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Effects of distance from coastal shoreline on survival and adaptation of Eastern Native Orchids, Thailand

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Abstract The impacts of distance from shoreline on survival and adaptation of Eastern Native Orchids was investigated. Results showed that only one species of *Cymbidium aloifolium* had the lowest survival percentage during 5 months of observation which significantly lower than the other species ($p\pm0.05$). Survival percentages of the other 8 eastern native orchids were not significantly different ($p>0.05$). However, survival of almost all orchids in zone 1, (5 meters from the coastline) tended to be lower than in other zones. Eastern Native Orchids grown in zone 1 adapted by dropping more leaves than in other zones. Meanwhile, orchids grown in zones 2 (100 meters from Zone 1) and 3 (100 meters from Zone 2) adapted, by downsizing of their leaves more than in zone 1. The study found that all 9 eastern native orchids planted in zone 3 have new root numbers, greater than in zone 1 and zone 2. Orchids named *D. friedericksianum*, and *D. farmeri* had highest new root numbers; while *R. retusa* had least new root numbers. There was interaction between the factor of different species and distance from the coastline on new root number, indicating that new roots number of *A. falcata, S. mirabilis, D. friedericksianum*, *D.crumenatum*, *M. pallida*, *D. farmeri* and *C. aloifolium* trend to more likely to form when is grown in zone 3. Whereas new roots number of *R. retusa* tend to lower likely to form when is grown in every zone.

Keywords: Eastern Native Orchids, Coastal zone, Adaptation

Introduction

Thailand is located in an area which comprised of the three main Southeast Asian floristic regions of the world; the Indo-Burmese, the Indo-Chinese and the western Malesian regions (Kaosa-ard, 1994). Each region provides a natural environment that encourages growth of a variety of orchids (Orchid; Orchidaceae), contributing to make Thailand the world's leading country for production and export of orchids; and continues to hold as the primary orchid exporter in the world (Thammasiri, 2015). In a year 2020, there is an export value of orchids of approximately 50.3 million US dollars,

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divided into 39.6 million US dollars for flowers and 10.7 million US dollars for plants (Office of Agricultural Economics, 2021).

Wild orchids are also included in the export of orchid plants (Worakuldamrongchai *et al*., 2014). Presently, the number of wild orchids in nature is decreasing, due to destruction of forests, commercial harvesting of wild orchids (Pittayawutwinit and Chinachit, 2016), plus climate variables affecting the natural propagation of wild orchids (Barman and Devadas, 2013). Decreased orchid population in the wild, leads to a decrease of genetic diversity in the future, and may cause increased risk of inbreeding. When genetics are weak, the ability to tolerate the environment is reduced. Therefore, the chance of extinction is higher than with populations of high genetic diversity (Frankham *et al*., 2017). Therefore, wild orchid conservation is urgently needed. However, conserving orchids is more complex than that of many plants because different species of orchids live in very different environments and ecosystems. Orchids are epiphytes, require the support of physical structures for anchorage (Chomba *et al*., 2011). They attach to trees and tend to grow on parts of trees that collect organic debris and water, such as on inner branches. Host trees with rough bark that hold water and humus in cracks and crevices tend to support orchids better than those with smooth bark (Flores-Palacios and Ortiz-Pulido, 2005; Yulia and Budiharta, 2011).

Growing of wild orchids, can affect the livelihood of those who live off the forest. Logging and removing forests for Agriculture further add detriment to wild orchid populations. In other words, best solutions are not easy. Attempts to conserve wild orchids in government facilities appears to be more successful. Thai Red Cross Association's Khao Lan Center, Khlong Yai District, Trat Province is a government agency used as a humanitarian and natural learning center for people and tourists. The center covers an area of approximately 67.84 hectares and contains many auspicious trees, forest trees and large economic trees. These large trees are suitable as habitats for wild orchids. However, most of the center's area is close to the sea. Thus, orchids growing in such coastal areas may be subjected to salt stress, due to continuous exposure of those plants to seawater winds (Kouali *et al*., 2017). However, there are some orchids species that can adapt to live well in these coastal habitats (Rindyastuti *et al*., 2018). Therefore, objective was to find out the optimal eastern native orchids for planting in the area of Rajakarun Center, Thai Red Cross Society, Khao Lan.

Materials and methods

Study area

This experiment was undertaken in Thai Red Cross Association's Khao Lan Center, located in Khlong Yai district, Trat province, Eastern Thailand

(Figure-1). The center is located in the Malesian floristic region (at 11° 46' 49.2" N, 102° 52' 41.1" E), covering an area of 678,400 m^2. The study area's climate is tropical, influenced by the southeast monsoon winds, causing significant rainfall during most months of the year. The average temperature is 26.4 °C. Annual rainfall is 3,234 mm (Climate-Data.org, 2018).

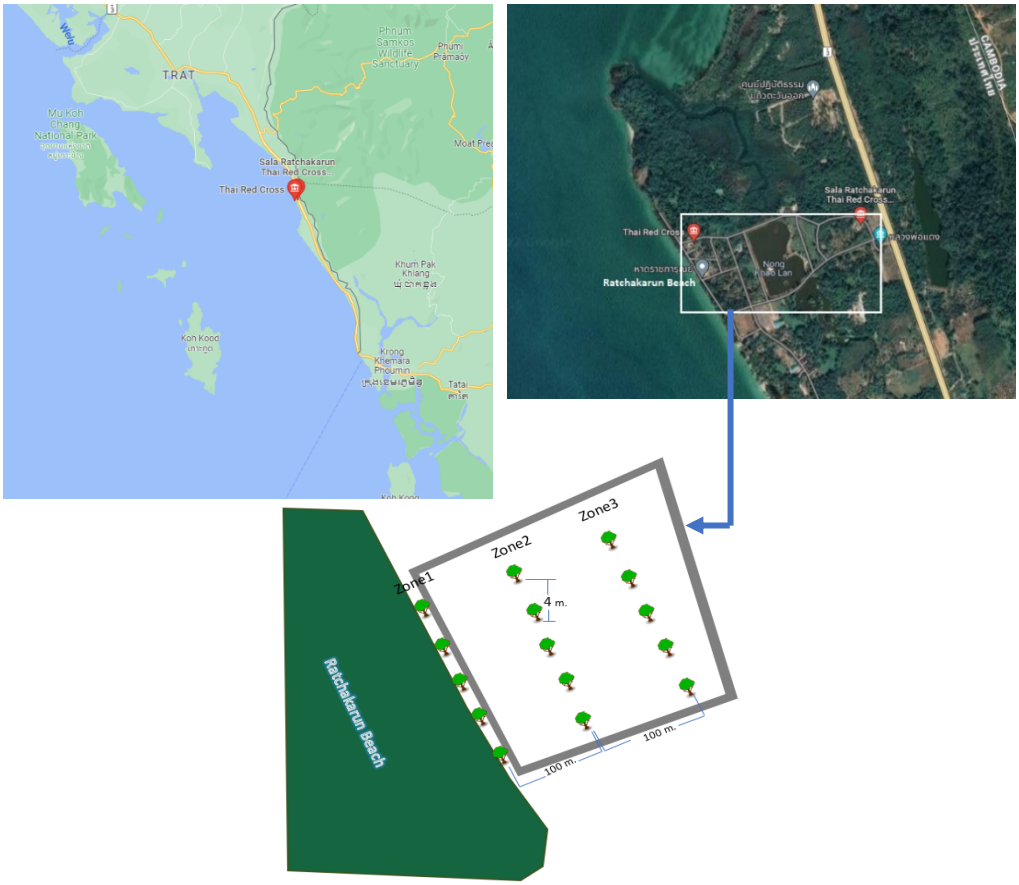

Figure 1. Map showing the location of Thai Red Cross Association's Khao Lan Center, with study plots and layout of experiment plan

Experimental design

Two factors, 3 planting zones and 9 species of eastern native orchids, were tested, to evaluate effects of distance from shoreline on survival ability of each eastern native orchid. The study was done based on factorials design in CRD, with five replicates. The planting area was divided into 3 zones, according to the distance from the coastline. The first zone is a distance of 5 meters from the coastline, the second zone is a distance of 100 meters from Zone 1, and the third zone is a distance of 100 meters from Zone 2. Forty

large trees with a height of more than 3 meters with rough bark, were selected in each zone, as host trees for the orchids. Nine species of eastern native orchids, namely *Aerides falcata* (Lindl. & Paxton), *Cymbidium aloifolium* (L.Sw.), *Dendrobium friedericksianum* (Rchb.f.), *D. crumenatum* (Sw.), (Rchb.f.), *D. farmeri* (Paxton), *D. hercoglossum* (Rchb.f.), *Micropera pallida* (Roxb.), *Rhynchostylis retusa* (L. Blume) and *Sarcoglyphis mirabilis* (Rchb.f.) were studied (Figure 2.).

Orchids plantation

In each zone, 5 large trees, with a trunk circumference of 80-90 centimeters, more than 3 meters high, with rough bark, were selected as habitats for orchids. Each tree was a minimum 4 meters apart, in the northwest and southeast planes. Layout of the experiment plan was shown in figure 2. Fifteen seedlings of each orchid species, obtained from the Department of Plant Production Technology and Landscape, Faculty of Agro-Industrial Technology, Rajamangala University of Technology Tawan-ok, Chanthaburi Campus, were randomly tied onto each selected tree, using motorcycle tires and plastic rope. One seedling of each species was tied to a tree 2 meters above the ground with each seedling 10 centimeter apart.

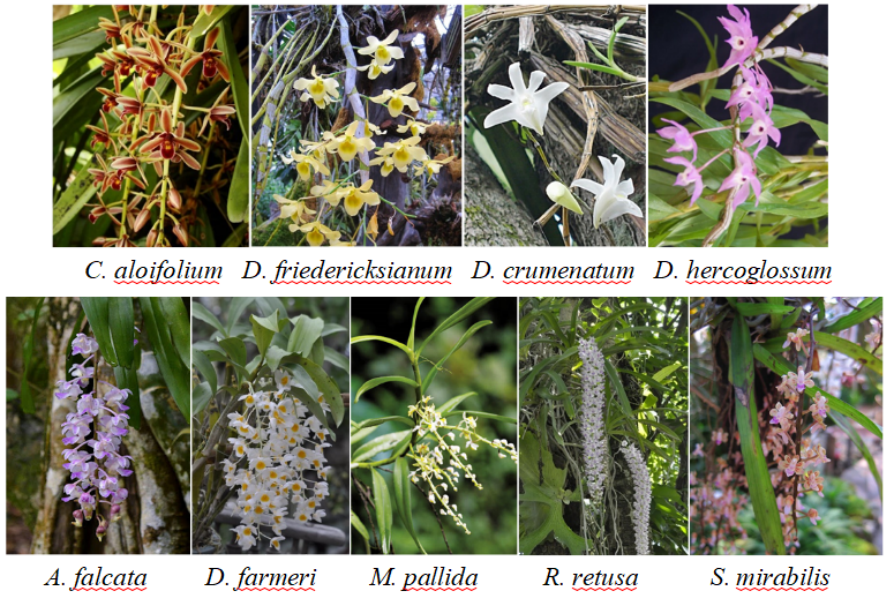

Figure 2. Nine species of eastern native orchids studied in the experiment
Sources: Adapted from the Botanic Garden Organization (2011)

Data collection

Number and length of leaves were record at beginning and 5 months after planting. Measuring tape was used to measure the leaves length. The roots came out from orchid's branch, counted as a new root produced, was recorded in each plant in interval of five months. After 5 months from planting, the number of living orchids on each tree was counted, to calculate the survival percentage.

Statistical analysis

Data collected from each treatment was subjected to statistical analysis through a Two-way ANOVA analysis. Differences among 9 species of eastern native orchids grown under zone treatment areas were compared, assessing differences and interactions. The multiple comparison of means was performed, using the Duncan' s New Multiple Range Test (DMRT), at significance levels of $\alpha = 0.05$.

Results

Survival

Overall results found that differences of orchid species do have an impact on survival. Distance from coastal shoreline had no effect on survival. There is also no interaction effect between the two factors. A summary of nine orchids species survival in different zone is shown in Figure 3.

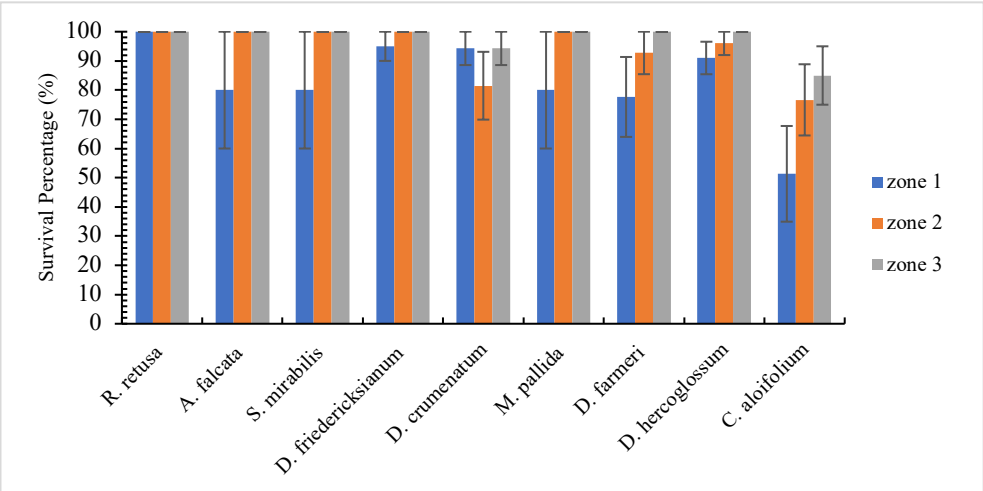

Figure 3. Survival of 9 eastern native orchids when living in coastal areas
Note: zone 1 is a distance of 5 meters from the coastline, zone 2 is a distance of 100 meters from Zone 1 and zone 3 is a distance of 100 meters from Zone 2

Results of multiple comparison analysis showed that one species of eastern native orchid, namely *C. aloifolium*, had the lowest survival percentage, significantly lower than the other species (Figure 3,). Survival percentage of the remaining 8 eastern native orchids were not significantly different ($p>0.05$). However, survival of most orchids in zone 1 tended to be lower than in the other zones.

Adapting to survive

The morphological parameters we investigated for the ability to adapt to survive include leaf dropping, reducing leaf size and number of new grown roots, which can be easily measured in the field. The effects of distance from shoreline on adaptation of difference nine eastern native orchids seedlings is summarized in Figure 4, 5, 6 and 7.

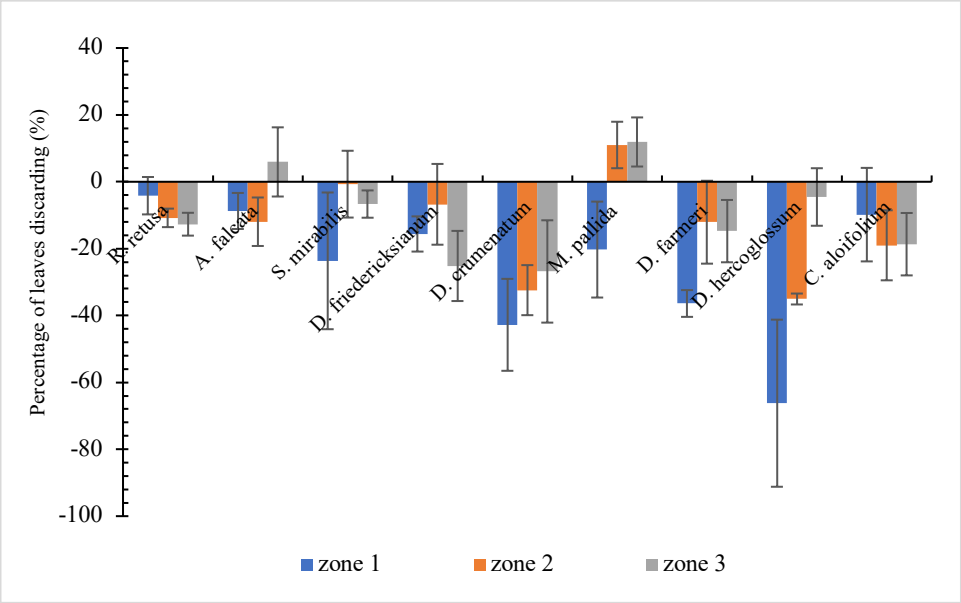

Figure 4. Leaves discarding of 9 eastern native orchids when living in coastal areas

Note: zone 1 is a distance of 5 meters from the coastline, zone 2 is a distance of 100 meters from Zone 1 and zone 3 is a distance of 100 meters from Zone 2

Five months after planting, it was found that leaf discarding was significantly affected by the main factors of different species and distance from the coastline, without their interaction. *D. hercoglossum* and *D. crumenatum* had the highest percentage of leaf dropping, significantly higher than *C. aloifolium*, *D. friedericksianum*, *S. mirabilis*, *R. retusa* and *M. pallida* ($p\leq0.05$). However, their leaf discarding was not statistically significantly different from that of *D. farmeri*. In addition, orchids grown in Zone 1 had

the highest leaf discarding percentage, significantly higher than those in other zones ($p \leq 0.05$). Meanwhile, orchids grown in zones 2 and 3 had no statistically significant difference in the percentage of leaf discarding ($p > 0.05$).

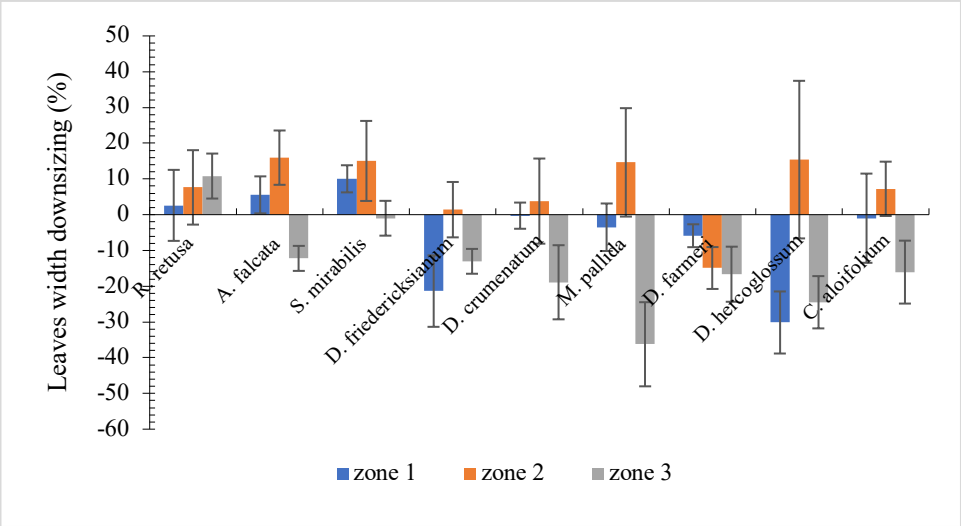

Figure 5. Leaf width downsizing of 9 eastern native orchids when living in coastal areas

Note: zone 1 is a distance of 5 meters from the coastline, zone 2 is a distance of 100 meters from zone 1 and zone 3 is a distance of 100 meters from zone 2

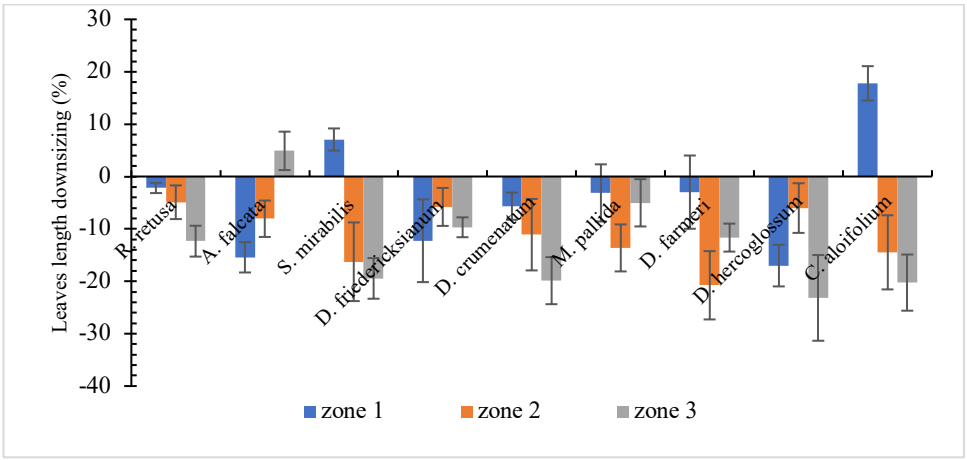

Figure 6. Leaf length downsizing of 9 eastern native orchids, when living in coastal areas

Note: zone 1 is a distance of 5 meters from the coastline, zone 2 is a distance of 100 meters from zone 1and zone 3 is a distance of 100 meters from zone 2

It was found that the leaf length downsizing of 9 native eastern orchid species was not significantly different, in vice versa to the leaf's width (Figures 5 and 6). Leaf width downsizing of most orchids was in a range of 1-16 percent, with *M. pallida* and *D. farmeri*, where their leaf width downsizing tended to be maximum. Leaf width downsizing of 9 native eastern orchids grown in zone 3 were significantly higher than those in other zones 1 and zone 2 ($p \leq 0.05$). Meanwhile, their leaf length downsizing grown in zone 2 and zone 3, were significantly higher than those in other zones 1 ($p \leq 0.05$). There was no significant in leaf width downsizing between orchids grown in zone 1 and zone 2. There was not significantly differed in leaf length downsizing between orchids grown in zone 2 and zone 3. There was no interaction between the factor of different species and distance from the coastline on the orchids leaf width downsizing; however, this is in vice versa to the leaf's length.

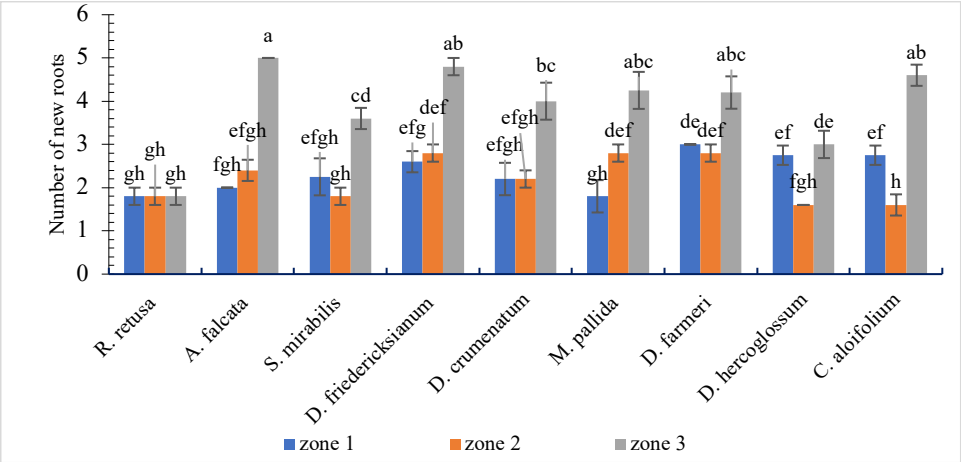

Figure 7. New roots number of 9 eastern native orchids when living in coastal areas

Note: zone 1 is a distance of 5 meters from the coastline, zone 2 is a distance of 100 meters from Zone 1 and zone 3 is a distance of 100 meters from Zone 2

It was found that number of new roots was significantly affected by the main factors of, different species and distance from the coastline (Figure 7). All 9 eastern native orchids planted in zone 3 had more new root number than in zone 1 and zone 2. Orchids, namely *D. friedericksianum* and *D. farmeri*, had highest new root numbers; while *R. retusa* had the least new root numbers. There was interaction between the factor of different species and distance from the coastline on new root number, indicating that new roots number of *A. falcata*, *S. mirabilis*, *D. friedericksianum*, *D. crumenatum*, *M. pallida*, *D. farmeri* and *C. aloifolium* trend to more likely to form when is grown in zone 3. Whereas new roots number of *R. retusa* tend to lower likely to form when is grown in every zone.

Discussion

Coastal ecosystems are characterized by severe environmental stresses, such as wind exposure, dryness, high light intensity, salt spray and soil salinity. To cope with these conditions, coastal plants often develop morphological and physiological traits, including succulent tissues to store water, a pubescent epidermis, a thick cuticle to reduce transpiration and water loss, and dwarfism to withstand strong wind (Hesp, 1991; Du and Hesp, 2020). Native orchids are the same. When living in a coastal area, these adaptations are necessary to survive and reproduce in environments different differing from their norm.

Nine species of eastern native orchids were planted in the coastal area, to optimize orchid species, noting various distances from coastal shoreline. The study found that most eastern native orchids will survive anywhere from 5 meters to 200 meters from the coast, with an average survival rate of over 90 percent, with *R. retusa* having a 100% survival percentage, in any zone. There is only one species, *C. aloifolium*, which has rather poor survival, with an average of just 71 percent. However, survival of most orchids in Zone 1 tended to be lower, than in the other Zones. It was expected, as Zone 1 is closest to the sea. Therefore, it first faces the severity of the wind waves blowing from the sea, including sea spray that is rich in salt. *C. aloifolium* is an epiphytic orchid usually found in open area, high land, with lots of sunlight (Hongthongkham and Promwong, 2017). When it was planted in coastal areas, covered with many large trees, blocking the light and facing excessive moisture from sea spray, it may have been a causal agent for lower survival.

Plants have physiological adaptation, in order to live in environments different from those in which they normally live. Orchids can be divided into 2 groups: leaf discard and non-leaf discard. Factors affecting the group that discards leaves are species and environment (Panchansingh, 2016). Leaf discarding, of most wild orchids, is a sign of flowering (Suwannaro, 2011). However, this study involved growing young seedlings of each species and collecting data after only 5 months of planting; therefore, leaf discarding of all 9 eastern native orchids is more likely a matter of adaptation for survival. It is thought that leaf discarding is a mechanism that orchids undertake to counteract the effects of excessive salt intake on plants. This is consistent with our results that found percentage of leaf discard tended to decrease in zones 2 and 3, respectively.

After orchids have adapted to living in all three coastal zone, they grow new roots to help find food for further growth. All 9 eastern native orchids planted in zone 3 had more new root number than in zone 1 and zone 2. This is expected to be a result of the sea spray, carrying salts and coming into contact with orchids in zones 1 and 2 more than zone 3, respectively, being that orchids grown in those zones are further from sea level.

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