Hydrocotyle umbellata L.: A NEW INVASIVE AQUATIC PLANT IN THAILAND

J. Pinsupa and S. Zungsontiporn
Weed Science Group, Plant Protection Research and Development Office, Department of Agriculture
Bangkok, Thailand
Pinsupa.j@gmail.com

Abstract: Water hyacinth (Eichhornia crassipes Solms) is one of the most well-known invasive aquatic plants in the world. In Thailand, apart from this species, there are plants species, which are gradually and steadily increasing their area of invasion, such as narrowleaf cattail (Typha angustifolia), Florida type water lettuce (Pistia stratiotes L.) and water milfoil (Myriophyllum brasiliensis Cambess.). The Dollarweed (Hydrocotyle umbellata L.) is also an invasive species and was intentionally introduced as an ornamental plant in aquaria about 10 years ago. The invasiveness of this plant was studied for its growth, competitiveness and reproduction ability, which is limited to the vegetative part. Even if the plant produces seeds, seedlings have never been found in the experimental field. The plant growth in water started increased 1 to 140 leaves within 3 months. The plant can compete against Asiatic pennywort (Centella asiatica L.) in experimental plots. At present, Hydrocotyle umbellata L has been found increasing its areas of invasion gradually in both aquatic and terrestrial habitats.

Key words: Ornamental plant, vegetative reproduction, Hydrocotyle umbellata

Introduction

Many aquatic plants were introduced for aquarium decoration or as general ornamental plants. Water hyacinth (Eichhornia crassipes Solm.) is a classic example of introduction of such an invasive aquatic plant through human intervention, which has made it distributed throughout the world. Thailand is now facing invasion of some aquatic invasive plants, which were intentionally introduced to the country. Water lettuce (Pistia stratiotes L.), the only species of genus Pistia L., especially the Asian type, could be found in closed water body such as swamps, ditches in orchards and ponds. However, the Florida type was introduced as an ornamental aquatic plant and was sold in Sunday markets. At present the plant can be found in many water bodies especially along roadsides or near communities.

Water milfoil (Myriophyllum brasiliensis Cambess.) was introduced for ornamental purpose about 20 years ago. Today the plant is still being sold as aquarium and aquatic ornamental plant in the market. The plant grows very well in the absence of natural enemies in canals, streams and swamps all over northern Thailand. The narrowleaf cattail (Typha angustifolia L.) is the most invasive plant in Thailand at present. It was introduced to Thailand for flower arrangements and as an ornamental plant about 30 years ago. Presently, the plant grows luxuriantly in swamps, shallow ponds, vacant paddy fields or waste land where soil is with high moisture, including roof-gardens in high building in downtown Bangkok. The plant can form pure stands after occupying the area within few months. Numerous tiny seeds with hair are blown by the wind to far away places make the plant distribute very fast.

Hydrocotyle umbellata L., is an aquatic, or water-loving, perennial plant with many common names such as Dollarweed, marsh or water pennywort or navelwort, native to America (NRCS, USDA, 2007). The plant was introduced to Thailand more than 10 years ago and sold in market as an ornamental plant. With shiny round leaves and easy growing, the plant has become popular in aquariums plant few years later. The plant can produce roots at every node and new shoots from lateral buds at leaf axils. Thus, it can propagate through vegetative parts, i.e. nodes with a leaf. Generally, this plant can grow vigorously as natural enemies are not found in aquaria (Plate 1)
The plant is still popular as an aquarium plant and through misidentification with Asiatic pennywort, it is consumed as a vegetable. Moreover, the entry route of ornamental plants is an important pathway of spreading these species far and fast, by human beings. Thus, the purpose of this study was to evaluate weed potential of Dollarweed in Thailand, aiming at preventing the spreading of this plant in nature.

**Materials and Methods**

**Propagation ability of vegetative parst.**
As Dollarweed (*Hydrocotyle umbrellata* L.) is a creeping plant and new shoots emerge from the lateral buds at every leaf axis, the shoot apex with four leaves of Dollarweed was selected and was cut at 0.5 - 1 cm away from both sides of the node. Each node with a leaf was placed in a beaker containing three different media namely, *i.e.* 100 ml water, 5 g soil + 100 ml water, and 10g soil + 100 ml of water, with 5 replicates. All beakers were placed at room temperature under natural conditions. Water levels in beakers were maintained at the same level throughout the experiment. The plant growth parameters such as root growth, leaf number and number of newly emerging shoots were recorded every 3 days for a period of one month.

**Growth of Dollarweed**
Cuttings containing one node with a mature leaf were grown in 34 cm x 47 cm x 12 cm pots containing soil at 8 cm deep, totaling to 38 pots. The water level was kept up to the top of the pot throughout the experiment, to simulate the flooded conditions. The number of leaves in each pot was recorded every 7 days up to 168 days.

**Competition with other plant**
Asiatic pennywort (*Centella asiatica* (L.) Urban), which is an indigenous vegetable and considered as a medicinal plant in Thailand, was used for competitive studies with Dollarweed. Both plants were grown in a 100 cm x 100 cm pots with a fixed population density, *i.e.* 5 plants per pot, while using the replacement series method to have the ratio of the number of Dollarweed:Asiatic pennywort in each pot as 5:0, 4:1, 3:2, 2:3, 1:4 and 0:5, with 3 replicates. Pots were watered everyday to field capacity. The leaf number of each plant was recorded every 7 days up to 154 days, and the first record was made at 14 days after planting. At the end of the experiment, all the plants were removed, cleaned to remove soil and weighed for fresh weight. Thereafter, all leaves were removed for measurement of the
leaf area using leaf area meter (Hayashi Denkoh, ACC-400). All plants were dried in an oven at 70°C for 3 days and the dry weight was recorded for individual plant.

Allelopathic potential
Allelopathy is considered as an important character of plants if they are to become strong weeds or an invasive plant. Roots, leaf stalks and leaves were prepared fresh and dried with 0 (control), 0.01, 0.05 and 0.1 g of materials placed separately between 10-10 agar (0.3%) in \( \Phi 29 \text{ mm} \times 130 \text{ mm} \) test tube. Then 5 seeds of lettuce were sown in each tube. The experiment was carried out with 3 replicates. The tubes were sealed with a transparent film and kept in 25°C under dark conditions. The root length and shoot height of each plant were recorded.

Field observations.
The area of infestation of Dollarweed in the wild was surveyed in the north, northeast and central region of Thailand. The habitat of the infestation was also recorded.

Results and discussion

Propagation ability of vegetative part
The planting material with the first node and the youngest leaf of the shoot apex, without roots, was green for a week and after that the plant died under all conditions. Although some plants had new short roots, they died later. A similar trend was observed with the first node in water + 5 or 10g of soil, but the plant green for a shorter period (Table 1). When the panting material with the second node was used, only the plant in water medium was green until the end of the experiment, but those in water + soil died. However, those that survived in water did not produce new leaves. The panting materials with the third node survived under all conditions but only 2 out of 5 plants in water produced new but small leaves. All the planting materials with the fourth node survived and grew well, producing new leaves in all growing conditions tested.

<table>
<thead>
<tr>
<th>Condition of growing</th>
<th>Order of node from shoot apex</th>
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<tbody>
<tr>
<td></td>
<td>1st node</td>
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<tr>
<td>Water</td>
<td>B-0</td>
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<tr>
<td>Water + 5g soil</td>
<td>0</td>
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<td>Water + 10g soil</td>
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Growth of Dollarweed.
In the first 7 days of the experiment, only few plants started producing new shoots, which later became the main shoot. The number of leaves of the plants increased gradually with time. After the lateral buds elongated with leaves on the branch, the number of leaves increased around 50 days after planting (Figure 2). The number of leaves increases after second and third branches were fully developed.

Competition with other plants
The number of leaves. The Average number of leaves at the onset of experiment for Dollarweed was 1, and for Asiatic pennywort 5. The number of leaves of both plants increased gradually with time (Figure 3). The increase in the number of leaves of both plants was followed a similar pattern, with the number leaves per plant in Dollarweed was marginally higher than that of the Asiatic pennywort. The number of leaves of the Asiatic pennywort was markedly higher than that of Dollarweed in the pots where this species was
grown 3 and 4 plants of Asiatic pennywort. However, at the end of the experiment, the total number of leaves per plant of the Asiatic pennywort was higher than that of the Dollarweed except in pots where the number of Asiatic pennywort was less. At the end of the experimentation, the average leaf number per plant for Dollarweed + Asiatic pennywort was 360±0, 527±455, 708±302, 386±577, 591±694 and 0±594 in pots where Dollarweed were grown alone, and in pots where Dollarweed plants : Asiatic pennywort was grown at a ratio of 4 + 1 Asiatic pennywort, 3 + 2, 1 + 4, and Asiatic pennywort alone, respectively.

Leaf Number

Figure 2. Growth of Dollarweed in pot (number of leaves)

Leaf area: The average leaf area of each treatment is shown in Figure 4. The average leaf area of both plants follow the same trend of change, and less competition was observed in the same species with the higher leaf area. Leaf area for individual plants of Dollarweed was 692, 1,110, 1,5159, 1,429 and 3,259 dm² when grown at 5, 4, 3, 2 and 1 plant per pot in combination with 0, 1, 2, 3, and 4 plants of Asiatic pennywort. The leaf area of Asiatic pennywort was 1,810, 924, 1502, 1055 and 902, respectively (Figure 4). 

370
Figure 4. Average leaf area of individual plant at the end of the experiment.

**Fresh weight and dry weight:** The average fresh weight of Dollarweed was higher than the Asiatic pennywort in all the treatments that included both species. The change of dry weight showed similar pattern to that of fresh weight, except that when the Dollarweed alone pots showed a lower dry weight per pot when compared that with Asiatic pennywort alone.

![Figure 5. Average fresh and dry weight of individual plant of Dollar weed and Asiatic pennywort](image)

**Allelopathic potential:** Lettuce grown in 0.3% agar with fresh dried leaf (DL), dried shoot (DS), dried root (DR), fresh leaf (FL), fresh shoot (FS) or fresh root (FR) at 0.01, 0.05 or 0.1g are shown in Figure 6. The root growth of lettuce decreased at higher rates of the Dollarweed. Both root and shoot growth of lettuce grown with dried Dollarweed was less than that under fresh Dollarweed. The root growth of lettuce did not show any progress when treated with all the rates of dried root of Dollarweed. The growth of lettuce (fresh weight) was 6.3, 1.2 and 0% of control when treated with 0.01, 0.05 and 0.1 g of the roots of Dollarweed, and shoot growth was 0 in all rates of dried root.

**Field observations**
Infestation of Dollarweed was found in a mango orchard where the plant was grown as an ornamental plant. It formed a thick mat on which a man could walk. The plant had to be cut to move out from the body of water, but small pieces of plant were spread out along the water way in the orchard, thus the plant could compete against torpedograss (*Panicum repens* L.). In a village in northern Thailand, the plant grew throughout the yard in front of a house even under dry soil conditions. The plant infestation was found both in the water along roadside as
well as on uplands with moist soil or dried areas. In some swamps the plant occupied both the water and more than 1 meter up in the bank, forming a thicket, which was previously occupied by a global invasive plant swamp, morning glory (Ipomoea aquatica Forsk). In all the locations it was noted that the plant had no damages from any natural enemies.

Figure 6. Effect of various parts of Dollarweed on growth of lettuce (root length and shoot height - % of control)

Since the plant has shiny green leaves it is attractive as an ornamental plant. Thus, the spread can be faster through the human intervention in the ornamental plant market. The plant roots at every node, new shoot emerge from the bud at leaf axil, and young shoots (2nd - 3rd leaf from shoot tip) can be used for propagation. The plant can grow rapidly (to reach 226 leaves within 168 days or around 6 months), and could form a pure colony and compete against other plants. In the case of grown together with the Asiatic pennywort, the leaf number and leaf area of Dollarweed is affected, however, its mass (dried weight) could be much higher than Asiatic the pennywort. Moreover, the plant exhibits allelopathic effects on other plants. These characters demonstrate the strong weedy nature of the species (Muenscher, 1980).

Moreover, the plant is non-native to the Asian continent, thus without natural enemies in the introduced environments, including Thailand.

**Literature cited**
