

**a. Project Title**

**Application of media composition, temperature adjustments, and silver compounds to improve somatic embryogenesis in Chinese chestnuts**

**b. Summary (100 words)**

The project will test the impact of media composition, temperature adjustments, and silver compounds on somatic embryogenesis (SE) success in Chinese chestnuts. Somatic embryogenesis success has been high with American chestnuts and hybrids with high American chestnut heritage, but low with pure Chinese chestnuts and in hybrids with high Chinese chestnut heritage. The project is a collaboration with Prof. Scott Merkle, and will build upon the SE protocols and media tested in the Merkle lab for chestnuts with high Chinese heritage. On the long term, the project will support the efforts to develop blight-resistant trees.

**c. Principal Investigator and Institutional Affiliation**

- **Dr. Susanna Keriö**, Assistant Agricultural Scientist, Department of Forestry and Horticulture, Connecticut Agricultural Experiment Station (CAES), susanna.kerio@ct.gov, tel. 203.974.8491

**d. Duration of project**

Project is expected to last 1 year.

**e. Total amount of funding requested**

- **Total requested in TACF grant: \$9702**
  - **Part-time research assistant salary: \$9702**
    - Salary costs for a part-time research assistant in the Keriö lab. Covers salary costs for 1 day/week of work over one year (\$5880 salary, \$3822 fringe). A suitable candidate for the position is already available (see attached CV).
- **Matching funding: \$6918**
  - **\$3336 for lab supplies.** Covered through Keriö's hatch/lab startup funding.
    - Lab consumables: \$1000 (petri plates, tubes, serological pipettes, pipettor)
    - Tissue culture vessels: \$1336 (GA-7 culture boxes, lids, trays)
    - Tissue culture reagents: \$1000
  - **\$970 for indirect costs:** As TACF does not cover overhead fees, the CAES will cover the indirect costs (10% of requested grant amount).
  - **Potential travel costs for a lab visit for Keriö: \$2882.** Covered through CT State Employees Union Professional Development funds, CAES funds, or other funding

sources. Used for a 2-week visit in the Merkle lab. The travel will depend on the travel restrictions imposed by the COVID-19 pandemic.

- **\$1170** Rental car (rate on 8/5/2021 \$945 + CDW \$225).
- **\$1227:** Air BnB, Athens, GA. 13 nights (rate \$78 + service fees).
- **\$250:** 2 hotel nights (estimated rate \$117+tax).
- **\$235** travel costs for Keriö: Fuel. Estimated 70 gallons at \$3.367/gallon (8/6/2021).

#### **f. Short and long-term goals of the project**

- **Short term:** Improve the SE process in Chinese chestnuts:
  1. Test the impact of media composition on SE production, germination, and plant development
  2. Test the impact of temperature adjustments on embryo germination and plant development.
  3. Test the impact of silver compounds on embryo germination and plant development
  4. Test the impact of media composition on SE induction.
- **Long-term:**
  - By end of project, report results of the SE protocol development for chestnut hybrids with high degrees of Chinese chestnut heritage.

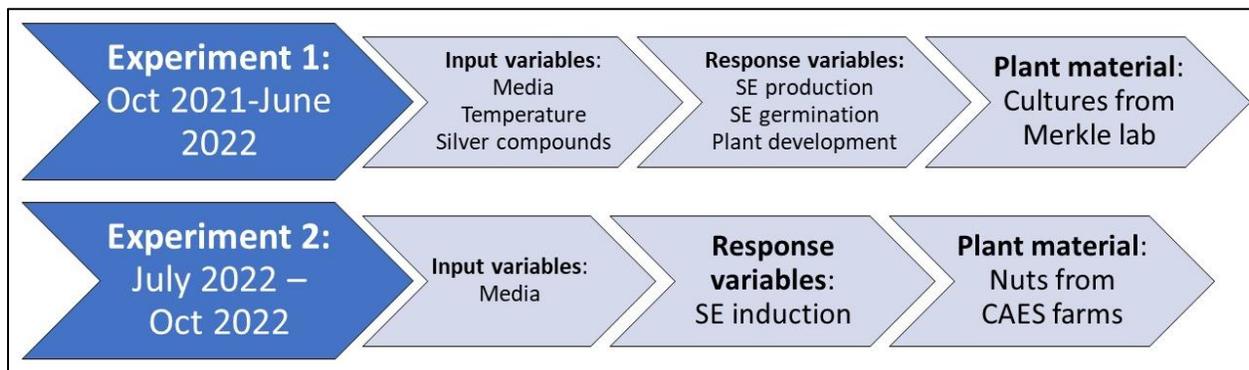
#### **g. Project narrative (5 pages)**

##### **Application of temperature adjustments, media composition, and silver compounds to improve somatic embryogenesis success in chestnut hybrids with high degrees of Chinese chestnut heritage**

Tissue culture is widely used for commercial production of tree species to produce clonal plant material (Nawrot-Chorabik and Pietrzykowski 2019) and has been long studied in chestnuts (Correioira et al. 2017; Merkle et al. 2020; Lovat 2019). A central process in chestnut tissue culture is the initiation of cell lines through somatic embryogenesis (**SE**). The combination of SE, genetic transformation, and axillary shoot culture has been applied to mass propagate genetically transformed American chestnuts for resistance breeding purposes (Oakes et al. 2016; Correioira et al. 2007; Polin et al. 2006; Newhouse et al. 2014).

The mechanisms controlling SE in chestnut are not entirely understood, which has made the optimization of SE protocols a challenge. Plant genotype and heritage greatly affect how the cell lines respond to the modifications in culture conditions (Andrade and Merkle 2005; Lovat and Donnelly 2019; Holtz et al. 2016). Development of more optimized SE protocols for Chinese chestnuts would enable more efficient conservation of chestnut germplasm, investigation of the resistance genes, and higher adaptational potential regarding the species restoration efforts. This would be a significant improvement for the ongoing work on chestnut breeding, genetic conservation, and identification of blight resistance genes.

This project intends to test the impact of temperature adjustments, growth media composition, and silver compounds on tissue culture success in Chinese chestnuts. **The project consists of two experiments (Figure 1). In experiment 1**, somatic embryo production is initiated from cultures provided by the Merkle lab. Impact of media composition, temperature, and silver compounds on embryo production, germination, and plant development will be tested (**Goals 1-3**). **In Experiment 2**, immature chestnut burs will be harvested from Chinese chestnuts growing in the Connecticut Agricultural Experiment Station (CAES) farms, and the impact of media composition on SE induction will be studied (**Goal 4**). The project is a collaboration with the Keriö and Merkle labs (see letter of support from Prof. Merkle). The project leverages the expertise in tissue culture work in the Merkle lab, expertise in plant molecular biology and plant stress research in the Keriö lab, and access to a unique collection of Chinese chestnuts in the CAES farms. The funds would be used to hire a highly motivated undergraduate student to assist with tissue culture work (see attached CV).



**Figure 1.** Outline of the planned experiments.

**Experiment 1: Impact of culture conditions on embryo production, germination, and plant development from embryo cultures (Goals 1-3)**

**Goal 1: Test the impact of media composition on SE production, germination, and plant development**

Various adjustments in SE culture conditions have been tested in order to improve embryo germination, shoot survival, root growth, and conversion (Merkle et al. 2020). The combination of plant growth regulators and media composition has been shown to impact SE success. The standard SE medium for American chestnut contains woody plant medium (WPM) supplemented with select vitamins, amino acids, and 2,4-dichlorophenoxyacetic acid (2,4-D) as a plant growth regulator to mimic auxin (Andrade and Merkle 2005). Activated charcoal is added to germination medium to promote healthy root growth. For Chinese chestnuts, SE induction rate of 1-2% has been achieved on WPM or similar supplemented with 6-benzylaminopurine (BA), a plant cytokinin, and naphthaleneacetic acid (NAA) as source of auxin instead

of 2,4-D (Holtz et al. 2016; Lu et al. 2017). Medium with BA and NAA has resulted in 1.6% SE induction in American chestnut (Xing et al. 1999), which is comparable to 1.5% SE induction reported for the medium with only 2,4-D (Holtz et al. 2016). However, Holtz et al. (2017) reported that SE induction failed for Chinese chestnuts or F1 hybrids on WPM with only 2,4-D (standard medium for American chestnut). The observed benefit of BA and NAA on SE induction in Chinese chestnuts indicates that the medium for Chinese chestnuts should contain BA and NAA in addition to 2,4-D (Lu et al. 2017). BA has also been shown to reduce shoot tip necrosis in axillary shoot cultures of American chestnuts (Lovat and Donnelly 2019), suggesting that BA may have benefits for improving plantlet conversion in Chinese chestnuts.

Another component worth revisiting is the used basal media. Majority of the work on Eurasian chestnuts has used Murashige-Skoog (MS) media (Merkle et al. 2020). A recent work where SE was induced in Chinese chestnut utilized both WPM and MS (Lu et al. 2017). Sezgin and Dumanoglu (2014) reported that for European chestnut, Driver & Kuniyuki Walnut medium (DKW) might increase SE success compared to WPM or MS (Sezgin and Dumanoglu 2014). As the SE success in Chinese chestnut, Chinese-American chestnut F1 and BC1 hybrids has been low (Holtz et al. 2016), it could be worthwhile to test if adjustments in the basal media could improve the SE success in pure Chinese chestnut.

**Planned experiments:** Embryo production will be initiated from cultures provided by Merkle lab. The submersion cultures will be initiated following the protocols specified in Andrade and Merkle (2005) and in Holtz et al. (2017). Media composition for submersion cultures is specified in **Table 1** (secondary medium). Final selection of cultures to be tested will be determined based on the benefit for the TACF chestnut breeding program, conversations with Prof. Merkle, and TACF collaborator preferences. The impact of media composition on embryo production will be measured after 45 days of growth. MS, WPM, and DKW media and growth regulators are commercially available. The Keriö lab has 4 growth chambers available for this work.

**Table 1.** Media compositions to be tested.

Treatment	Primary medium	Secondary medium
1	DKW, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	DKW, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA
2	DKW, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	MS, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA
3	DKW, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	WPM, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA
4	MS, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	DKW, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA
5	MS, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	MS, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA
6	MS, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	WPM, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA
7	WPM, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	DKW, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA
8	WPM, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	MS, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA
9	WPM, 1 mg·L <sup>-1</sup> 2,4-D and 1 mg·L <sup>-1</sup> BA	WPM, 0.1 mg·L <sup>-1</sup> BA and 0.05 mg·L <sup>-1</sup> NAA

## Goal 2: Test the impact of pre-germination cold treatment length and germination temperature on plant conversion

Temperature is one of the critical factors that affect SE success and tissue culture in chestnuts. Results from cold treatment trials suggest that distinct embryogenic lines of American chestnut may vary in their embryo germination rates depending on the length of pre-germination cold treatment (Andrade and Merkle 2005). For American chestnut, 12-week cold treatment has resulted in high embryo germination and conversion rates (59%) (Andrade and Merkle 2005; Merkle et al. 2020). For European chestnut, 8 weeks has been sufficient (Corredoira et al. 2008). Recent results from axillary shoot tissue culture suggest that even 37% of American chestnut genotypes might benefit from temperature optimization during tissue culture (Lovat and Donnelly 2019). Additionally, testing of 120 chestnut genotypes including American chestnuts, hybrids (BC<sub>3</sub>F<sub>3</sub> and F1), and pure Chinese chestnuts indicate that embryogenesis success rate from pure Chinese chestnuts and F1 Chinese-American hybrids is low in the culture and temperature conditions optimized for American chestnut (Holtz et al. 2016). It would be of value to test whether temperature adjustments in the established SE-protocols could enhance embryo germination and conversion in embryogenic lines with high Chinese chestnut heritage. If cold treatment times could be reduced, this would result in time savings in the SE process.

**Planned experiments:** Impact of cold treatment length on embryo maturation and impact of germination temperature on plant conversion will be tested in the combinations specified below (**Table 2**). The developed embryos will be transferred from the liquid submersion media to solid germination media (secondary media composition in Table 1). The protocols for embryo germination will follow those in Andrade and Merkle (2005) and Holtz et al. (2017). Cultures for this work will be supplied by Merkle lab. The 4 growth chambers in Keriö lab will facilitate simultaneous testing of different temperature regimes.

**Table 1.** Combinations of cold treatment times and germination temperatures to be tested on embryo germination and plant conversion.

Cold treatment, weeks	Germination and growth temperature, °C (day/night)			
	23/20	25/20	27/20	29/20
0	23/20	25/20	27/20	29/20
2	23/20	25/20	27/20	29/20
4	23/20	25/20	27/20	29/20
6	23/20	25/20	27/20	29/20
8	23/20	25/20	27/20	29/20
10	23/20	25/20	27/20	29/20
12	23/20	25/20	27/20	29/20
14	23/20	25/20	27/20	29/20

### **Goal 3: Test the impact of silver compounds on plant conversion**

A less-studied avenue to improve SE in chestnuts is through modulation of ethylene production in the tissue culture vessels. Silver compounds including silver nitrate ( $\text{AgNO}_3$ ), silver thiosulfate (STS), and silver nanoparticles (AgNPs) have been shown to have potential as inhibitors of ethylene synthesis and to improve shoot development, callus induction, and root formation in several plants (Mahendran et al. 2019). STS at 20  $\mu\text{M}$  has improved germination and conversion of somatic embryos of oak (Martinez et al. 2017; Martínez et al. 2015). In European chestnut,  $\text{AgNO}_3$  may have benefits for SE induction in combination with plant growth regulators (Sezgin and Dumanoglu 2014). In coffee,  $\text{AgNO}_3$  at 40  $\mu\text{M}$  improved SE success (Kumar et al. 2007). STS at 60  $\mu\text{M}$  was reported to increase shoot regeneration in plums and finger lime (Petri and Scorza 2010; Mahmoud et al. 2020), whereas doses of 120  $\mu\text{M}$  caused chlorosis (Petri and Scorza 2010). Silver nanoparticles (AgNPs) have been shown to reduce ethylene production and to prevent leaf abscission in finger lime tissue culture (Mahmoud et al. 2020). AgNPs have also been shown to control microbial contamination in plant tissue culture (Tariq et al. 2020; Mahendran et al. 2019), which might benefit the SE process in chestnut. In wheat, AgNPs were more effective in promoting embryo germination than  $\text{AgNO}_3$  (Malik et al. 2021). It would be worth studying the potential of the mentioned silver compounds in improving the SE success in Chinese chestnut.

**Planned experiments:** STS,  $\text{AgNO}_3$  and AgNPs will be applied to the germination media (secondary WPM, MS, or DKW, **Table 1**). The impact of silver compounds will be tested in conjunction with the temperature and media testing in Goals 1 and 2. Based on the literature, a concentration of 20-60  $\mu\text{M}$  will be used. Cultures for this work will be supplied by the Merkle lab.

### **Experiment 2: Impact of media composition on SE induction from immature burs (Goal 4)**

**Planned experiments:** The plant material will be acquired from immature chestnut burs and maintained in tissue culture following the protocols specified in Andrade and Merkle (2005) and in Holtz et al. (2017). Immature open-pollinated burs will be harvested in July 2022 from known pure Chinese chestnuts growing in the CAES farms. Besides ‘Nanking’ and ‘Mahogany’, final selection of genotypes will be determined based on the benefit for the TACF chestnut breeding program, conversations with Prof. Merkle, and TACF collaborator preferences. After surface sterilization, the immature seeds will be maintained on primary medium (**Table 1**) for 2 months (transfer to fresh medium after one month). Subsequently, the cultures are transferred to secondary medium (**Table 1**). The impact of media composition on SE induction will be scored 10 weeks after culture initiation. MS, WPM, and DKW media and growth regulators are commercially available (e.g. Caisson labs). Plant material for the Chinese chestnut cell lines will be selected in summer 2022 based on their relevance for the TACF chestnut breeding program. The Keriö lab has 4 growth chambers available for this work. Project funds would be used to hire a research assistant to perform the tissue culture work.

#### **h. Timeline, showing start and completion dates for each goal**

- **Short-term: see Figure 2 for details.**
  - Improve somatic embryogenesis in Chinese chestnuts:
    1. Test the impact of media composition on embryo production (Oct-Nov 2021).
    2. Test the impact of temperature adjustments (Dec 2021 – May 2022)
    3. Test the impact of silver compounds (Dec 2021 -May 2022)
    4. Test the impact of media composition on SE induction (July-Oct 2021).
- **Long-term: Report results of the SE protocol development for Chinese chestnuts (Oct 2022)**

Experiment 1: SE production from cultures	Experiment 2: SE induction from immature seeds
<ul style="list-style-type: none"><li>• <b>Goal 1:</b> Impact of media on embryo production<ul style="list-style-type: none"><li>• Submersion cultures 45 days (10-11/2021)</li><li>• Score for embryos: 11/2021</li></ul></li><li>• <b>Goals 2 &amp; 3:</b> Impact of temperature and silver compounds on germination and plant development<ul style="list-style-type: none"><li>• Transfer to solid media 12/2021</li><li>• Cold treatment 0-14 weeks → 3/2022</li><li>• Germination &amp; Plant development → 5/2022</li><li>• Acclimation → 6/2022</li><li>• Soil growth 7/2022 →</li><li>• Phenotyping 7/2022</li></ul></li></ul>	<ul style="list-style-type: none"><li>• <b>Goal 4:</b> Impact of media composition<ul style="list-style-type: none"><li>• Nut harvest (7/2022)</li><li>• Seeds in primary media 7-9/2022 (2 months)</li><li>• Transfer to secondary media 9/2022</li><li>• Score for SE induction 10/2022</li></ul></li></ul>

**Figure 2.** Approximate timeline for the experimental steps and how they relate to achieving the set goals.

#### **i. How results will be measured and reported**

Main phenotypic variables of interest include SE initiation, embryo germination, and conversion. The PI will disseminate the results both through presentations and peer-reviewed publications. Results will be targeted for publication in Journal of Environmental Horticulture (open access), Plant Cell, Tissue and Organ Culture (PCTOC, 5-year impact factor 2.73), or Trees – Structure and Function (5-year impact factor 2.56).

#### **j. Breakdown of how and when funds will be spent**

Funds are needed for research assistant salary starting November 2021. Monthly hiring cost \$808.5.

### **k. Brief Curriculum Vitae (CV) for each Principal Investigator.**

CV attached.

Letter of support from Prof. Merkle attached.

CV of candidate research assistant attached.

### **l. Conflict of Interest or Commitment (COI or COC) statement.**

No conflict of interest to declare.

### **References**

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## Education

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**D.Sc., Agriculture and Forestry, Dpt. of Forest Sciences, University of Helsinki** June 2010 – Jan 2016

*Title of thesis:* Terpene analysis and transcript profiling of the conifer response to *Heterobasidion annosum* s.l. infection and *Hylobius abietis* feeding.

**M.Sc., Agriculture and Forestry, Dpt. of Forest Sciences, University of Helsinki** May 2009 – Oct 2010

*Field of study:* Major studies in forest ecology, minor studies in biotechnology  
*Title of thesis:* Molecular and physicochemical analysis of the response of *Heterobasidion annosum* (Fr.) Bref. to conifer wood extracts and osmotic stress

**B.Sc., Agriculture and forestry, Dpt. of Forest Sciences, University of Helsinki** Sep 2004 – May 2009

*Field of study:* Major studies in forest ecology, minor studies in forest resource management  
*Title of thesis:* Antimicrobial defences of forest trees against fungal pathogens

## Research Experience

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**Assistant Agricultural Scientist II**, Connecticut Agricultural Experiment Station Apr 2020 - Current  
**Research associate**, Dpt. of Botany and Plant Pathology, Oregon State University Feb 2017 – Apr 2020  
**Graduate researcher**, Dpt. of Forest Sciences, University of Helsinki June 2010 – Nov 2015  
**Graduate thesis worker**, Dpt. of Forest Sciences, University of Helsinki Jan 2009 – Mar 2010  
**Trainee**, Finnish Forest Research Institute (current Natural Resource Institute Finland) June 2008 – Aug 2008

## Peer-Reviewed Publications

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**An outbreak of Septoria canker caused by *Sphaerulina musiva* on *Populus trichocarpa* in eastern Oregon.** Søndreli, K.L., Keriö, S., Frost, K., Muchero, W., Chen, J.G., Haiby, K., Gantz, C., Tuskan, G., and LeBoldus, J.M. *Plant Disease* (2020). 10.1094/PDIS-03-20-0494-PDN

**Localization of (+)-catechin in *Picea abies* phloem: responses to wounding and fungal inoculation.** Jyske, T., Kuroda, K., Keriö, S., Pranovich, A., Linnakoski, R., Hayashi, N., Aoki, D., Fukushima, K. *Molecules* (2020). 10.3390/molecules25122952.

**Non-toxic and low-cost DNA extraction method suitable for studying tree-microbe interactions.** Keriö, S., Terhonen, E-L., LeBoldus, J.M. *Bioprotocol* (2020). Vol. 10(11). 10.21769/BioProtoc.3634

**Population genomic analyses reveal connectivity via human-mediated transport across *Populus* plantations in North America and an undescribed sub-population of *Sphaerulina musiva*.** Tabima J.F., Søndreli, K.L., Keriö, S., Feau, N., Sakalidis, M., Hamelin, R., LeBoldus, J.M. *Molecular plant-microbe interactions* (2019). 10.1094/MPMI-05-19-0131-R

**Increased streamflow in catchments affected by a forest disease epidemic.** Bladon, K. D., Bywater-Reyes, S., LeBoldus, J. M., Keriö, S., Segura, C., Ritóková, G., Shaw, D. C. *Science of the total environment* vol. 691, 112-123 (2019). 10.1016/j.scitotenv.2019.07.127

**Variation in susceptibility of tanoak to the NA1 and EU1 lineages of *Phytophthora ramorum*, the cause of sudden oak death.** Søndreli, K.L., Kanaskie A., Keriö, S., LeBoldus, J.M. *Plant disease* (2019). 10.1094/PDIS-04-19-0831-RE

**From genomes to forest management - tackling invasive *Phytophthora* species in the era of genomics.** Keriö, S., Daniels, H., Gomez-Gallego, M., Tabima Restrepo, J., Lenz, R., Søndreli, K.L., J., Grünwald, N.J., McDougal, R., Williams, N.M., LeBoldus, J.M. *Canadian Journal of Plant Pathology* (2019). Invited review. 10.1080/07060661.2019.1626910

**Multiplex qPCR for detection and quantification of *Sphaerulina musiva* in *Populus* stems.** Abraham, N.D., Chitrampal, P., Keriö, S., LeBoldus, J. M. *Plant Pathology*, vol. 67 (2018). 10.1111/ppa.12913

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**Endophytic fungi of Norway spruce roots in boreal pristine mire, drained peatland and mineral soil and their inhibitory effect on *Heterobasidion parviporum* in vitro.** Terhonen, E., **Keriö, S.**, Sun, H., Asiegbu, F.O. *Fungal Ecology*, Vol. 9: 17–26 (2014). 10.1016/j.funeco.2014.01.003

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**Distribution and bioinformatic analysis of cerato-platanin protein family in *Dikarya*.** Chen H., Kovalchuk, A., **Keriö S.**, Asiegbu FO. *Mycologia* 105:1479-1488 (2013). 10.3852/13-115

**Role of the HaHOG1 MAP Kinase in Response of the Conifer Root and Butt Rot Pathogen (*Heterobasidion annosum*) to Osmotic and Oxidative Stress.** Raffaello T., **Keriö S.**, Asiegbu F.O. *PLoS ONE* 7(2): e31186. doi:10.1371/journal.pone.0031186 (2012). 10.1371/journal.pone.0031186

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## Grants, Awards and Funded Proposals

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- |   |                  |
|---|------------------|
| • Experiment Station Associates Award, CAES, <b>8 000 US dollars</b>                      | <b>Mar 2021</b>  |
| • Subaward with the American Chestnut Foundation, <b>9000 US dollars</b>                  | <b>Jan 2021</b>  |
| • Postdoctoral Excellence Award, Oregon State University, <b>1 000 US dollars</b>         | <b>Sep 2019</b>  |
| • Professional Development Award, OSU Postdoctoral Association, <b>1 000 US dollars</b>   | <b>Oct 2018</b>  |
| • Research grant, Oskari Huttunen Foundation, <b>30 000 euros</b> (declined by applicant) | <b>Sep 2016</b>  |
| • Research grant, The Finnish Association of Forest Sciences, <b>10 020 euros</b>         | <b>May 2015</b>  |
| • Travel grant, The Finnish Association of Forest Sciences, <b>1 300 euros</b>            | <b>May 2015</b>  |
| • Research grant, Finnish Cultural Foundation, <b>22 000 euros</b>                        | <b>Feb 2014</b>  |
| • Travel grant, Foundation for Forest Tree Breeding, <b>1 600 euros</b>                   | <b>Mar 2014</b>  |
| • Travel grant, University of Helsinki Chancellor's travel grant, <b>1 600 euros</b>      | <b>Apr 2013</b>  |
| • Research grant, Doctoral Program in Plant Sciences, <b>12 000 euros</b>                 | <b>Jan 2013</b>  |
| • Travel grant, University of Helsinki Chancellor's travel grant, <b>1 300 euros</b>      | <b>Apr 2012</b>  |
| • Travel grant, Fund for Agricultural and Forest Sciences, <b>800 euros</b>               | <b>June 2011</b> |
| • Scholarship, Metsämiesten säätiö Foundation, <b>250 euros</b>                           | <b>Mar 2010</b>  |

## Leadership Experience

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### Primary instructor

- |  |                           |
|--|---------------------------|
| • Trained two research assistants to perform tree stress research at CAES.         | <b>May 2021 – present</b> |
| • Hosted an intern in a research project at CAES. Provided mentoring and guidance. | <b>March – May 2021</b>   |
| • Guided the laboratory work of two summer interns at CAES.                        | <b>July – Aug 2020</b>    |



UNIVERSITY OF  
**GEORGIA**

**Warnell School of Forestry  
and Natural Resources**

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August 13, 2021

Susanna Keriö, D.Sc.  
Assistant Agricultural Scientist  
Department of Forestry and Horticulture  
Connecticut Agricultural Experiment Station  
123 Huntington Street  
New Haven, CT 06504-1106

Dear Susanna:

I am writing in support of your proposed project for The American Chestnut Foundation, “Application of media composition, temperature adjustments, and silver compounds to improve somatic embryogenesis in Chinese chestnut.” Specifically, as we have discussed, we are willing to supply you with copies of our existing Chinese chestnut embryogenic cultures so you can go ahead and begin your experiments on improving somatic embryo germination and conversion while you get your own cultures started. We will also be glad to supply you with copies of our protocols and media recipes for chestnut culture, and any other information we have that may be useful for your work with Chinese chestnut and F1 hybrids. Finally, we would be happy to host a visit by you to our lab anytime in the coming year, to help you get up to speed with our protocols and techniques for chestnut embryogenesis induction and somatic embryo and somatic seeding production.

We look forward to cooperating with you on this research.

Sincerely,

Scott A. Merkle  
Professor

# JACQUELINE LEMMON

UNDERGRADUATE STUDENT

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Westerly, RI 02891



## EDUCATION

BOTANY & PLANT PATHOLOGY,  
CHEMISTRY

Oregon State University,  
Oregon  
2020 – 2022

ZOOLOGY

Kent State University, Ohio  
2012 – 2014

## SKILLS

Plant Care/Maintenance

Writing/Editing

Customer Service

Data Input

Project Management

Training

Time Management

Written Communication

Creativity

## RESEARCH INTERESTS

Microbial-plant interactions, especially in context of stressors and climate change, on resilience in forests and other plant communities.

## EXPERIENCE

### CAES AGRICULTURAL SUMMER RESEARCH ASSISTANT

Dr. Susanna Kerio, Forestry and Horticulture Lab / Connecticut / 2021-Present

Interaction of drought stress, nanoparticles, & Chestnut blight in Chestnut trees.

- Lab work and field work

### URSA INTERNSHIP

Dr. Navneet Kaur Lab / Oregon / 2021-2021

Endophyte interaction with pest insects in agricultural crop systems

- Literature review

### HORTICULTURIST

The Farmer's Daughter / Rhode Island / 2020 – Present

Assisting in the care, planting & maintenance of cutting flower fields, sowing seed in flats for retail sale stock at regional farm and greenhouse destination.

- Watering/fertilizing and weeding of cutting garden fields, plant health monitoring
- Sowing seed for retail sale and planting plugs and dahlia tubers in fields
- Greenhouse/nursery care and stocking

### DESIGNER/TEAM LEADER

Clark Farms Garden Center / Rhode Island / 2017 – 2020

Assisting store management, store container/arrangement designer and merchandising, and plant retail store and greenhouse.

- Employee training
- Design custom planted containers for clients and retail
- Maintenance/care of planted containers on clients' private property
- Customer service/retail

### STORE ASSOCIATE

Verde Design & Horticulture / Rhode Island / 2019 – 2020