

*Paris luquanensis* x *P. polyphylla* var.  
*stenophylla* Hybrid: A Unique, Yet  
Vulnerable, Species with Medicinal and  
Horticultural Value

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**Figure 1:** *Paris polyphylla* var. *stenophylla* inflorescence (Chen, 2017)



**Figure 2:** *Paris luquanensis* inflorescence (Crustacare, 2016)

## EXECUTIVE SUMMARY

The genus *Paris* contains many species of rhizomatous, herbaceous, perennial plants with similar appearance and characteristics to one another. All species of *Paris* develop varying amounts of steroidal saponins of medicinal value in their rhizomes. This medicinal value is the primary factor for the plant's rise in popularity in south-west Asia and Indo-China. These steroidal saponins have been shown to have positive effects on a plethora of medical conditions, from bug bites to halting the initiation and proliferation of several forms of cancer cells. The unique appearance of the entirety of the plant, particularly the structure of the inflorescence, is hard to ignore, making this a strong potential new exotic plant on the markets. This new crop review focuses on the marketing potential of the new and previously undocumented and unnamed cross of *Paris luquanensis* x *Paris polyphylla* var. *stenophylla*. Several challenges for this new cross were identified, such as difficulty germinating, a long seed dormancy of 5+ months, slow growth, and low leaf number. The long seed dormancy of over 7 months is notably

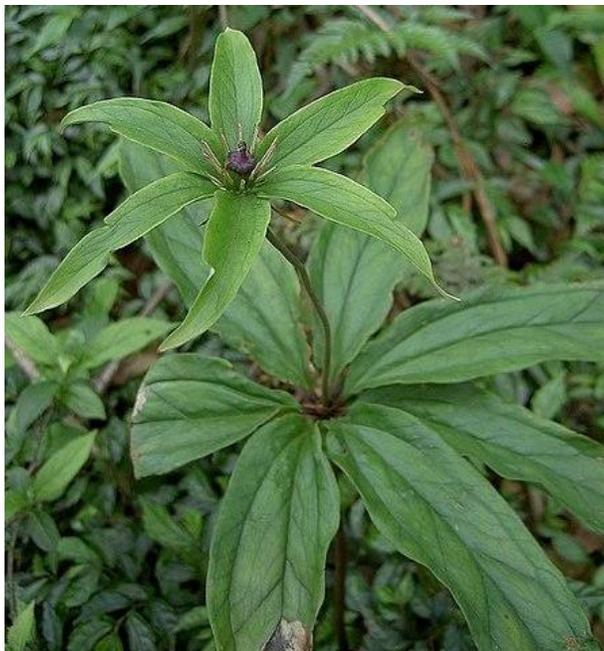
challenging to deal with from a commercial production environment perspective. However, the challenges are largely redacted when propagated through rhizomal division. *Paris x sereniflora* was chosen as the scientific name for this cross along with Forest's Whisper as the common name. With a wide range of hardiness zones, a love for shade, and a lone eye-catching flower that rests in serenity, the name speaks for itself. Follow along to be whisked away by the magic of Forest's Whisper.

## I. INTRODUCTION

### A. Study Species.

*Paris luquanensis x Paris polyphylla var. stenophylla*

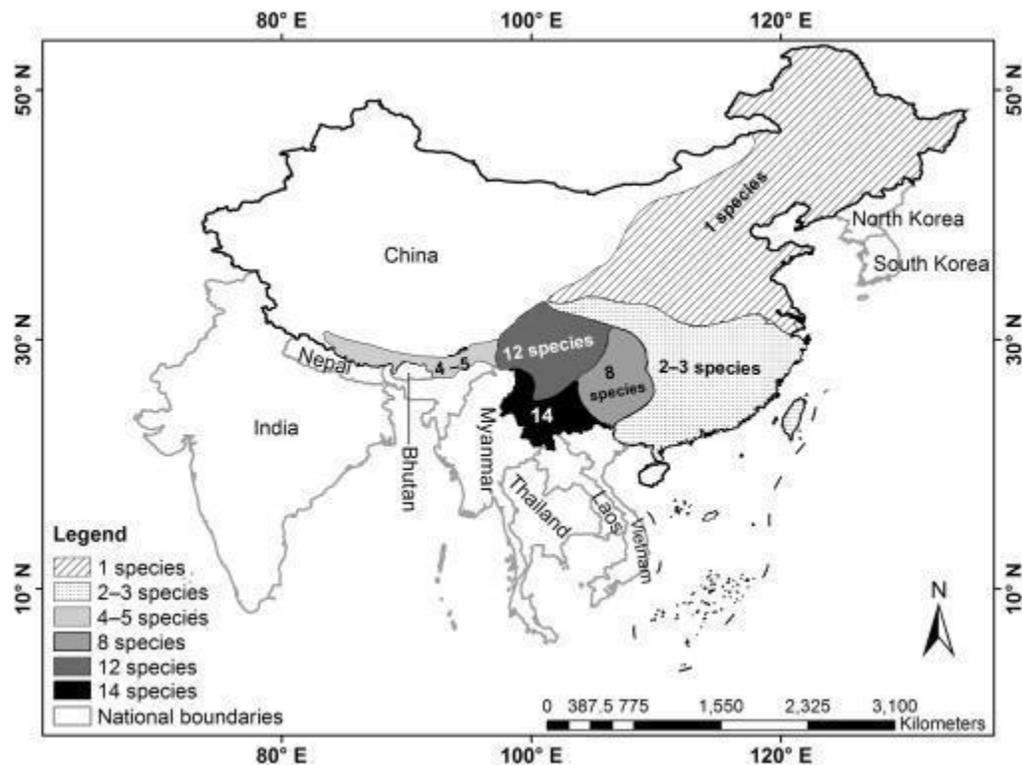
This is an interspecific hybrid between two *Paris species* and has not been named as a new, interspecific hybrid. It is unclear why this is the case, although the opportunity exists to name it. Considering the natural environment, ornamental value and rare exotic characteristics of this cross, *Paris x sereniflora* is suggested as the scientific name for this new hybrid with a common name of Forest's Whisper.



**Figure 3:** *Paris polyphylla* leaves and flower bud – 七葉一枝花 “qiye yizhihua” (Alnus, 2008).

## B. Taxonomic Classification and Geographic Distribution in the Wild.

The genus *Paris* originates in Southwest Asia, tracing its roots back to China, Taiwan, Indochina, and the Indian Subcontinent (Cunningham, A. B. et al. 2018). As a monocot that is a member of the Melanthiaceae family, *Paris* is closely related to the genus *Trillium*, possessing similar rhizome structures. *Paris polyphylla* is known as *qiye yizhuhua* (seven leaves one flower) in Mandarin Chinese, alluding to the peculiar look of *Paris* (Figure 3). The simple structure often with twenty-two or fewer leaves with one eye-catching flower is consistent amongst all *Paris* subspecies with variation occurring in the number of leaves and inflorescence structure, and color.



**Figure 4:** Species distribution map of *Paris polyphylla* species (Cunningham, A. B. et al. 2018).

*Paris* has many unique and far-spread subspecies, namely the *Paris japonica*, which diverged from *Paris polyphylla* around 20 million years ago when islands of Japan were separated from Asia (Yang, et al. 2019). *Paris japonica* is found in sub-alpine regions of Japan and claims the title of the most complex genome of any organism on earth with up to a

staggering 150 Gbp (1C = 152 pg) (Pellicer, et al. 2010). The furthest extent of the spread of *Paris* has not been precisely documented, however *P. var. quadrofolia* is a native Eurasian variety that was found from Iceland to the Mongolian steppes (Ding, et al. 2021), suggesting a vast distribution of the *Paris* genus. With the recent decline in *Paris* sub-populations, it is unlikely to discover the total global distribution of *Paris* at its peak. The center of diversity of *Paris* is in southwest Asia with fourteen species located there, with the number of species decreasing from that region (Figure 4).



**Figure 5:** Distribution of *P. luquanensis*  
(Royal Botanical Gardens Kew)



**Figure 6:** Distribution of *P. p. var. stenophylla*  
(Royal Botanical Gardens Kew)

*Paris luquanensis* was first published as a unique species in 1982 and is native to temperate Southern Sichuan and North central Yunnan, China (Figure 5). It is a dwarf variety growing only a few inches off the ground, presenting up to eight leaves in whorls of four with white variegation on dark green leaves. *P. luquanensis* displays a beautiful purple coloration on the stem up to the ovary. The purple ovary is surrounded by six bright green leaflets that are complemented by six yellow string-like petals (Figure 2). When pollinated, *Paris luquanensis* produces a single bright red fruit similar to other native Asian *Paris* species (Figure 7). *P. luquanensis* is a dwarf variety with a height of 6in (15 cm) or less and a width of 3in (7.6 cm) or

less. The rhizome of *P. luquanensis* is among the smallest of all the *Paris* genus, only reaching sizes of 5-6in (12-15 cm).

**Figure 7:** Mature fruit containing seed of *Paris luquanensis*. (Crustacare, 2016)

*Paris polyphylla* var. *stenophylla* was discovered in 1888 (Nouv. Arch. Mus. Hist. Nat. 1888) and is native closer to the Indochinese mountainous region as well as southern China in the provinces of Tibet and Yunnan (Kunwar, et al. 2020). In these temperate and alpine climates, the perennial *P. p.* var. *stenophylla* regrows from its rhizome after each winter through the summer months into spring displaying long yellow string-like petals (Figures 1, 8). The height of *P. stenophylla* ranges 4-35 in (10-90cm) and displays a width of ~12in (~30cm) at the leaves. *P. stenophylla* possesses the same style red fruit upon successful fertilization (Figure 7).



*Paris* plants form a single fruit with many ovules containing approximately 50-60 seeds per plant at maturity (Figure 7). However, the *Paris* genus overall displays an incredibly slow rate of germination with its seeds taking 5-8 months to germinate depending on the variety (Phurailatpam, et al. 2022). This slow rate of reproduction has allowed only the most genetically fit plants to survive in each given climate, leading to species variation based on geographical location. *Paris* displays a tendency to naturalize and coexist with its environment, where it contributes to ground cover with its relatively small footprint.

*Paris polyphylla* has been used for a multitude of traditional medicines in its native area of South China and Indochina. Traditional medicine in the Asian and Indochinese regions has utilized the rhizome of *Paris polyphylla* to treat several ailments. The rhizome of all subspecies of *Paris* possess medicinal value but vary in effect and efficacy based on the subspecies' phytochemical properties and composition.



**Figure 8:** *Paris p. var. stenophylla* inflorescence in bloom (Chen, 2017)

In traditional Chinese medicine, rhizoma Paradis, the dried rhizome of *Paris polyphylla*, is known to treat abnormal uterine bleeding, Alzheimer's, and most notably inhibiting the proliferation of liver, ovarian, bladder cancer (Pang, et al. 2020; Liu, et al. 2022; Guo, et al. 2018), among many other uses. *Paris polyphylla* var. *yunnanensis* is currently an attractive variety of *Paris* for research due to its rhizome possessing many medicinally beneficial phytochemicals. These phytochemicals are known as steroidal saponins, over twelve of which have been identified (Thapa, et al. 2022). The current twelve identified steroidal saponins consist of polyphyllin I (PPI) through polyphyllin VII (PPVII), and polyphyllin D, E, F, G, and H. Two of the mentioned steroidal saponins, polyphyllin II and polyphyllin E are notably

effective in inhibiting the proliferation, migration, and invasion of liver and ovarian cancer respectively (Pang, et al. 2020; Liu, et al. 2022). Both PPII and polyphyllin E demonstrate anti-cancer properties by down-regulating the AKT/NF- $\kappa$ B signaling pathway, causing marked cell death of cancerous cells. The extent of the effects steroidal saponins exhibit in inhibiting cancer proliferation, migration and invasion is not yet fully understood.

The effects of *Paris* saponins on various forms of cancer are of particular interest and have been attracting a steadily increasing amount of research around this potentially life-changing interaction in recent years. However, these promising medicinal research efforts are often thwarted by the species' rapid decline due to the overharvesting of wild plants. The positive and desirable effects of *Paris* paired with the incredibly slow rate of reproduction and difficult-to-break dormancy put the species in a difficult place for further research.

The unnamed and undocumented cross of *Paris luquanensis* x *Paris* var. *stenophylla* has yet to be researched, leaving the steroidal saponin composition, and thus the medicinal value of the rhizome unknown. It can be deduced that the rhizome of *P. luquanensis* x *P. var. stenophylla* likely possesses steroidal saponins similar to that of all other analyzed subspecies of *Paris*. However, further research and phytochemical analyses are needed to identify the specific phytochemical composition of this new cross to determine its potential medicinal value.

## **II. CROP SPECIES**

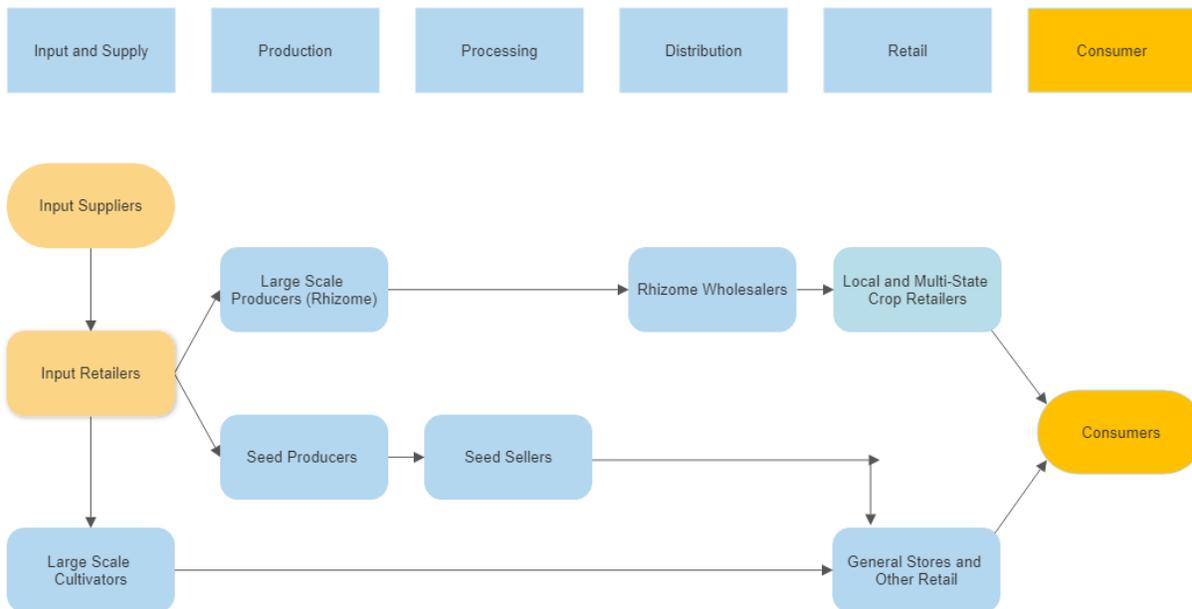
### **A. History and Potential Uses.**

*Paris* has a long history of use with humans, serving as ancient Chinese medicine and treating ailments as simple as a snake or bug bite to treating various forms of cancer (Jagmohan, et al. 2014). The medicinal value along with its unique perfect complete flower appearance has certainly led to humans keeping the plant around. The desire for individuals to personally seek out and cultivate *Paris* is evident in Nepal, with the locally native species *Paris polyphylla* Smith

becoming highly sought after in the wild and even making it on the International Union for Conservation of Nature (IUCN) list of vulnerable species in 2020. *Paris polyphylla* has been notoriously harvested in the wild, one of the key reasons it is listed as vulnerable on IUCN's red list. There are currently no large-scale, consolidated, traceable supply/distribution chains in Asia, Indochina, or the Indian subcontinent (Kunwar, et al. 2020). Aside from the limited number of identifiable small legal operations, most companies or individuals that sell or use rhizoma *Paradis* collect it from feral sources, or unregulated and often illegal cultivation.

There are a multitude of small businesses attempting to market the relevant parental varieties of this review, *P. polyphylla* var. *luquanensis* and *P. p.* var. *stenophylla* as well as *P. p.* var. *yunnanensis* and possibly more species in extremely low quantities. However, there are few sites that have seed in stock. If seeds were available, the long and tedious germination process of *Paris* seed is effectively a barrier to mass production and adoption of the plant. Therefore, asexual propagation of the rhizome is necessary to ensure continuous and consistent sales for cultivators. Currently, no major producers, distributors, or cultivators are selling any variation of the *Paris* genus in the United States. Therefore, a hypothetical distribution chain is presented below with the intent of highlighting the possibility of *Paris luquanensis* x *P. polyphylla* var. *stenophylla* being cultivated asexually for both medicinal and horticultural purposes.

Due to the long (5+ months with stratification) and hard to break dormancy of the seeds, a supply and distribution chain for both noted varieties of *P. polyphylla*, the crop *Paris luquanensis* x *P. polyphylla* var. *stenophylla* would need to be asexually propagated by rhizomes. Therefore, the supply chain must focus on establishing large volumes of rhizomes to be harvested, then distributed down the chain while still maintaining biological functionality. This ends up creating a supply chain that is like other rhizo-propagated crops such as *Zingiber officinale*, *Lilium*, and *Hosta*.



**Figure 9:** Hypothetical horticultural distribution chain for *Paris luquanensis* x *P. polyphylla* var. *stenophylla*.

### III. PRODUCTION INFORMATION

#### A. Anticipated Cultural Requirements.

##### Life Cycle:

*Paris polyphylla* var. *stenophylla* x *Paris luquanensis* is an herbaceous perennial plant. Its perennial nature means that it can be marketed as a long-lived garden plant, providing visual interest and potential medicinal benefits for multiple years. The genus *Paris* has the ability to be asexually propagated through rhizome division which is convenient and simple for home and commercial growers alike.

##### Plant Characteristics:

*Paris* is primarily known for its unique and attractive flowers, as well as the medicinal value contained within the rhizome. The new cross *P. luquanensis* x *P. p.* var. *stenophylla* has the ability to tap into several markets. *P. luquanensis* is a dwarf variety of *Paris*, and *P. p.* var. *stenophylla* is also a shorter variant of its direct ancestor, *P. polyphylla*. Given this short height, this new cross can be marketed as a potted plant for outdoor gardens or as an indoor house plant.

*P. luquanensis* x *P. p. var. stenophylla* should also be marketed as an herbaceous perennial, to be used for bordering or to complement woodland or shade gardens with its unique appearance and its late season purples. This cross takes up very little space with a relatively low leaf count, thin inflorescence, and an estimated height of ~12 in ( ~31 cm) and width of ~6 in (~15 cm) based on the parental phenotypes, giving a foot print of 0.5 ft<sup>2</sup> (0.05 m<sup>2</sup>). *P. luquanensis* x *P. p. var. stenophylla* could be used as a foliage plant as well as an edible crop, as the rhizome can be harvested and prepared for its medicinal effects.

### **Winter Hardiness & Heat/Drought Tolerance:**

Both *Paris polyphylla var. stenophylla* and *Paris luquanensis* are native to subtropical, temperate, and alpine regions of Asia. Given this native region, a USDA Hardiness Zone of 5a to 9b is likely suitable for rhizome survival. The USDA Heat Zone is approximated to be 5-8. Although the plant could likely survive the temperatures of southern United States climates, the sun may be too intense as there is little shade, leaving some room for adjustment on the USDA zone recommendations. The zones listed cover most of the United States, allowing for this new cross to be marketed to a vast majority of America's population. Even in the areas that are not ideal for outdoor cultivation, the small stature of this new cross allows for indoor cultivation, giving everyone an opportunity to grow this new and exciting cross.

### **Potential Production Environment:**

#### **1. Seed/Cutting:**

- **Light:** Partial shade to shade. 55-65% shade/ day.
- **Photoperiod response:** Not day length sensitive.
- **Day/Night Temperature:** 68-72°F (20-22°C) for germination. Once germinated or for rhizome propagation, Day: 60-75°F (15-24°C) Night: 50-60°F (10-15°C).
- **Nutrition and watering:** Apply a balanced fertilizer (10-10-10) every 4-6 weeks after the first set of true leaves develop. Water regularly when needed, ensuring the media remains moist.

- **Soil or soilless media type:** Well-draining seed starting mix for germination, then well-draining loamy soil with a pH of 5.5-7.0.
- **Plant growth regulators:** Soak uncoated, dried seeds in 600 mg/L GA<sub>3</sub> for 48 h prior to stratification. For rhizome production, drench rhizome in media with a mixed solution of 0.5 µg mL<sup>-1</sup> 6-benzylaminopurine (BAP) and 0.2 µg mL<sup>-1</sup> α-naphthalene acetic acid (NAA) to promote rhizome shoot growth.
- **Pest and disease management:** Common pests, location dependent. Susceptible to Pepper mild mottle virus (PMMoV)
- **Container Size:** 128 plug trays for germination. 2.5-3” (6.4cm-7.6cm) pot for rhizome propagation.

## 2. Vegetative:

- **Light:** Partial shade to dappled sunlight. 50-60% shade/ day.
- **Photoperiod response:** Not day length sensitive.
- **Day/Night Temperature:** Day: 60-75°F (15-24°C). Night: 50-60°F (10-15°C).
- **Nutrition and watering:** Apply a balanced fertilizer (10-10-10) every 4-6 weeks. Water regularly when needed, ensuring the media remains moist.
- **Soil or soilless media type:** Well-draining loamy soil with a pH of 5.5-7.0.
- **Disease/Insect control measures:** Monitor for common pests like aphids, spider mites, and slugs; use integrated pest management (IPM) strategies. Susceptible to Pepper mild mottle virus (PMMoV) and botrytis (gray mold).
- **Pinching:** Not required.
- **Plant growth regulators:** For rhizome production, apply 6-benzylaminopurine (BAP) and/or α-naphthalene acetic acid (NAA) to promote rhizome shoot growth. Concentration variable based on rhizome size.
- **Container Size:** 2.5” – 4” (6.4cm-10.2cm) pots depending on size of plant and rhizome.

## 3. Flowering:

- **Light:** Partial shade to dappled sunlight. 40-60% shade/ day.
- **Photoperiod response:** Not day length sensitive.
- **Day/Night temperature:** Day: 60-75°F (15-24°C). Night: 50-60°F (10-15°C).

- **Nutrition and watering:** Apply a balanced fertilizer (10-10-10) every 4-6 weeks. Water regularly when needed, ensuring the media remains moist.
- **Soil or soilless media type:** Well-draining loamy soil with a pH of 5.5-7.0.
- **Disease/Insect control measures:** Monitor for common pests like aphids, spider mites, and slugs; use integrated pest management (IPM) strategies. Susceptible to Pepper mild mottle virus (PMMoV) and botrytis (gray mold).
- **Container Size:** 2.5"- 6" (6.4cm-15.24cm) pots depending on size of plant and rhizome.

## B. Market Niche

Introducing the enchanting "Forest's Whisper": a captivating new dwarf hybrid born from the rare and mysterious *Paris luquanensis* crossed with the striking *Paris polyphylla* var. *stenophylla*. This extraordinary plant combines the best of both parents, featuring a mesmerizing floral structure, contrasting light and dark green variegated foliage, and compact growth providing many options for propagation location. Forest's Whisper is a versatile and elegant addition to any garden, thriving in shaded environments and bringing a touch of mystical forest to your home and garden.

This remarkable hybrid not only adds visual allure to your space but also carries the legacy of the *Paris* genus, boasting potential medicinal properties that have been revered in traditional medicine for centuries. As an herbaceous perennial, Forest's Whisper is a low-maintenance option that will reward you with its exquisite beauty year after year.

Several factors set Forest's Whisper apart from its direct competitor and related genus *Trillium*, such as its unique medicinal properties and longer bloom duration, make Forest's Whisper a sought-after gem for gardeners across a wide range of USDA Hardiness Zones. So, whether you're an avid gardener looking to create a serene woodland retreat, a traditional medicine enthusiast seeking to explore the healing potential of nature, or simply looking to add an eye-catching ornamental to your home, Forest's Whisper promises to be an exceptional and

enchanting addition to your collection. Join us in the 2026 unveiling of Forest's Whisper, and let it whisper its secrets to your heart.

### **Target Sales Date(s):**

The primary target range for sales of Forest's Whisper in the United States is spring, as the demand for perennials and garden plants overall is at its peak. However, Forest's Whisper could also be promoted during other times of the year such as summer, when the plant is in bloom. While in bloom, the unique features of Forest's Whisper will surely sell themselves. Indoor greenhouse facilities could continuously produce Forest's Whisper over the winter months, as its size and slow growth make for an excellent house plant.

### **Programmability:**

Forest's Whisper could be readily forced year-round if potted and kept indoors over the winter months. This could be done by moving the plant from the outdoors to indoors, or by permanently keeping the plant indoors, where it will adapt to the environment. Given its perennial nature, outdoor non-potted Forest's Whisper would be grown for a single season from spring to fall.

### **Potential Crop Limitations:**

Both *P. luquanensis* and *P. p. var. stenophylla* are native to subtropical regions, with *P. p. var. stenophylla* flowing into temperate and sub-alpine regions. Although suited for most climates within the United States, climate sensitivity problems may exist, limiting outdoor cultivation and propagation to specific areas. Since Forest's Whisper is a new and undocumented cross, the specific USDA Hardiness and Heat Zone recommendations are approximate and will be adjusted as this new crop gains popularity in various microclimates around the United States and the world. It can be deduced based on the given native climates that Forest's Whisper may struggle in excessively arid and frigid conditions.

Pests and disease interactions with Forest's Whisper are yet to be investigated, as the fauna and pathogens in the United States vary significantly from that of Asia. Botrytis is a common strain of fungus many plants suffer infection from, and Forest's Whisper is no exception. A new species of botrytis was recently discovered causing molding of *Paris polyphylla* foliage (Zhong, et al., 2019), suggesting that unknown pathogens may arise in this new cross upon migration and distribution around the United States. Further research and evaluation are needed to better identify the interactions and susceptibility of Forest's Whisper to pests and diseases.

The cultivation and propagation of *Paris* is notoriously time-consuming, particularly when germinating seed. 16-24 months is the expected germination time of seeds in the wild, but this can be reduced to 5-6 months through low-temperature stratification. Stratification of *Paris* seed also tends to increase the percent germination as well, making this a viable method. However, due to the immense duration for germination to take place, it is unlikely that this form of propagation will become mainstream in the ornamental perennial market niche. Although the exact germination time for Forest's Whisper is unknown, similar values can be approximated.

### **Competitive Crops:**

Forest's Whisper will be in direct competition with other ornamental perennial plant varieties such as *Trillium* and *Helleborus*. As a fellow member of the Melanthiaceae family, *Trillium* is also an herbaceous perennial that is popular in woodland and shade gardens and is known for its beautiful three-petaled flowers. *Helleborus* are popular ornamental perennials, most known for their early spring blooms and ability to thrive in shaded environments. Offered in a wide range of colors and forms, *Helleborus* occupies a niche share of the ornamental perennial market. *Trillium* and *Helleborus* will likely be the primary competitors for Forest's

Whisper, as they occupy the same market niche, particularly with growers looking for unique and visually attractive ornamental perennials.

## PRODUCT INFORMATION GUIDE (PIG) & CROP SCHEDULE

Seed production was evaluated in this review and due to the strong dormancy of *Paris x sereniflora*, the scheduling of seed propagation was omitted, as the vast majority of businesses and growers will utilize vegetative propagation using rhizomal divisions.

**Table 1:** Product information guide for *Paris x sereniflora*

SPECIES	POT SIZE	DAY/NIGHT TEMP	MEDIA PH/EC	DAY LENGTH	FINISHING METHODS
PARIS <i>Paris x sereniflora</i> Forest's Whisper	~3"	Day: 60-75°F (15-24°C)  Night: 50-60°F (10-15°C)	PH: 5.5-7.0  EC: 1.0 and 1.5 dS/m*	Day Neutral*	Container size:4"/4.5"/ Quart/10 cm (1 ppp)

**P.I.G Notes:** Due to the lack of research and researchable specimens, the day length sensitivity and EC (marked with \*) are deduced values rather than experimentally observed, therefore should be noted by the grower to be aware of potential adjustments.

### Commercial Production Schedule for Forest's Whisper (*Paris x sereniflora*)

#### Propagation Method: Vegetative (Rhizomal Divisions)

##### Phase 1: Rhizome Preparation and Planting (Weeks 1-2)

- Container size: 1-gallon pots or larger, depending on the size of the rhizomes.
- Prepare rhizomes by soaking them in water for 24 hours to hydrate and promote root initiation.
- Plant rhizomes in well-draining, moist, humus-rich soil, with the growth tips facing upwards and 2-3 inches below the soil surface.

- Space plants 12-18 inches apart to provide ample room for growth and prevent overcrowding.
- Water thoroughly after planting to settle the soil around the rhizomes.
- PGR: Solution mixture of 100mg/ml BAP + NAA , soak for 24 hours.

### **Phase 2: Establishment and Vegetative Growth (Weeks 3-30)**

- Environment: Shade house or greenhouse with 50-75% shade cloth to protect plants from direct sunlight.
- Light: Maintain a daily light integral (DLI) of 10-15 mol/m<sup>2</sup>/day and a PPFD of 200-300 μmol/m<sup>2</sup>/s to support healthy growth without causing stress.
- Temperature: 60-70°F (15-21°C) during the day and 45-55°F (7-13°C) at night to encourage steady growth.
- Humidity: Maintain 50-70% relative humidity to prevent the growth of mold and mildew.
- Water: Keep the soil consistently moist but not waterlogged to prevent root rot and other water-related issues.
- Nutrition: Apply a balanced, slow-release fertilizer every 6-8 weeks during active growth to support the development of healthy foliage and roots.

### **Phase 3: Flower Bud Initiation (Weeks 31-40)**

- Environment: Gradually transition plants to a shade house, or greenhouse with 30-50% shade cloth to support flower bud initiation.
- Light: Maintain a DLI of 15-20 mol/m<sup>2</sup>/day and a PPFD of 300-400 μmol/m<sup>2</sup>/s to support bud development.
- Temperature: 65-75°F (18-24°C) during the day and 50-60°F (10-16°C) at night to facilitate flower bud formation.
- Humidity: Maintain 40-60% relative humidity to reduce the risk of disease during the flowering phase.

- Continue watering, nutrition, and PGR applications as needed to support plant health and development.

#### **Phase 4: Flower Development (Weeks 41-48)**

- Environment: Same as Phase 3, ensuring adequate airflow and sunlight for optimal flower development.
- Light, temperature, and humidity: Same as Phase 3, adjusting as needed based on plant response and environmental conditions.
- Monitor plants for pests and diseases, applying control measures as necessary to protect the crop and maintain quality.
- Continue watering, nutrition, and PGR applications as needed to support flowering and overall plant health.

#### **Phase 5: Harvest and Post-Harvest / Distribution of Mature Plants (Weeks 49-50)**

- Harvest mature rhizomes or prepare mature plants for sales, depending on the target market (e.g., ornamental, medicinal, or both). Harvest in the early morning or late afternoon to minimize stress and maximize freshness.
- Post-harvest requirements: Clean and package rhizomes, foliage, and flowers according to industry standards to ensure product quality and appeal. Store products in a cool, dark place until ready to ship.
- Shipping: Ship products in temperature-controlled vehicles to maintain freshness and minimize stress. Use appropriate packaging materials to protect the products during transport.

#### **Future Changes to Aid In Domestication**

The primary aspects of Forest's Whisper that will need to be refined is its growth time, seedling vigor and dormancy, enhancement of steroidal saponin composition, as well as rhizome size. These factors can be readily improved through a wide array of breeding strategies and genetic/genomic analysis. The fixing and enhancement of desired traits will be a long process

due to the slow reproductive speed of *Paris x sereniflora*, though it surely is worth the time and effort for such a special plant.

The most suitable location to begin commercial propagation operations in the United States is in the south-eastern states such as Tennessee, Georgia and N. Carolina. These areas are closely related to the point of origin for both parental species of *Paris*, which will allow for more rapid development of the market space in the US. After several years of cultivation in the United States, a refined, exotic and desirable ornamental perennial will emerge. Let's listen to the Forest's Whisper together.

#### **IV. ACKNOWLEDGEMENTS**

Thank you to Dr. Neil Anderson for providing the seeds for this exciting new cross, I am grateful that these precious gems landed in my hands. Also thank you to Laura Irish for discussing stratification and assisting with all my random questions.

## V. LITERATURE CITED

- Cunningham, A. B., Brinckmann, J. A., Y.-F. Bi, S.-J. Pei, Schippmann, U., Luo, P., 2018.  
*Paris in the spring: A review of the trade, conservation and opportunities in the shift from wild harvest to cultivation of Paris polyphylla (Trilliaceae)*. Journal of Ethnopharmacology, 222:208-216, ISSN 0378-8741.  
<https://doi.org/10.1016/j.jep.2018.04.048>. Accessed 03/23/2023.
- Ding, Y. G., Zhao, Y. L., Zhang, J., Zuo, Z. T., Zhang, Q. Z., & Wang, Y. Z. 2021.  
*The traditional uses, phytochemistry, and pharmacological properties of Paris L. (Liliaceae): A review*. Journal of Ethnopharmacology, 278, 114293.  
<https://doi.org/10.1016/j.jep.2021.114293> Accessed 03/27/2023.
- Duan, BZ., Wang, YP., Fang, HL. et al. 2018. *Authenticity analyses of Rhizoma Paridis using barcoding coupled with high resolution melting (Bar-HRM) analysis to control its quality for medicinal plant product*. Chin Med 13:8.  
<https://doi.org/10.1186/s13020-018-0162-4> Accessed 02/18/2023.
- Guo, Y., Liu, Z., Li, K., Cao, G., Sun, C., Cheng, G., Zhang, D., Peng, W., Liu, J., Qi, Y., Zhang, L., Wang, P., Chen, Y., Lin, Z., Guan, Y., Zhang, J., Wen, J., Wang, F., Kong, F., Xu, D., Zhao, S. (2018). *Paris Polyphylla-Derived Saponins Inhibit Growth of Bladder Cancer Cells by Inducing Mutant P53 Degradation While Up-Regulating CDKN1A Expression*. *Current urology*, 11(3), 131–138.  
<https://doi.org/10.1159/000447207> Accessed 03/23/2023.
- Jagmohan, N. S., Vinod, B. K., Arvind, B. K., Vijay B. P., Pramod, S., Narayan, S. 2014.

*Paris polyphylla*: Chemical and Biological Prospectives. Anti-Cancer Agents in Medicinal Chemistry. 14(6).

<https://dx.doi.org/10.2174/1871520614666140611101040> Accessed 03/23/2023.

Kunwar, R. M., Adhikari, Y. P., Sharma, H. P., et al. 2020. *Distribution, use, trade and conservation of Paris polyphylla Sm. in Nepal*. Global Ecology and Conservation, 23: e01081. ISSN 2351-9894.

<https://doi.org/10.1016/j.gecco.2020.e01081>. Accessed: 03/23/2023.

Liu, Y., Cao, Y., Kai, H., Han, Y., Huang, M., Gao, L., & Qiao, H. 2022. *Polyphyllin E Inhibits Proliferation, Migration and Invasion of Ovarian Cancer Cells by Down-Regulating the AKT/NF- $\kappa$ B Pathway*. Biological & pharmaceutical bulletin, 45(5):561–568.

<https://doi.org/10.1248/bpb.b21-00691> Accessed 03/23/2023.

Nouvelles Archives du Muséum d'Histoire Naturelle. 1888. 2(10):97.

Pang, D., Yang, C., Li, C., Zou, Y., Feng, B., Li, L., Liu, W., Luo, Q., Chen, Z., & Huang, C. 2020. *Polyphyllin II inhibits liver cancer cell proliferation, migration and invasion through downregulated cofilin activity and the AKT/NF- $\kappa$ B pathway*. Biology open, 9(2): bio046854. <https://doi.org/10.1242/bio.046854> Accessed 03/23/23.

Pellicer, J., Fay, M. F., Leitch, I. J. 2010. *The largest eukaryotic genome of them all?* Botanical Journal of the Linnean Society, 164(1):10-15.

<https://doi.org/10.1111/j.1095-8339.2010.01072>. Accessed 03/22/2023.

Phurailatpam, A., & Choudhury, A. 2022. *Paris polyphylla*: An Important Endangered Medicinal Plants of Himalayan Foothills. Medicinal Plants.

<https://doi.org/10.5772/intechopen.102920> Accessed 03/23/2023.

Puwein, A., & Thomas, S. C. 2020. *An overview of Paris polyphylla, a highly vulnerable*

*medicinal herb of Eastern Himalayan region for Sustainable Exploitation*. The Natural Products Journal, 10(1), 3–14.

<https://doi.org/10.2174/2210315508666180518081208> Accessed 03/29/2023.

Schoch, C. L., Ciuffo, S., Domrachev, M., Hotton, C. L., Kannan, S., Khovanskaya, R., Leipe, D.,

Mcveigh, R., O'Neill, K., Robbertse, B., Sharma, S., Soussov, V., Sullivan, J. P., Sun, L., Turner, S., & Karsch-Mizrachi, I. 2020. *NCBI Taxonomy: a comprehensive update on curation, resources and tools*. The journal of biological databases and curation, baaa062.

<https://doi.org/10.1093/database/baaa062> Accessed 03/23/2023.

Sharma, Angkita & Kalita, Pankaj & Tag, Hui. 2015. *Distribution and phytomedicinal aspects of*

*Paris polyphylla Smith from the Eastern Himalayan Region: A review*. TANG [HUMANITAS MEDICINE] 5:15.1-15.12.

<https://doi.org/10.5667/tang.2015.0001> 03/23/23. Accessed 02/20/2023.

Thapa, C. B., Paudel, M. R., Bhattarai, H. D., Pant, K. K., Devkota, H. P., Adhikari, Y. P.,

Pant, B., 2022. *Bioactive secondary metabolites in Paris polyphylla Sm. and their biological activities: A review*. Heliyon, 8(2): e08982. ISSN 2405-8440.

<https://doi.org/10.1016/j.heliyon.2022.e08982>. Accessed 03/23/2023.

Van de Peer, Y. 2011. *Genomes: the truth is in there*. EMBO reports 12(2):93.

<https://doi.org/10.1038/embor.2011.1> Accessed 02/11/2023.

Yang, L., Yang, Z., Liu, C. et al. 2019. *Chloroplast phylogenomic analysis provides insights into*

*the evolution of the largest eukaryotic genome holder, Paris japonica (Melanthiaceae)*.

BMC Plant Biol 19:293.

<https://doi.org/10.1186/s12870-019-1879-7> Accessed 03/22/2023.

Zhong, S., Zhang, J., & Zhang, G.-Z. 2019. *Botrytis polyphyllae*: A New *Botrytis* Species Causing Gray Mold on *Paris polyphylla*. *Plant Disease*, 103(7), 1721–1727.

<https://doi.org/10.1094/pdis-07-18-1284-re> Accessed 03/29/2023.