman and Ward (1999) published the findings that morphological variation is high in both vegetative and floral characteristics. And estimates of gene flow among populations are high and genetic variation is above average. While Morales *et al.*, (2010) have found crassulacean acid metabolism (CAM) in *Tol. variegata*. Nevertheless, the general morphology introduced by Baker and Baker (2006) as plants which are a variable sympodial epiphyte with fanlike growth (Fig. 1A) and being terrestrials and lithophytes adaptable in moist and semiarid arid regions in both humid and dry subtropical forests still stands. Plant growth ranges from a prostrate to climbing rhizome that is wiry and slender. These rhizomes arise from the leaf axils and develop at the base of each growth as numerous and rather thick, flexuous, fleshy roots. The plant does not has pseudobulb develop but are in the flattened pseudobulb, spindle-shaped pseudobulb or inconspicuous pseudobulb, the pseudobulbs are completely hidden by overlapping, longitudinally folded basal of the distichous leaves. Ackerman *et al.* (1996) reported each year a new shoot grows from rhizomatous enlargement at the base of the previous year's growth. Moreover, the leaves are oblong-lanceolate, lanceolate, longitudinally folded, overlapping and distichous along the stem. Their sharply pointed, sickle-shaped leaves are folded longitudinally along the midvein of the leaf to produce rather triangular or V-shaped cross sections (Fig. 1B) and they have somewhat saw toothed margins (Baker and Baker, 2006).

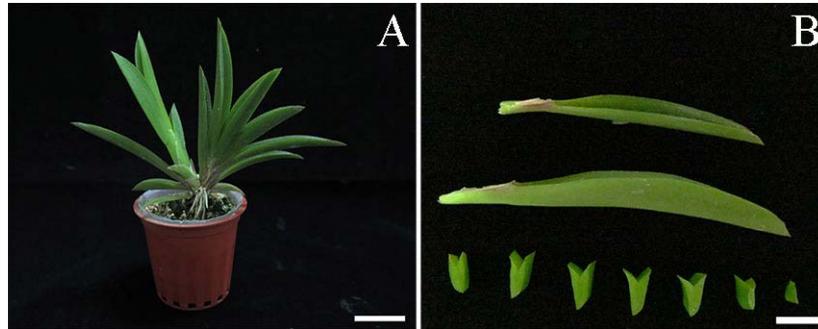


Fig 1. The morphology of *Tolumnia* Snow Fairy. (A) Vegetative phase (bar 2 cm), (B) Leaf cross section (bar 1 cm).

### Flowering characteristics

White (2009) studied the flowering time of *tolumnias* and concluded that it can flowered at anytime, with bloom peaks in autumn or spring and often flower continually. Authors studied their flowering time. For example, for *Tol. variegata*, Sabat and Ackerman (1996) found that the flowering time last mostly from September to December. Ackerman and Galarza-Pérez (1991) also reported most populations flower in May-June, whereas some populations have a second flowering in September to October and indicated two flowering time peaks, one in April and other in November. In addition, they also reported that their flowering times are not completely discontinuous although distinct lulls occur in flowering during December to June. Moir and Moir (1980) suggested not only *Tol. variegata* flowered in the spring but also *Tol. leiboldii* flowered in autumn. Moreover, Sauleda and Adams (1989) also reported in *Tol. bahamensis* have flowered in April to May. Baker and Baker (2006) discovered that inflorescences are generally slender, erect flower spike emerges from the leaf axis of the basal leaves and bear one to several flowers. Flowers carried a raceme toward the apex of the spike, and a flowering branch may develop (Fig. 2). And their colorful flowers come in combinations of lavender, white, red, pink, purple, bright yellow and orange tones (White, 2009). The column bears prominent wings on flanking the stigma.

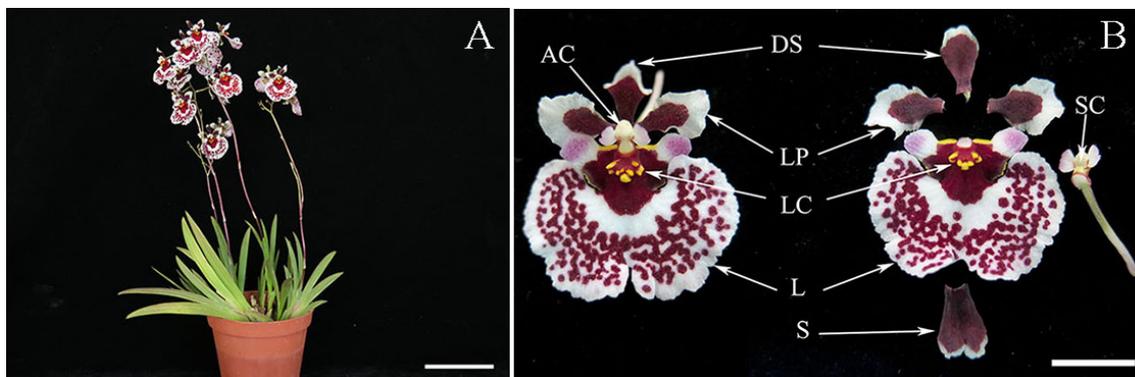


Fig 2. (A) The reproductive phase of *Tolumnia* Snow Fairy (bar 5 cm), and (B) Flower composition (bar 1 cm). DS = Dorsal sepal, AC = Anther cap, LP = Lateral petal, LC = Lip callus, L = Lip, S = Lateral sepal and SC = Stigmatic cavity.

### Pollination and fruit set

The pollination and fruit set of tolumnias orchids have been studied such as *Tol. variegata* (Ackerman and Galarza-Pérez, 1991; Calvo, 1993; Meléndez and Ackerman, 1993; Ackerman *et al.*, 1996; Sabat and Ackerman, 1996; Ackerman *et al.*, 1997; Ackerman and Ward, 1999; Otero *et al.*, 2005; Tremblay *et al.*, 2005), *Tol. henekenii* (Chase *et al.*, 2009) and *Tol. guibertiana* (Vale *et al.*, 2011). Flowers are mostly self-incompatible (Ackerman and Montero, 1985; Calvo, 1993; Meléndez and Ackerman, 1993; Ackerman *et al.*, 1997; Chiu and Chang, 2011), offering no reward to their pollinators and severely pollination-limited (Ackerman and Montero 1985; Calvo, 1993; Meléndez and Ackerman, 1993). These species are pollinated by male and female *Centris* bees (Sabat and Ackerman, 1996; Ackerman *et al.*, 1997; Ackerman and Ward, 1999; Vale *et al.*, 2011). For example, Female bees *Centris versicolor* in *Tol. lucayana* and female bees *Centris decolorata* in *Tol. variegata* (Morales *et al.*, 2010) but also male bees *Centris versicolor* in *Tol. bahamense* (Ackerman *et al.*, 1997; Van der Cingel, 2001) while *Tol. guibertiana* are pollinated by female bees *Centris poecila* (Vale *et al.*, 2011). Flowers show single anthers bearing two globular pollinia. Upon the bees visiting the flower, they shortly grasp the lip in an orientation that butts their head against the column. The anther are removed and cemented to the face of pollinators; pollinia are deposited on the stigma which then fertilizes almost all the ovules (Ackerman *et al.*, 1996; Sabat and Ackerman, 1996; Ackerman *et al.*, 1997). Several publications have shown low natural fruit set while hand-pollination resulted in fruit set rates much higher than in open-pollination (Calvo, 1993). For example in the case of *Tol. variegata*, it was shown

that natural fruit sets resulted generally in low fruit set production, whereas hand-pollination resulted in a dramatic increase in fruit set production (Ackerman and Montero 1985; Calvo, 1990; Meléndez, 1990; Calvo, 1993; Meléndez and Ackerman, 1993; Sabat and Ackerman, 1996; Ackerman *et al.*, 1997; Tremblay *et al.*, 2005). Calvo and Horvitz (1990) and Calvo (1993) investigated the relative effects of pollination and resource limitation on fruit by using a demographic model. Sabat and Ackerman (1996) showed that fruit set during peak flowering was half of the average fruit set for the whole season. It has been shown that several factors influence low pollination which may depend on both floral characters such as variants in color, shape, size, or fragrance, some may differentially attract pollinators as deceits of various forms, including the pseudocopulatory syndrome of *Tol. henekenii* (Ackerman Montero, 1985; Ackerman and Galarza-Pérez, 1991; Calvo, 1993; Meléndez and Ackerman, 1993; Chase *et al.*, 2005).

Moreover, several factors also showed that low fruit sets depend on plants and pollinators. For example, Sabat and Ackerman (1996) showed fruit set was lowest when the abundance of *Tol. variegata* flowers peaked and it was highest when the number was lowest and resulting sometimes in geitonogamous pollination, in which led to flower or fruit abortion (Tremblay *et al.*, 2005). Moreover, the habitat may affect to fruit set production as Morale and Ackerman (Tremblay *et al.*, 2005) found in *Tol. variegata* when plants in sunny habitats bear fruit sets better than plants in shady habitats. While, Meléndez and Ackerman (1993) discovered that rust disease infection affected either short term vegetative or reproductive success. The cost of high fruit set seems to be relatively low (Calvo, 1993).

Finally, Ackerman *et al.* (1996) discovered after the spring pollinations, fruits usually matured during the summer and seed were dispersed by fall and peak germination occurred from late autumn through the winter, that was supported by Sabat and Ackerman (1996) who found that *Tol. variegata* flowers early in the spring after being pollinated and observed, that fruit maturation lasts 2-3 months, after several thousand minute seeds which are dust-like and wind dispersed (Ackerman and Montero, 1985; Calvo, 1993), seedling begin to appear within a few months.

### **Cytogenetics studies**

In these orchids, the number of chromosomes may range from  $2n = 10$  to 200, the most common are 28, 38 and 42 (Arditti, 1992). While, Baker and Baker (2006) found out that in *Tolumnia*, the number of chromosome in somatic cell counts are  $2n = 40, 42, 84, 126$  and 133. Phang *et al.* (1979) also reported the species belonging to the section *Oncidium* (Equitantia) have

$2n = 40, 42, 84$  and  $126$  and supported by Moir and Moir (1980) interpreted most species have 42 chromosomes. For example, *O. triquetrum* (*Tol. bahamensis*), a member of this section with  $2n = 42$  chromosomes (Phang *et al.*, 1979), but some are tetraploids (*Tol. sylvestre* (Lindley) Braem,  $2n = 84$ ) or aneuploids (*Tol. guianense* (Aublet) Braem,  $2n = 40$ ) (Sinoto, 1962). Not only is their chromosome number fewer but also their genome size is smaller (Chase *et al.*, 2005). Genome size in *Tolumnia* ranges from 1.0-6.6 pg in a 1C (Leitch *et al.*, 2009). For example, genome size in *Tol. varvelum* Moir having a DNA C-value of  $1C = 1.95$  pg. (Jones *et al.*, 1998; Chase *et al.*, 2005). In addition, Ackerman (1998) found that genetic structure of orchid populations such as in *Tol. variegata* show less population differentiation whereas estimates of gene and genetic variation are high. They also indicated that patterns of morphological variation for *tolumnia* mirror its patterns of genetic variation.

### **Tolumnias breeding**

In current years, several hybridizers have been taken interest in *Tolumnia* breeding programs, because the hybrids present a surprising array of colors and have been hybridized for a relative short term to reach flowering size which enabled breeders to breed important advances in a few years (Aldrich, 1994). Peter (1989), Aldrich (2001) and Cole (2012) claimed that it was W.W. Goodale Moir, who during the 1950s to 1980s, established the foundations of *Tolumnia* breeding. This was followed by a second period lasting between in 1980s to 1990s, where several exciting crosses were produced by the Richard and Stella Mizuta (Richella Orchids), Robert and Susan Perreira, and Jon and Kaoru Oka. This was followed by a more recent third period, with the hybridizers being Anita Aldrich, Thomas Kosaki, Puanani, and Joane Molenock. Finally, William Savage is the most recent of the more important hybridizers of *tolumnias* today. The objective of breeding hybrid includes the establishment of new varieties characterized by the following features: vigorous growth, production of large flowers of full shape, strong but moderately short and branching inflorescences with many well-spaced flowers that shows new combination of colors and patterns (Peter, 1989).

*Tol. urophyllum*, *Tol. pulchellum*, *Tol. guianense*, *Tol. henekenii* and *Tol. triquetrum* are orchid specues which have been used in breeding programs to create new varieties possessing all the essential qualities for good, vigorous, floriferous and fascinating hybrids (Table.1) (Moir, 1978; Midgett, 1989; Ackerman and Galarza-Pérez, 1991; Teoh, 2005). Furthermore, the essential characteristics offered by *Tol. urophyllum* includes: good horticultural characteristic size, yellow color and lip which tends to spread (Midgett, 1989; Aldrich, 2001; Cole, 2012).

*Tol. pulchellum* lends its genes for dark purple, pink or rose color, large size, often branching inflorescences, full shape and long shell life (Moir, 1978; Aldrich, 2001; Cole, 2012). *Tol. guianense* filled the petal shape, increasing overall roundness of the flowers (Aldrich, 2001; Cole, 2012). *Tol. henekenii* created new directions in breeding dark reds and purples, as well as better arrangement and shingling (Peters, 1989; Cole, 2012). And *Tol. triquetrum* supplied the potential of sports, fine form, shorter of inflorescences and colors are transmitted to its numerous interspecific hybrids (Aldrich, 2001; Teoh, 2005; Cole, 2012).

Table 1. Origin of features in *Tolumnia grexes*.

Inherited from these species	Characteristics	Authors
<i>Tol. urophyllum</i>	<ul style="list-style-type: none"> <li>• Good horticultural characteristic size, large flower</li> <li>• Full shape, round lip</li> <li>• Yellow color</li> </ul>	<p>Midgett (1989) Aldrich (2001) Cole (2012)</p>
<i>Tol. pulchellum</i>	<ul style="list-style-type: none"> <li>• Lager flower</li> <li>• Full shape, round lip</li> <li>• Better arrangement and shingling</li> <li>• Good flower count</li> <li>• Dark purple, rose, pink to red colors</li> <li>• Long shell life</li> </ul>	<p>Moir (1978) Aldrich (2001) Cole (2012)</p>
<i>Tol. guianense</i>	<ul style="list-style-type: none"> <li>• Large lip and side lobes to fill in the lip</li> <li>• Wide petals to fill in the top of the flower</li> <li>• Increasing overall roundness of flower</li> </ul>	<p>Aldrich (2001) Cole (2012)</p>
<i>Tol. henekenii</i>	<ul style="list-style-type: none"> <li>• Better arrangement and shingling</li> <li>• Dark red and purple colors</li> </ul>	<p>Peters (1989) Cole (2012)</p>
<i>Tol. triquetrum</i>	<ul style="list-style-type: none"> <li>• Supplied the potential of sports</li> <li>• Fine form</li> <li>• Shorter of inflorescences</li> <li>• Color are transmitted to its numerous interspecific hybrids</li> </ul>	<p>Aldrich (2001) Teoh (2005) Cole (2012)</p>

The innovations of the hybridizers listed above, as well as the list of the five species, are most recommended for the breeding of hybrids and have been leading to numerous new varieties of hybrids. Recently, 1,829 hybrids were recorded in Royal Horticulture Society (RHS) using this orchid as the parents include, intragenerics of which there are 1,434 hybrids and intergenerics of which there are 395 hybrids 186 of which were fertilized from pollen and 209 by seed. Firstly, several intragenerics were produced (Phang *et al.*, 1979; Peters, 1989; Nash *et al.*, 2005; Cole, 2012). For example, the first primary hybrid and most important was *Tol.* Golden Glow (Monnier, 1985; Peters, 1989; Nash *et al.*, 2005), it was combined with *Tol. urophyllum* an 84 chromosomes tetraploid and *Tol. triquetrum* a 42 chromosomes diploid. It exhibited as a triploid with 63 chromosomes (Monnier, 1985; Peters, 1989) and registered in 1957 by Goodale Moir (Peters, 1989). The triploid was usually produced for increasing vigorous growth and outstanding flower production (Peters, 1989). Particularly, Moir (1978) suggested true triploid are poor breeders in orchids while *Tolumnia* have produced excellent triploids such as *Tol.* Catherine Wilson, *Tol.* St. Anne, *Tol.* Jamaica or the group of 40 x 42 chromosome hybrids of *Tol.* Tiny Tim, *Tol.* Delight, *Tol.* Red Velvet and *Tol.* Waikiki Sunset. Furthermore, *Tol.* Golden sunset (*Tol.* Stanley Smith x *Tol.* Tiny Tim) was created and registered in 1975 by Perreiras.

Other fairly hybrids are combined four of five species including *Tol. urophyllum*, *Tol. pulchellum*, *Tol. guianense* and *Tol. triquetrum* (Aldrich, 2001; Nash *et al.*, 2005). Current champion is at begetting quality *Tolumnias* (Peters, 1989) and important key component in the main line. Not only *Tol.* Golden Sunset (*Tol.* Stanley Smith x *Tol.* Tiny Tim) was produced by Perreira but also *Tol.* Linda (*Tol.* Rainbow x *Tol.* Waikiki Sunset) was produced from the similar background by Jon Oka that starts of the main line of *Tolumnia* (Cole, 2012).

Secondly, several *Tolumnias* hybrids were generated (Moir, 1978; Peters, 1989; Nash *et al.*, 2005; Cole, 2012). For example, *Tol.* Red Velvet (*Tol. triquetrum* x *Tol. henekenii*) and *Tol.* Delight (*Tol. pulchellum* x *Tol. henekenii*) (Moir, 1978; Peters, 1989; Aldrich, 2001; Cole, 2012) which first used *Tol. henekenii* as one parent for open breeding dark red and purple by Perreira (Peters, 1989), *Tol.* Tiny Tim was bred by combination of *Tol. guianense* with *Tol. triquetrum* (Moir, 1978; Peters, 1989), *Tol.* Robsan (*Tol.* Golden sunset x *Tol.* Susan Perreira) has been proven a good source of yellow (Aldrich, 2001; Cole, 2012), *Tol.* Ivory Queen (*Tol.* Calypso Queen x *Tol.* Little Chickadee) began white color flowers (Cole, 2012), *Tol.* Elfin Star (*Tol.* Ole x *Tol.* Kathleen Oka) are minimal branching inflorescences (Aldrich, 2001; Cole, 2012).

Moreover, the backcross is also an important method for producing new hybrids. For example, *Tol.* Red Belt was bred by *Tol.* Golden Glow breeding it back to *Tol. triquetrum* that looked similar to *Tol.* Golden Glow while *Tol.* Red Belt showed the red mark and had shorter inflorescences than *Tol.* Golden Glow (Moir, 1978; Peters, 1989). Furthermore, Phang *et al.*

(1979, 1981) established intragenerics and intergenerics of *Tolumnia* with other genus. The results were shown in *Tol. triquetrum* combination with *Tol. variegata* that it have 42 chromosomes as well as *Tol. triquetrum* showed strong chromosome homology with *Tol. variegata* while combination with different genus showed weak homology.

Finally, in view of what has been detailed above, we suggested not only intragenerics species should be seen as important but intergeneric species as well. The goal of *Tolumnia* intergenerics species generated by genera adapted to warmer conditions interbred with genera adapted to cooler conditions is to enable faster growth under warm, intermediate or cool climate (Monnier, 1985) as well as acquiring hybrids of dominant vigor, producing flowers large and fully shaped, vigorous, being fairly short and branching inflorescences with well-spaced that show new combinations of colors and patterns (Peters, 1989) while at the same time taking advantage of the different qualities of other species (Cole, 2012). Other genera which have been crossed with *Tolumnia* include *Rodriguezia*, *Zelenkoa*, *Oncidium*, *Trichocentrum* (Phang, 1979, 1981; Cole, 2012) and *Erycina pusilla* in genus *Erycina* (Liu *et al.*, 2011). Many intergenerics of *Tolumnias* were bred, for example, *Rodrumnia* orchidom Showtime (*Tol.* Fan Dancer × *Rdza.* Whitewater), *Zelemnica* Carotene (*Tol.* Golden Sunset x *Trixie*) and *Golmnia* Orchidom Sainty (*Tol.* Charity × *Gom sarcodes*) has been created. Cole (2012) likened the breeding of hybrids a relay race, with each breeder taking full advantage of the best innovations of prior breeders and passing on their best innovations in turn.

### **Tolumnias cultures**

*Tolumnias* orchids grow well within an intermediate range of environment (Aldrich, 1986, 1994). Baker and Baker (2006) and Cole (2012) concluded that suitable light intensity ranges between 358-797  $\mu\text{mol m}^{-2}\text{s}^{-1}$  and should be filtered or diffused, to avoid sunburn. Strong air movement should be provided times because it is necessary to promote relatively rapid desiccation (Cole, 2012) while relative humidity of 70-85% can be provided (Aldrich, 1994; Baker and Baker, 2006).

Cole (2012) reported that *Tolumnia* orchids have reputations for being hard to grow, which are the forebears in natural habitat. Whereas recent years they were developed into many hybrids into easily grow. Watering frequency is very important. These orchids should be watered often while actively growing but their roots must dry out between watering (Aldrich, 1986). In autumn, water should be decreased after new growth matures and in winter normally plants need less water. Furthermore, fertilizer applications were decreased or eliminated until the start of new

growth and heavy watering decreased in spring (Baker and Baker, 2006) to avoid accumulation of fertilizer salts (Aldrich, 1986). Cole (2012) suggested that fertilizer should dilute with watering once every week or two.

### Conclusions

*Tolumnia*, although once classified as *Oncidium* section *Variegata*, have been moved to the genus *Tolumnia* by Rafinesque. *Tolumnia* plants are native to the Caribbean islands however it can still be grown in a wide variety of places in an intermediate range. Plants are variable sympodial epiphytes with fanlike growth and it can flower at anytime, with bloom peaks in autumn or spring and often flower continually. Moreover, flowers are mostly self-incompatible and the numbers of chromosome in diploid are 40, 42, 84, 126 and 133. Their beautiful and wide array of floral color and patterns aroused the interest of many growers and hobbyists. Furthermore, more than 60 years ago several breeders took interest in *tolumnias* hybridization since *tolumnias* orchid have been hybridized for a relative short term to reach flowering size which enabled breeders to breed important advances in a few years. One of the best hybrids of *tolumnias* is *Tol.* Golden Sunset. Moreover, *tolumnias* hybrids are easy to cultivate and highly valued by orchid growers for their miniature size and ability to adapt to diversity of conditions either under lights or on windowsills. Hence, we have attempted to put together most of the available literature on a survey of biology research in *tolumnias* orchid of scientific name taxonomy, plant morphology, habitat, flowering characteristics, pollination, fruit set, cytogenetics studies, breeding and cultures. In view of the above mentioned details, we hope to create greater awareness of the importance of *tolumnias* orchids, as well as encourage the commercial and industrial exploitation offered by the distinct characteristics of the various hybrids created using this genus.

### References

- Ackerman, J. D. 1998. Evolutionary potential in orchids: patterns and strategies for conservation. *Selbyana* 19: 8-14.
- Ackerman, J. D. and J. C. Montero. 1985. Reproductive biology of *Oncidium variegatum*: moon phases, pollination, and fruit set. *Amer. Orchid Soc. Bull.* 54: 326-329.
- Ackerman, J. D. and M. Galarza-Pérez. 1991. Patterns and maintenance of extraordinary variation in the Caribbean orchid, *Tolumnia (Oncidium) variegata*. *Syst. Bot.* 16: 182-194.

- Ackerman, J. D. and S. Ward. 1999. Genetic variation in a widespread, epiphytic orchid: where is the evolutionary potential. *Syst. Bot.* 24: 282-291.
- Ackerman, J. D., A. Sabat, and J.K. Zimmerman. 1996. Seeding establishment in an epiphytic orchid: an experimental study of seed limitation. *Oecologia* 106: 192-198.
- Ackerman, J. D., E. J. Meléndez, and J. Salguero-Faria. 1997. Variation in pollinator abundance and selection on fragrance phenotypes in an epiphytic orchid. *Amer. J. of Bot.* 84: 1383-1390.
- Aldrich, A. 1986. Equitant oncidium culture-tapping the potential. *Amer. Orchid Soc. Bull.* 55: 676-683.
- Aldrich, A. 1991. Equitant oncidium culture – A practical approach. *Amer. Orchid Soc. Bull.* 60: 314-315.
- Aldrich, A. 1994. Orchid care “Equitant oncidium”. *Amer. Orchid Soc. Bull.* 63(8): 904-907.
- Aldrich, A. 2001. Oncidium Golden Sunset a growing legacy. *Amer. Orchid Soc.* 70: 526-537.
- Arditti, J. 1992. Heredity and breeding. In: *Fundamentals of orchid biology*. John Wiley & sons, inc. pp. 571-585.
- Baker, M. L. and C. O. Baker. 2006. *Orchid species culture Oncidium/Odontoglossum alliance*. Timber Press, Oregon. pp. 871-889
- Calvo, R. N. 1990. Pollinator limitation, cost of reproduction, and fitness in plants: a demographic approach. Dissertation. University of Miami, Coral Gables, Florida, USA.
- Calvo, R. N. 1993. Evolutionary demography of orchids: intensity and frequency of pollination and the cost of fruiting. *Ecol.* 74: 1033-1042.
- Calvo, R. N. and C. C. Horvits. 1990. Pollinator limitation, cost of reproduction, and fitness in plants: a transition matrix demographic approach. *Amer. Nat.* 136: 499-516.
- Chase, M. W., L. Hanson, V. A. Albert, W. M. Whitten, and N. H. Williams. 2005. Life history evolution and genome size in subtribe Oncidiinae (Orchidaceae). *Ann. bot.* 95: 191-199.
- Chase, M. W., N. H. Williams, A. Donisete de Faria, K. M. Neubig, M. C. E. Amaral, and W. M. Whitten. 2009. Floral convergence in Oncidiinae (Cymbidieae; Orchidaceae): an expanded concept of *Gomesa* and a new genus *Nohawilliamsia*. *Ann. bot.* 104: 387-402.
- Chiu, Y. T. and C. Chang. 2011. Crossing potential and inbreeding depression in three *Tolumnia* cultivars. *Hort. NCHU* 36(1): 31-38. (Chinese/English abstr).
- Cole, R. 2012. The hybridizers behind contemporary *Tolumnias*. *Amer. Orchid Soc.* 81: 404-415.
- Jones, W. E., A. R. Kuehnle, and K. Arumuganathan. 1998. Nuclear DNA content of 26 orchid (Orchidaceae) genera with emphasis on *Dendrobium*. *Ann. Bot.* 82: 189-194.
- Leitch, I. J., I. kahandawala, J. Suda, L. Hanson, M. J. Ingrouille, M. W. Chase, and M. F. Fay. 2009. Genome size diversity in orchids: consequences and evolution. *Ann. Bot.* 104: 469-481.

- Liu, K. T., Y. T. Chiu, and C. Chang. 2011. Intergeneric cross between *Erycina pusilla* and *Oncidiinae* species and Cultivars. Seed and Nursery (Taiwan) 13: 31-39 (Chinese/English abstr)
- Meléndez, E. J. 1990. The effect of a fungal disease on the fitness of individual in a natural population of *Tolumnia variegata* (Orchidaceae). Thesis. University of Puerto Rico, Río Piedras, Puerto Rico.
- Meléndez, E. J. and J. D. Ackerman. 1993. The effect of a rust infection on fitness components in natural population of *Tolumnia variegata* (Orchidaceae). *Oecologia* 94: 361-367.
- Meléndez, E.J. and J. D. Ackerman. 1994. Factors associated with rust infection (*Sphenoshora saphena*) in an epiphytic orchid (*Tolumnia variegata*). *Amer. J. Bot.* 81: 287-293.
- Midgett, R. J. 1989. An all-yellow form of *Oncidium urophyllum*. *Amer. Orchid Soc. Bull.* 58: 124-125.
- Moir, W. W. G. 1978. A history of Variegata *Oncidium* breeding. *Amer. Orchid Soc. Bull.* 47: 204-208.
- Moir, W. W. G. and M. A. Moir. 1980. Breeding Variegata *Oncidiums*. Harold L. Lyon Arboretum/University Press of Hawaii, Honolulu.
- Monnier, G. 1985. *Oncidium* intergenerics for all climates. *Amer. Orchid Soc. Bull.* 54: 1072-1079.
- Morales, M., J. D. Ackerman, and R. L. Tremblay. 2010. Morphological flexibility across an environmental gradient in the epiphytic orchid, *Tolumnia variegata*: complicating patterns fitness. *Bot. J. Linn. Soc.* 163: 431-446.
- Nash, N., S. A. Frowine, and M. Rogers. 2005. *Oncidium*. Complete guide of orchids. Meredith Books, Iowa. pp. 164-171
- Otero, J. T., P. Bayman, and J. D. Ackerman. 2005. Variation in mycorrhizal performance in epiphytic orchid *Tolumnia variegata in vitro*: the potential for natural selection. *Evol. Ecol.* 19: 29-43.
- Peters, B. 1989. Equitant *Oncidium* of primary importance. *Amer. Orchid Soc. Bull.* 58: 114-123.
- Phang, V. P. E., U. Charanasri, and H. Kamemoto. 1979. Genome relationships of intra-and intersectional species hybrids of *Oncidium triquetrum*. *Amer. J. Bot.* 66: 805-809.
- Phang, V. P. E., U. Charanasri, and H. Kamemoto. 1981. Meiotic chromosome behavior in intersectional and intergeneric species hybrids in the *Oncidium Alliance*. *J. Amer. Soc. Hort. Sci.* 106: 177-181.
- Pridgeon, A. M., P. J. Cribb, M. W. Chase, and F. N. Rasmussen. 2009. *Genera Orchidacearum*. Vol. 5. Epidendroideae (Past two). Oxford University Press. Oxford.

- Royal Horticulture Society. 2014. Search the international orchid register: Find orchids by parentage or grex name searches.  
<<http://apps.rhs.org.uk/horticulturaldatabase/orchidregister/orchidregister.asp>> (Accessed 2015-01-30).
- Sabat, A. M. and J. D. Ackerman. 1996. Fruit set in a deceptive orchid: the effect of flowering phenology, display size, and local floral abundance. *Amer. J. Bot.* 83: 1181-1186.
- Sauleda, R.P. and R.M. Adams. 1989. The orchid genera *Oncidium* SW. and *Tolumnia* Raf. in Florida. *Rhodora* 91: 188-200.
- Sinoto, Y. 1962. Chromosome numbers in *Oncidium alliance*. *Cytologia* 27: 306-313.
- Teoh, E. S. 2005. Sympodial orchids "Genus *Oncidium*". 3<sup>rd</sup> ed. Times editions-Marshall Cavendish, Singapore.
- Tremblay, R. L., J. D. Ackerman, J. K. Zimmerman, and R. N. Calvo. 2005. Variation in sexual reproduction in orchids and its evolutionary consequences: a spasmodic journey to diversification. *Biol. J. Linn. Soc.* 84: 1-54.
- Vale, Á., L. Navarro, D. Rojas, and J. C. Álvarez. 2011. Breeding system and pollination by mimicry of the orchid *Tolumnia guibertiana* in Western Cuba. *Plant Species Biology*, [no pagination].
- Van der Cingel, N. A. 2001. Maxillarieae: Oncidiinae "*Tolumnia*". *An Atlas of orchid pollination: European orchids*. CRC Press, Botterdam. pp. 115.
- White, J. 2009. *Tolumnia* Hybrids "Equitant oncidium". *Bloom-again orchid: 50 easy-care orchids that flower again and again and again*. Timber Press, Oregon. pp. 116.
- Wilson, K.S. 1985. The equitant oncidium. *Proceedings of the 11<sup>th</sup> world orchid conference*, ed. K. Tan. Miami, Florida. pp. 396-401

## 劍葉文心蘭生物學研究概況

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關鍵字：劍葉文心蘭、植株形態、育種、栽培

**摘要：**劍葉文心蘭原生於加勒比海的島嶼上，生長棲地廣泛。其最早被歸類於文心蘭屬中，於1836年建立劍葉文心蘭屬。劍葉文心蘭植株形態為葉基部重合、不具假球莖之細枝附生型蘭花，並具有全年開花特性，主要花季為春和秋季。研究顯示劍葉文心蘭被歸類為無報酬的詐騙傳粉型蘭花，並具有自交不親合性。劍葉文心蘭之育種歷史已超過60年，至目前已有1800多個劍葉文心蘭種間或屬間雜交品種於英國皇家園藝學會被登錄。栽培劍葉文心蘭時，需要排水良好的介質，並生長於光線充足的環境。劍葉文心蘭因個體差異大、花色豐富且鮮艷、生長勢佳、幼年期短、雜交親合性較高等特性，被廣泛應用於文心蘭之育種上，為具有發展潛力之育種親本，且適應臺灣之生長環境，如再進行其花卉栽培特性之研究，期能發展成為新興文心蘭盆花品種。

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