US00PP28216P3

(12) **United States Plant Patent**
Mehlenbacher et al.

(10) **Patent No.: US PP28,216 P3**
(45) **Date of Patent: Jul. 25, 2017**

(54) ***CORYLUS* PLANT NAMED 'BURGUNDY LACE'**

(50) Latin Name: ***Corylus avellana* cultivar**
Varietal Denomination: **Burgundy Lace**

(71) Applicant: **Oregon State University**, Corvallis, OR (US)

(72) Inventors: **Shawn A. Mehlenbacher**, Corvallis, OR (US); **David C. Smith**, Corvallis, OR (US); **Rebecca L. McCluskey**, Corvallis, OR (US)

(73) Assignee: **Oregon State University**, Corvallis, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

(21) Appl. No.: **14/756,596**

(22) Filed: **Sep. 21, 2015**

(65) **Prior Publication Data**

US 2017/0086341 P1 Mar. 23, 2017

(51) **Int. Cl.**
A01H 5/12 (2006.01)

(52) **U.S. Cl.**
USPC **Plt./152**

(58) **Field of Classification Search**
USPC Plt./152
See application file for complete search history.

(56) **References Cited**

PUBLICATIONS

Bassil et al, "Additional Microsatellite Markers of the European Hazelnut," *Acta Hortic.* vol. 686, pp. 105-110, 2005.
Bassil et al, "Microsatellite Markers in Hazelnut: Isolation, Characterization, and Cross-species Amplification," *J. Amer. Soc. Hort. Sci.*, vol. 130(4), pp. 543-549, 2005.
Bassil et al, "Nuclear and chloroplast microsatellite markers to assess genetic diversity and evolution in hazelnut species, hybrids and cultivars," *Genet. Resour. Crop Evol.*, vol. 60(2), pp. 543-568, 2012.
Boccacci et al, "Characterization and evaluation of microsatellite loci in European hazelnut (*Corylus avellana* L.) and their transferability to other *Corylus* species," *Molecular Ecology Notes*, vol. 5, pp. 934-937, 2005.
Boccacci et al, "DNA typing and genetic relations among European hazelnut (*Corylus avellana* L.) cultivars using microsatellite markers," *Genome*, vol. 49, pp. 598-611, 2006.
Gökirmak et al, "Characterization of European hazelnut (*Corylus avellana*) cultivars using SSR markers," *Genet. Resour. Crop Evol.*, vol. 56(2), pp. 147-172, 2008.
Gürcan et al, "Genetic diversity in hazelnut (*Corylus avellana* L.) cultivars from Black Sea countries assessed using SSR markers," *Plant Breeding*, vol. 129, pp. 422-434, 2010.
Gürcan et al, "Development, characterization, segregation, and mapping of microsatellite markers for European hazelnut (*Corylus avellana* L.) from enriched genomic libraries and usefulness in genetic diversity studies," *Tree Genetics & Genomes*, vol. 6, pp. 513-531, 2010.
Gürcan et al, "Transferability of Microsatellite Markers in the Betulaceae," *J. Amer. Soc. Hort. Sci.* 135(2), pp. 159-173, 2010.
Gürcan and Mehlenbacher. "Development of microsatellite marker loci for European hazelnut (*Corylus avellana* L.) from ISSR fragments," *Molecular Breeding* 26:551-559, 2010.
Mehlenbacher et al., "Inheritance of the Cutleaf Trait in Hazelnut," *HortScience*, vol. 30(3), pp. 611-612, 1995.
Mehlenbacher et al., "'Tonda Pacifica' hazelnut," *HortScience* 46:505-508, 2011.
Mehlenbacher et al., "'Santiam' hazelnut" *HortScience* 42:715-717, 2007.
Mehlenbacher et al., "RAPD markers linked to eastern filbert blight resistance in *Corylus avellana*," *Theor. Appl. Genet.*, vol. 108, pp. 651-656, 2004.
Sathuvalli et al., "Characterization of American hazelnut (*Corylus americana*) accessions and *Corylus americana*×*Corylus avellana* hybrids using microsatellite markers," *Genet. Resour. Crop. Evol.*, vol. 59, pp. 1055-1075, 2012.

Primary Examiner — Anne Grunberg
(74) *Attorney, Agent, or Firm* — Klarquist Sparkman, LLP

(57) **ABSTRACT**

A new and distinct *Corylus* plant named 'Burgundy Lace' characterized by rich dark burgundy-colored developing leaves and burgundy-colored fully expanded leaves during the spring and summer; deeply dissected leaves; burgundy color of the catkins and leaf buds; moderate vigor and upright-spreading plant habit; resistance to eastern filbert blight (EFB) caused by the fungus *Anisogramma anomala* (Peck) E. Müller; presence of random amplified polymorphic DNA markers 152-800 and 258-580 in DNA; expression of incompatibility alleles S_6 and S_{20} in the styles; catkins that are abnormal and small, and produce little pollen; and DNA fingerprints at 14 of 24 microsatellite marker loci differ from 'Cutleaf'.

9 Drawing Sheets

1

ACKNOWLEDGMENT OF GOVERNMENT SUPPORT

This invention was made with government support under Specific Cooperative Agreement No. 58-5358-4-025 awarded by the United States Department of Agriculture. The government has certain rights in the invention.

Botanical denomination: *Corylus avellana* cultivar.
Variety designation: 'Burgundy Lace'.

2

BACKGROUND

The present disclosure relates to a new and distinct cultivar of *Corylus* plant, botanically known as *Corylus avellana*, and hereinafter referred to by the name 'Burgundy Lace'.

The new *Corylus* resulted from a controlled cross of female parent OSU 562.034 (unpatented)×OSU 562.062 (unpatented) made in 1998 to create a new ornamental cultivar (FIG. 1). OSU 562.034 is from a cross of 'Cutleaf'×

VR6-28 (unpatented), and OSU 562.062 is from a cross of 'Cutleaf'×Redleaf #3 (unpatented). The grandparent 'Cutleaf '(unpatented) is known as *Corylus avellana* f. *heterophylla*, for which the form names laciniata, urticifolia, quercifolia and incisa pinnatifida are also used. VR6-28 is from a cross of 'Riccia di Talanico'×'Gasaway', and carries a dominant allele for a very high level of resistance to eastern filbert blight (EFB) from 'Gasaway' (unpatented). OSU 562.062 and Redleaf #3 carry a dominant allele for leaf anthocyanin. Redleaf #3 is an open-pollinated seedling of 'Barcelona' (unpatented). The pollen parent is believed to be the Redleaf 'Rode Zeller' (syn. 'Rote Zellernuss') (unpatented).

Hybrid seeds from the controlled cross were harvested in August 1998, stratified, and the resulting seedlings grown in a glasshouse during the summer of 1999. Seedlings that combined red leaf color and the 'Cutleaf' trait were preferred, and 38 of the 40 seedlings planted in the field in October 1999 combined these two traits. 'Burgundy Lace' was discovered and selected as a single plant within the progeny of the stated cross-pollination in a controlled environment in Corvallis, Oreg., USA. The new variety was originally assigned the designation OSU 954.076, which indicates the row and tree location of the original seedling.

The new cultivar was asexually reproduced by rooted suckers annually for five years (2005, 2006, 2008, 2011 and 2013) in Corvallis, Oreg. The unique features of this new *Corylus* are stable and reproduced true-to-type in successive generations of asexual reproduction.

SUMMARY

The following traits have been observed and are determined to be the unique characteristics of 'Burgundy Lace'. These characteristics in combination distinguish 'Burgundy Lace' as a new and distinct cultivar:

1. Rich dark burgundy-colored developing leaves and burgundy-colored fully expanded leaves during the spring and summer.
2. Deeply dissected leaves.
3. Burgundy color of the catkins and leaf buds.
4. Moderate vigor and upright-spreading plant habit.
5. Resistance to eastern filbert blight (EFB) caused by the fungus *Anisogramma anomala* (Peck) E. Müller.
6. Presence of random amplified polymorphic DNA markers 152-800 and 268-580 in DNA of 'Burgundy Lace' amplified by the polymerase chain reaction. These two markers are linked to a dominant allele for resistance to eastern filbert blight from the cultivar 'Gasaway' (unpatented).
7. Expression of incompatibility alleles S_6 and S_{20} in the styles.
8. Catkins that are abnormal and small, and produce little pollen.
9. DNA fingerprints of 'Burgundy Lace' differ from 'Cutleaf' at 14 of 24 microsatellite marker loci. Additional DNA fingerprints of 'Gasaway' and 'Rode Zeller', which are ancestors of 'Burgundy Lace', and 12 other reference cultivars, are shown in Table 7.

'Burgundy Lace' is well-suited to the ornamental market. 'Burgundy Lace' combines red leaf color, deeply dissected leaves, and resistance to eastern filbert blight (EFB) caused by *Anisogramma anomala* (Peck) E. Müller. Comparisons in two trials conducted in Corvallis, Oreg., plants of 'Burgundy Lace' in the guard rows differed from plants of the *Corylus avellana* cultivars 'Barcelona' (unpatented) and 'Jefferson' (unpatented), and other cultivars and selections of *Corylus avellana* known to the Inventors primarily in nut size, nut shape, kernel percentage (ratio of kernel weight to nut weight), frequency of defects (blank nuts, moldy kernels, twins, etc.), time of pollen shed, time of nut maturity, length of the husk or involucre, and plant size.

The tree is moderately vigorous, similar in size to 'Jefferson', and has a desirable upright-spreading growth habit that should be easy to manage in a landscape setting. The nuts are small and the kernels are edible, but nut yields are low and quality is not suitable for the kernel market. 'Burgundy Lace' has far fewer blanks (shells lacking kernels) than 'Cutleaf'. 'Burgundy Lace' has intermediate ratings for bud mite (primarily *Phytoptus avellanae* Nal.), similar to 'Clark'. Like its grandparent 'Cutleaf', catkins of 'Burgundy Lace' shed very little pollen. Pollen shed and female receptivity are late.

DNA markers and field observations indicate that 'Burgundy Lace' has resistance to eastern filbert blight (EFB) caused by the fungus *Anisogramma anomala* (Peck) E. Müller. The resistance is conferred by a dominant allele from 'Gasaway'. EFB is now present throughout the Willamette Valley and in the eastern USA where it naturally occurs on the wild American hazelnut (*C. americana*), but causes little damage. Pruning to remove cankers and fungicide applications are currently used to manage the disease in susceptible cultivars. Thus, 'Burgundy Lace' is suitable for planting in areas with high disease pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying colored photographs illustrate the overall appearance of the new cultivar, showing the colors as true as it is reasonably possible to obtain in colored reproductions of this type. Foliage colors in the photographs may differ slightly from the color values cited in the detailed botanical description which accurately describe the colors of the new *Corylus*.

FIG. **1** is a chart showing the pedigree of hazelnut selection 'Burgundy Lace' (OSU 954.076).

FIG. **2** is a chart showing time of pollen shed (green), female receptivity (red) and leaf budbreak for 'Burgundy Lace' and 'Cutleaf' over two years for ornamental hazelnut selection.

FIG. **3** is a digital image taken at end of the 6^{th} growing season of a tree of 'Burgundy Lace' growing in Corvallis, Oreg., in the winter, showing upright-spreading growth habit. Tree was planted in the spring of 2007.

FIG. **4** is a digital image taken in June of the 5^{th} growing season of the original 'Burgundy Lace' tree growing in Corvallis, Oreg.

FIG. **5** is a digital image taken in June of the 5^{th} growing season of a tree of 'Burgundy Lace' growing in Corvallis, Oreg. Tree planted in the spring of 2007.

FIG. **6** is a digital image taken in mid-August of the 5^{th} growing season of the original 'Burgundy Lace' tree growing in Corvallis, Oreg., showing older leaves. Tree planted in the spring of 2007.

FIGS. **7-9** are digital images showing young leaves of 'Burgundy Lace' in Corvallis, Oreg. in late May.

FIG. **10** is a digital image showing nuts and husks of 'Burgundy Lace' on a branch in Corvallis, Oreg. in August of the 4^{th} growing season.

FIG. **11** is a digital image of catkins of 'Burgundy Lace' with frost.

FIG. **12** is a digital image showing shoots of 'Burgundy Lace' grown in Corvallis, Oreg. with nuts.

FIG. **13** is a digital image showing shoots of 'Burgundy Lace' grown in Corvallis, Oreg. showing upper and lower leaf surfaces.

FIGS. **14-15** are digital images showing leaves, husks and nuts of 'Barcellona', 'Cutleaf' and 'Burgundy Lace' varieties. FIG. **14** shows the lower surface of the leaves and nuts, and FIG. **15** shows the upper surface of the leaves and nuts.

FIG. **16** is a digital image of comparing nuts of 'Barcelona', 'Cutleaf' and 'Burgundy Lace'.

DETAILED DESCRIPTION

The cultivar 'Burgundy Lace' has not been observed under all possible environmental conditions. The phenotype may vary somewhat with variations in environment such as temperature and light intensity, without, however, any variance in genotype. The aforementioned photographs and following observations and measurements describe plants grown in Corvallis, Oreg. under commercial practice outdoors in the field during the fall, winter and spring. Plants used for the photographs and description were propagated by tie-off layerage and growing on their own roots, and seven or eight years old. In the following description, color references are made to The Royal Horticultural Society Colour Chart, 1966 Edition, except where general terms of ordinary dictionary significance are used.

Botanical classification: *Corylus avellana* cultivar 'Burgundy Lace'.

Parentage:
- *Female, or seed, parent.*—*Corylus avellana* cultivar 'OSU 562.034' (unpatented).
- *Male, or pollen, parent.*—*Corylus avellana* cultivar 'OSU 562.062' (unpatented).

Propagation (type rooted suckers):
- *Time to initiate roots.*—About 30 days at 20° C.
- *Time to produce a rooted young plant.*—About six months at 22° C.
- *Root description.*—Fine to thick; freely branching; creamy white in color.

Propagation (type whip grafting):
- *Time to budbreak on the scions.*—About 14 days at 25° C.
- *Time to produce a grafted plant.*—About six months at 25° C.

Plant description:
- *General appearance.*—Perennial shrub. Upright-spreading plant habit.
- *Growth and branching habit.*—Freely branching; about 15 lateral branches develop per plant. Pinching, that is, removal of the terminal apices, enhances branching with lateral branches potentially forming at every node.
- *Vigor.*—Moderate vigor growth habit.
- *Size.*—Plant height is about 5 meters; plant diameter or spread is about 5 meters.

Lateral branch description:
- *Length.*—About 51 cm.
- *Diameter.*—About 3.8 mm.
- *Internode length.*—About 3.3 cm.
- *Texture.*—Smooth, glabrous.
- *Strength.*—Strong.
- *Color, immature.*—152B.
- *Color, mature.*—152B.

Foliage description:
- *Arrangement.*—Alternate, simple.
- *Length.*—About 11.4 cm.
- *Width.*—About 7.4 cm.
- *Shape.*—Cutleaf (deeply serrated).
- *Apex.*—Obtuse to acute.
- *Base.*—Cordate.
- *Margin.*—Deeply serrated.
- *Texture, upper and lower surfaces.*—Slightly pubescent.
- *Venation pattern.*—Pinnate.
- *Color.*—Developing foliage, upper surface 144A, lower surface 145A. Fully expanded foliage, upper surface: Spring and summer, 143A; late summer and fall, 143A. Fully expanded foliage, lower surface: Spring and summer, 139C; late summer and fall, 139C. Venation, upper surface: Spring and summer, 139C; late summer and fall, 139C. Venation, lower surface: Spring and summer, 139D; late summer and fall, 139D.

Petiole description:
- *Length.*—About 27 mm.
- *Diameter.*—About 1.8 mm.
- *Texture, upper and lower surfaces.*—Pubescent.
- *Color, upper surface.*—Spring and summer, 139D; late summer and fall, 139D.
- *Color, lower surface.*—Spring and summer, 139D; late summer and fall, 139D.

Flower description: Male inflorescences are catkins, color prior to elongation 194C. Female inflorescence style color 048B.

Nut description:
- *Length.*—About 19.1 mm.
- *Width.*—About 20.7 mm.
- *Depth.*—About 18.2 mm.
- *Nut shape.*—Round. Nut shape index [(Width+Depth)/2*Length]=1.02. Nut compression index (Width/Depth)=1.14.
- *Nut shell color.*—164B. Nut weight: About 1.72 grams.
- *Kernel weight.*—About 0.76 grams.
- *Kernel percentage* (*kernel weight/nut weight*).—About 44%.

Disease/pest resistance: Plants of the new *Corylus* are highly resistant to eastern filbert blight caused by the fungus *Anisogramma anomala* (Peck) E. Müller, although a few small cankers may develop under high disease pressure. Plants of the new *Corylus* are moderately susceptible to bud mites (*Phytoptus avellanae* Nal.), while plants of 'Tonda Gentile delle Langhe' are highly susceptible, and plants of 'Barcelona' are highly resistant.

Temperature tolerance: Plants of the new *Corylus* have been observed to tolerate temperatures from −21 to 38° C. in the field in Corvallis, Oreg.

Comparative data:
- *Tree size, growth habit, yield, and yield efficiency.*—Tree sizes in the trials were estimated by measuring trunk diameters 30 cm above the soil line, at the end of the 7th growing season (December 2013 and 2014, respectively). Trunk cross-sectional area (TCA) was calculated from trunk diameter. Trees of 'Burgundy Lace' are moderately vigorous, similar in size to 'Jefferson' (Tables 1 & 2). In previous trials, TCAs of 'Jefferson' and 'Lewis' were about 70% of 'Bar-

celona'. Their upright-spreading growth habit of 'Burgundy Lace' trees should be easy to manage in a landscape setting. In the 2007 trial, total nut yield per tree averaged 10.04 kg for 'Burgundy Lace', which is less than the other four cultivars (Table 1). Nut yield efficiency for OSU 954.076 (0.122 kg/cm^2), which adjusts for differences in tree size, was similar to 'Felix' (0.133 kg/cm^2), and lower than 'Jefferson' (0.299 kg/cm^2), 'Santiam' (unpatented) (0.267 kg/cm^2) and 'McDonald' (0.245 kg/cm^2). In the 2008 trial, total nut yield per tree averaged 11.39 kg for 'Burgundy Lace', which is more than 'Eta' (unpatented) (7.78 kg) but less than the other 13 genotypes (Table 2). Nut yield efficiency for OSU 954.076 (0.134 kg/cm^2), which adjusts for differences in tree size, was similar to the pollinizer 'Theta' (unpatented) (0.149 kg/cm^2), higher than 'Eta' (0.100 kg/cm^2) and lower than 'Jefferson' (0.292 kg/cm^2) and the others in the trial. Although 'Burgundy Lace' would generally not be planted for nut production, its nuts show a very low frequency of defects (Tables 3 & 4). In the 2007 trial, nut weight was 1.72 g and kernel percentage was 44.1%, the latter being similar to 'Barcelona' (typically 43%). The amount of fiber on the pellicle was rated on a scale of 1 (no fiber) to 4 (heavy fiber) (Table 5). The rating for 'Burgundy Lace' (2.8) was similar to 'Jefferson' (3.0) and indicates a moderate amount of fiber. Kernel blanching, or ease with which the pellicle can be removed with dry heat followed by rubbing, was rated on a scale of 1 (complete pellicle removal) to 7 (no pellicle removal). The rating for 'Burgundy Lace' (6.6) indicates that very little of the pellicle is removed by dry heat. Very few moldy kernels were observed in 'Burgundy Lace' (0.5%), in striking contrast to 'Santiam' (17.3%) (Table 3). The results from the second trial (Table 4) were nearly identical: nut weight 1.71 g, kernel percentage 44%, fiber rating 2.8, blanching rating 6.6, with 87.5% good nuts and very few defects. The kernels, raw or roasted, are not attractive.

Nut maturity date.—Most nuts of 'Burgundy Lace' are borne in clusters of two, in husks about half as long as the nuts. The nuts are slightly long and compressed. The husks open as they dry at maturity, and about 98% of the nuts fall free of the husk. When mature, the shells are medium brown in color and have pubescence at the apical end. Harvest date is estimated to be three days before 'Barcelona'.

Incompatibility and pollinizers.—'Burgundy Lace' has incompatibility alleles $S_{\underline{6}}$ and S_{20} as determined by fluorescence microscopy. Both alleles are expressed in the females, but only S_6 is expressed in the pollen because of dominance. By convention, alleles expressed in the pollen are underlined. The trees set a moderate number of catkins. The catkins are abnormal and small, as are those of 'Cutleaf', and shed very little pollen. For practical purposes, 'Burgundy Lace' is male-sterile, although collection of a handful of catkins can give a trace of pollen. Time of pollen shed and female receptivity were observed weekly from December 2012 to March 2013 and December 2013 to March 2014 (FIG. **2**). Female flower receptivity of 'Burgundy Lace' is late and about one week earlier than 'Cutleaf' and four weeks later than 'Barcelona'. Time of catkin elongation of 'Burgundy Lace' is also late and about three weeks earlier than 'Cutleaf' and three weeks later than 'Barcelona'. Date of leaf budbreak is about one week later than 'Cutleaf' and 2.5 weeks later than 'Barcelona'. Pollen of the following EFB-resistant cultivars is compatible on females of 'Burgundy Lace': 'Yamhill' ($S_{\underline{8}}$ S_{26}), 'Dorris' ($S_{\underline{1}}$ $S_{\underline{12}}$), 'McDonald' (S_2 $S_{\underline{15}}$), 'Wepster' ($S_{\underline{1}}$ S_2), 'York' (S_2 $S_{\underline{21}}$), 'Gamma' (S_2 $S_{\underline{10}}$), 'Jefferson' (S_1 $S_{\underline{3}}$), 'Felix' ($S_{\underline{15}}S_{\underline{21}}$) and 'Theta' ($S_{\underline{5}}$ $S_{\underline{15}}$). Because females of 'Burgundy Lace' are receptive late in the season, the late-shedding pollinizers 'Felix' and 'Theta' are most effective.

Pests and diseases.—Based on DNA marker data, 'Burgundy Lace' has a very high level of resistance to EFB conferred by a dominant allele from 'Gasaway', so fungicide applications are not needed. RAPD markers 152-800 and 268-580 that flank the resistance allele in 'Gasaway', are present in 'Burgundy Lace'. Trees of 'Burgundy Lace' have not yet been challenged with the EFB pathogen in glasshouse or structure inoculations. Susceptibility to bacterial blight caused by *Xanthomonas campestris* pv. *corylina* has not been quantified, but none of the three trees in the two trials were affected. Nevertheless, copper sprays to minimize damage from this pathogen can be performed. Susceptibility to big bud mite (primarily *Phytoptus avellanae* Nal.) was rated in the 2007 trial (Table 3) after leaf fall once per year for five years (December 2009-2013). The scale was from 1 (no blasted buds) to 5 (many blasted buds). The average rating for 'Burgundy Lace' (3.0) is similar to that for 'Clark' and lower than for 'Cutleaf' (4.0), which was rated one year at the Smith Farm and three years (2000-2002) at the nearby USDA National Clonal Germplasm Repository. In the 2008 trial, the rating for 'Burgundy Lace' (3.1) is the same as for the moderately susceptible 'Clark' (3.0). The number of blasted buds for 'Burgundy Lace' is lower than 'Cutleaf' and sprays should not be necessary to control this pest. The other check cultivars in the two trials had lower bud mite ratings.

Propagation.—'Burgundy Lace' was propagated by tie-off layerage of the suckers of the original seedling tree in late June over five years (2005, 2006, 2008, 2011 and 2013). On average, 22 suckers were layered, with rooting rated good on 11 and fair on 7, poor on 3 and no roots on one. The size (caliper) was rated as medium to large in most years. Layers are moderately vigorous and root well, but have lower vigor and caliper than those of 'Jefferson' and 'Barcelona'.

DNA fingerprinting.—Primers used are shown in Table 6, and results shown in Table 7. 'Burgundy Lace' differs from 'Cutleaf' at 14 of 24 loci.

REFERENCES

Bassil N. V., Botta R., Mehlenbacher S. A. 2005a. Microsatellite markers in hazelnut: Isolation, characterization and cross-species amplification. J. Amer. Soc. Hort. Sci. 130: 543-549.

Bassil N. V., Botta R., Mehlenbacher S. A. 2005b. Additional microsatellite markers of the European hazelnut. Acta Hort. 686:105-110.

Bassil N., Boccacci P., Botta R., Postman J. and Mehlenbacher S. 2012. Nuclear and chloroplast microsatellite markers to assess genetic diversity and evolution in hazelnut species, hybrids and cultivars. Genetic Resources and Crop Evolution (on-line) DOI10.1007/s10722-012-9857-z

Boccacci P., Akkak A., Bassil N. V., Mehlenbacher S. A., Botta R. 2005. Characterization and evaluation of microsatellite loci in European hazelnut (*C. avellana*) and their transferability to other *Corylus* species. Molec. Ecol. Notes 5:934-937.

Boccacci R, Akkak, A. and Botta, R. 2006. DNA typing and genetic relations among European hazelnut (*Corylus avellana* L.) cultivars using microsatellite markers. Genome 49:598-611.

Gökirmak T., Mehlenbacher S. A., Bassil N. V. 2009. Characterization of European hazelnut (*Corylus avellana*) cultivars using SSR markers. Genetic Resources and Crop Evolution 56:147-172.

Gürcan, K. and S. A. Mehlenbacher. 2010. Transferability of microsatellite markers in the Betulaceae. J. Amer. Soc. Hort. Sci. 135:159-173.

Gürcan, K. and S. A. Mehlenbacher. 2010. Development of microsatellite marker loci for European hazelnut (*Corylus avellana* L.) from ISSR fragments. Molecular Breeding 26:551-559.

Gürcan, K. and S. A. Mehlenbacher and V. Erdogan. 2010a. Genetic diversity in hazelnut cultivars from Black Sea countries assessed using SSR markers. Plant Breeding 129:422-434. (available on-line doi:10.1111/j.1439-0523.2009.01753.x).

Gürcan, K., S. A. Mehlenbacher, R. Botta and P. Boccacci. 2010b. Development, characterization, segregation, and mapping of microsatellite markers for European hazelnut (*Corylus avellana* L.) from enriched genomic libraries and usefulness in genetic diversity studies. Tree Genetics and Genomes 6:513-531. (available on-line as DOI:10.1007/s11295-010-0269-y)

Mehlenbacher et al., 2004. RAPD markers linked to eastern filbert blight resistance in *Corylus avellana*. Theor. Appl. Genet. 108:651-656.

Mehlenbacher and Smith. 1995. Inheritance of the cutleaf trait in hazelnut. HortScience 30:611-612.

Sathuvalli, V. R. and S. A. Mehlenbacher. 2012. Characterization of American hazelnut (*Corylus americana*) accessions and *Corylus americana*×*Corylus avellana* hybrids using microsatellite markers. Genetic Resources and Crop Evolution 59:1055-1075. DOI10.1007/s10722-011-9743-0.

TABLE 1

Nut yield, trunk cross-sectional area, yield efficiency and bud mite ratings of hazelnut cultivars and selections (including two trees of 'Burgundy Lace' in a guard row) in a trial planted in 2007.

Cultivar	No. trees	Yield per tree (kg) Year 3	Year 4	Year 5	Year 6	Year 7	Total	TCA[z] (cm^2)	YE[y] ($kg \cdot cm^{-2}$)	BBM
'McDonald'	4	0.15	1.10	4.85	7.38	7.95	21.43	87.6	0.245	1.8
'Felix'	4	0.06	1.04	2.91	7.93	4.95	16.88	128.4	0.133	2.0
'Jefferson'	4	0.55	1.97	5.63	4.60	10.25	22.99	77.5	0.299	1.2
'Santiam'	4	0.20	1.11	4.09	5.46	6.83	17.68	66.8	0.267	2.2
LSD $_{0.05}$		0.21	0.43	0.54	2.04	1.18	2.45	13.48	0.029	0.2
'Burgundy Lace'	2	0.09	0.56	2.29	2.87	4.24	10.04	82.2	0.122	3.0

[z]Trunk cross-sectional area calculated from trunk diameters measured in late fall at the end of the 7th season.
[y]Yield efficiency = Total nut yield/TCA.

TABLE 2

Nut yield, trunk cross-sectional area, yield efficiency and bud mite ratings of hazelnut cultivars and selections in two trials planted in 2008.

Selection	SelNo	No. trees	Nut yield per tree (kg) 2010	2011	2012	2013	2014	Total	TCA[z]	YldEff[y]	BBM[x]
EFB-resistant selections											
918.045	1	4	0.233	2.593	3.585	4.513	6.148	17.070	69.0	0.249	1.5
951.086	2	4	0.213	1.718	5.073	7.557	9.510	24.069	92.7	0.258	2.0
964.073	3	4	0.100	1.163	40.998	6.223	8.870	20.453	85.1	0.242	1.0
981.067	4	4	0.027	0.968	2.740	3.630	6.550	13.914	83.3	0.168	1.2
990.035	5	4	0.088	1.258	4.350	4.800	8.420	18.915	72.5	0.259	1.7
992.015	6	4	0.053	0.945	2.068	3.625	6.288	12.978	74.0	0.177	1.4
992.022	7	4	0.040	1.978	4.470	7.338	8.340	22.165	98.8	0.224	1.4
1014.058	8	4	0.210	3.580	3.148	5.538	6.368	18.843	74.0	0.256	2.3
1018.001	9	4	0.105	2.210	2.738	4.695	6.178	15.925	74.1	0.215	1.3
Eta	10	4	0.055	0.665	1.688	1.867	3.503	7.777	77.9	0.100	2.0
Gamma	11	4	0.153	0.780	3.310	5.133	8.240	17.615	97.6	0.181	2.9
Jefferson	12	4	0.223	2.650	4.793	5.875	8.570	22.110	75.9	0.292	1.2
Theta	13	4	0.038	1.240	4.003	4.910	4.560	14.750	101.7	0.149	1.6
Yamhill	14	4	0.218	2.833	4.793	6.805	8.698	23.345	73.7	0.318	1.1
LSD 0.05			0.113	0.524	0.945	1.243	1.552	3.296	14.4	0.038	0.4
Burgundy Lace	h	1	0.020	1.480	2.270	3.110	4.510	11.390	84.9	0.134	3.1

TABLE 2-continued

Nut yield, trunk cross-sectional area, yield efficiency and bud mite ratings of hazelnut cultivars and selections in two trials planted in 2008.

Selection	SelNo	No. trees	Nut yield per tree (kg) 2010	2011	2012	2013	2014	Total	TCA[z]	YldEff[y]	BBM[x]
Performance of hazelnut cultivars and selections (including 'Burgundy Lace') in two trials planted in 2008. EFB-susceptible selections in nearby trial											
919.031	1	3	0.050	1.547	4.890	5.200	8.057	19.743	102.0	0.195	1.0
961.021	2	3	0.225	1.527	3.507	4.770	7.793	17.821	91.1	0.196	2.5
961.063	3	3	0.153	1.707	2.707	3.937	4.490	12.993	56.4	0.231	1.7
978.057	4	3	0.227	1.553	3.063	5.710	5.037	15.590	83.3	0.189	2.9
978.058	5	3	0.207	1.533	3.297	5.025	7.633	17.695	88.1	0.201	1.7
978.064	6	3	0.190	2.083	2.790	4.270	4.387	13.720	57.7	0.238	1.0
1012.074	7	3	0.127	0.790	1.340	3.937	4.475	10.668	93.6	0.115	3.0
Barcelona	8	3	0.197	1.650	4.670	5.357	8.313	20.187	125.8	0.161	1.0
Clark	9	3	0.483	3.416	1.873	6.130	6.320	18.223	72.5	0.251	3.0
Lewis	10	3	0.370	3.350	2.210	7.643	6.833	20.407	80.0	0.255	2.7
Sacajawea	11	3	0.050	0.857	4.247	6.855	9.060	21.068	99.1	0.214	1.1
LSD 0.05			0.185	0.580	0.866	0.942	1.569	2.811	16.7	0.028	0.4

[z]Trunk cross-sectional area calculated from trunk diameters measured in late fall at the end of the 7th season.

[y]Yield efficiency = Total nut yield/TCA.

[x]Susceptibility to bud mite (primarily *Phytoptus avellanae* Nal.) was rated on four trees of each selection on a scale of 1 (no blasted buds) to 5 (many blasted buds). Shown are mean ratings for 5 years (2010-2014). (many blasted buds). Shown are mean ratings for 5 years (2010-2014).

LSD = least significant difference.

TABLE 3

Frequency of good nuts, and of nut and kernel defects in hazelnut cultivars and selections (including two trees of 'Burgundy Lace' in a guard row) in a trial planted in 2007.

Selection	# trees	Frequency (%)[z] Good	Blanks	Brown stain	Moldy	Shrivel	Poor fill	Twins	Black tips
'McDonald'	4	83.5	5.1	0.1	2.1	4.5	4.5	0.1	0.3
'Felix'	4	88.9	4.2	0.2	2.1	0.4	2.9	0.3	1.1
'Jefferson'	4	80.1	4.3	0.3	5.7	0.4	8.9	0.6	0.6
'Santiam'	4	68.8	2.8	0.1	17.3	1.8	9.6	0.1	0.1
LSD 0.05		3.5	2.5	0.3	2.3	1.0	2.5	0.4	0.5
'Burgundy Lace'	2	87.5	6.8	0.0	0.5	0.3	4.8	0.0	0.3

[z]Means of years 4-7.

LSD = Least Significant Difference

TABLE 4

Frequency of good nuts and of nut and kernel defects in hazelnut cultivars and selections in a trial planted in 2008.

Selection	SelNo	# trees	10-NutWt	10-KerWt	PctKer	Fib	Blanch	GD	BL	BS	MO	SH	PF	TW	BT
EFB-resistant selections															
918.045	1	4	25.81	11.69	45.31	1.5	3.9	73.26	4.18	0.56	2.18	0.44	18.38	1.06	0.12
951.086	2	4	27.88	12.43	44.54	2.2	5.4	82.92	5.86	0.64	1.78	0.08	11.22	0.58	0.50
964.073	3	4	26.09	12.33	47.20	2.2	4.7	82.20	1.80	0.14	1.34	1.26	13.14	0.00	0.26
981.067	4	4	23.97	11.38	47.53	3.7	3.9	90.62	4.32	0.18	0.56	0.18	2.82	1.26	0.06
990.035	5	4	23.90	11.34	47.56	1.6	4.7	75.11	3.50	0.06	2.94	1.26	15.62	1.32	0.44
992.015	6	4	24.33	12.32	50.71	2.6	4.5	85.06	7.56	0.18	2.06	0.50	4.06	0.12	0.76
992.022	7	4	26.50	12.82	48.41	3.2	3.8	80.32	4.62	0.00	3.18	0.82	10.76	0.18	0.26
1014.058	8	4	25.20	11.73	46.63	1.7	4.9	92.32	1.44	0.32	0.76	0.88	3.76	0.18	0.38
1018.001	9	4	25.60	12.05	47.17	2.9	3.8	83.68	4.88	0.06	4.18	0.18	6.62	0.50	0.12
Eta	10	4	30.21	14.21	47.12	3.1	3.9	85.86	2.80	1.80	2.06	0.40	5.74	1.00	0.66
Gamma	11	4	24.06	12.40	51.66	3.0	6.4	78.76	5.18	0.68	2.18	1.38	11.50	0.26	0.12
Jefferson	12	4	36.51	16.48	45.23	2.9	4.5	75.56	4.06	0.12	5.82	0.38	13.12	0.62	1.18
Theta	13	4	22.73	11.48	50.52	2.2	2.6	89.06	2.38	0.26	1.76	0.32	5.82	0.26	0.26
Yamhill	14	4	23.59	11.13	47.26	1.4	5.1	76.00	2.32	0.12	2.50	0.82	18.44	0.06	0.26
LSD 0.05			0.94	0.34	0.77	0.2	0.4	3.58	2.56	0.56	1.22	0.74	3.38	0.48	0.08
'Burgundy Lace'		1	17.16	7.56	44.08	2.8	6.6	87.50	6.75	0.00	0.50	0.25	4.75	0.00	0.25

TABLE 4-continued

Frequency of good nuts and of nut and kernel defects in hazelnut cultivars and selections in a trial planted in 2008.

Selection	SelNo		NutWt	KerWt	PctKer	Fib	Blanch	GD	BL	BS	MO	SH	PF	TW	BT
EFB-susceptible selections in nearby trial															
919.031	1	3	26.53	13.55	51.15	2.3	2.1	81.50	4.30	0.40	1.60	0.60	11.20	0.00	0.40
961.021	2	3	25.53	12.00	46.99	1.3	3.5	84.26	4.76	0.16	2.00	3.34	4.76	0.66	0.26
961.063	3	3	25.87	12.25	47.48	1.9	2.6	88.84	2.16	0.76	1.84	0.58	4.34	1.42	0.34
978.057	4	3	29.38	13.91	47.42	3.1	3.0	83.50	8.00	0.00	2.66	1.00	4.16	0.26	0.76
978.058	5	3	30.98	14.78	47.71	2.6	2.6	85.82	4.36	0.36	1.46	1.00	5.18	0.72	1.18
978.064	6	3	25.62	13.13	51.22	2.2	3.3	74.50	7.58	0.08	3.76	6.66	5.92	0.16	1.66
1012.074	7	3	23.17	11.84	51.08	2.1	2.2	89.36	3.64	0.64	1.82	0.64	3.46	0.18	0.36
Barcelona	8	3	38.87	17.08	44.00	2.5	4.3	68.26	5.26	0.16	4.00	1.42	16.00	6.00	0.16
Clark	9	3	24.73	12.41	50.02	2.6	3.1	73.08	2.58	1.00	4.00	0.50	18.34	0.84	0.34
Lewis	10	3	29.41	13.60	46.20	1.3	4.1	65.26	2.00	0.16	11.00	1.26	19.66	2.00	0.76
Sacajawea	11	3	28.07	14.55	51.85	1.3	3.1	82.72	4.90	0.00	4.72	2.10	5.00	0.18	0.54
LSD 0.05			1.64	0.67	0.72	0.3	0.3	5.94	2.02	0.70	1.60	1.10	6.36	0.78	0.50
919.031	1	3	26.53	13.55	51.15	2.3	2.1	81.50	4.30	0.40	1.60	0.60	11.20	0.00	0.40
961.021	2	3	25.53	12.00	46.99	1.3	3.5	84.26	4.76	0.16	2.00	3.34	4.76	0.66	0.26
961.063	3	3	25.87	12.25	47.48	1.9	2.6	88.84	2.16	0.76	1.84	0.58	4.34	1.42	0.34
978.057	4	3	29.38	13.91	47.42	3.1	3.0	83.50	8.00	0.00	2.66	1.00	4.16	0.26	0.76
978.058	5	3	30.98	14.78	47.71	2.6	2.6	85.82	4.36	0.36	1.46	1.00	5.18	0.72	1.18
978.064	6	3	25.62	13.13	51.22	2.2	3.3	74.50	7.58	0.08	3.76	6.66	5.92	0.16	1.66
1012.074	7	3	23.17	11.84	51.08	2.1	2.2	89.36	3.64	0.64	1.82	0.64	3.46	0.18	0.36
Barcelona	8	3	38.87	17.08	44.00	2.5	4.3	68.26	5.26	0.16	4.00	1.42	16.00	6.00	0.16
Clark	9	3	24.73	12.41	50.02	2.6	3.1	73.08	2.58	1.00	4.00	0.50	18.34	0.84	0.34
Lewis	10	3	29.41	13.60	46.20	1.3	4.1	65.26	2.00	0.16	11.00	1.26	19.66	2.00	0.76
Sacajawea	11	3	28.07	14.55	51.85	1.3	3.1	82.72	4.90	0.00	4.72	2.10	5.00	0.18	0.54
LSD 0.05			1.64	0.67	0.72	0.3	0.3	5.94	2.02	0.70	1.60	1.10	6.36	0.78	0.50

Notes (%):
GD = good kernels, BL = blanks, BS = brown stain, MO = moldy kernels, SH = shriveled kernels, PF = poorly filled nuts, TW = twins, BT = black tips.

TABLE 5

Ten-nut and 10-kernel weight, kernel percentage, and ratings for fiber and blanching for hazelnut cultivars and selections (including 'Burgundy Lace') in a trial planted in 2007.

Selection	No. trees	10-nut wt	10-ker wt	Kernel percentage	Fiber[y]	Blanching[x]
McDonald	4	26.2	13.7	52.3	2.6	3.3
Felix	4	27.1	13.7	50.8	3.0	2.2
Jefferson	4	37.6	16.7	44.5	3.0	4.3
Santiam	4	22.8	11.5	50.6	3.0	4.2
LSD $_{0.05}$		2.2	0.4	1.0	0.1	0.4

TABLE 5-continued

Ten-nut and 10-kernel weight, kernel percentage, and ratings for fiber and blanching for hazelnut cultivars and selections (including 'Burgundy Lace') in a trial planted in 2007.

Selection	No. trees	10-nut wt	10-ker wt	Kernel percentage	Fiber[y]	Blanching[x]
'Burgundy Lace'	2	17.2	7.6	44.1	2.8	6.6

[z]Means for nuts and kernels are over four years.
[y]Amount of fiber on the pellicle was rated in the second trial from 1 (none) to 4 (much).
[x]Blanching was rated from 1 (complete pellicle removal) to 7 (no pellicle removal).
LSD = least significant difference.

TABLE 6

Primers, annealing temperatures, and characterisitics for the 24 microsatellite marker loci used to fingerprint 'Burgundy Lace' and other hazelnut cultivars.

Locus	Repeat Motif	Allele sizes	Primers (5'-3') (forward above, reverse below)	Tm (° C.)	n	He	Ho	PIC	r	LG	Locus Reference
A613	$(TC)_{13}(CA)_{12}$	149-177	Ned- CACACGCCTT GTCACTCTTT (SEQ ID NO: 1) CCCCTTTCAC ATGTTTGCTT (SEQ ID NO: 2)	60	14	0.86	0.85	0.85	0.00	11R	A613 Gurcan et al. 2010
A614	$(TC)_{17}(CA)_{10}$ $NNN(CA)_6$	125-156	Hex- TGGCAGAGCT TTGTCAGCTT (SEQ ID NO: 3) GCAGTGGAGG ATTGCTGACT (SEQ ID NO: 4)	60	14	0.85	0.85	0.84	0.00	6S, 6R	A614 Gurcan et al. 2010

TABLE 6-continued

Primers, annealing temperatures, and characterisitics for the 24 microsatellite marker loci used to fingerprint 'Burgundy Lace' and other hazelnut cultivars.

Locus	Repeat Motif	Allele sizes	Primers (5'-3') (forward above, reverse below)	Tm (° C.)	n	He	Ho	PIC	r	LG	Locus	Reference
A616	$(AC)_{11}$	136-162	Fam-CACTCATACC GCAAACTCCA (SEQ ID NO: 5) ATGGCTTTTG CTTCGTTTTG (SEQ ID NO: 6)	60	13	0.85	0.85	0.83	0.00	8R	A616	Gurcan et al. 2010
A640	$(CT)_{15}(CA)_{13}$	354-378	F-TGCCTCTGCA GTTAGTCAT (SEQ ID NO: 7) Fam-CGCCATATAATTG GGATGCTTGTTG (SEQ ID NO: 8)	67	11	0.80	0.73	0.77	0.04	10R	A640	Gurcan et al. 2010
B617	$(GA)_{15}$	280-298	Fam-TCCGTGTTGA GTATGGACGA (SEQ ID NO: 9) TGTTTTTGGT GGAGCGATG (SEQ ID NO: 10)	60	9	0.80	0.78	0.78	0.01	8S, 8R	B617	Gurcan et al. 2010
B619	$(TC)_{21}$	146-180	Fam-AGTCGGCTCC CCTTTTCTC (SEQ ID NO: 11) GCGATCTGAC CTCATTTTTG (SEQ ID NO: 12)	60	14	0.88	0.88	0.87	0.00	3S, 3R	B619	Gurcan et al. 2010
B634	$(AG)_{15}$	218-238	Hex-CCTGCATCCA GGACTCATTA (SEQ ID NO: 13) GTGCAGAGGT TGCACTCAAA (SEQ ID NO: 14)	60	9	0.76	0.76	0.73	0.00	4R	B634	Gurcan et al. 2010
B657	$(AG)_{15}$	210-228	Ned-GAGAGTGCGT CTTCCTCTGG (SEQ ID NO: 15) AGCCTCACCT CCAACGAAC (SEQ ID NO: 16)	60	8	0.84	0.98	0.82	−0.08	11S, 1 1R	B657	Gurcan et al. 2010
B662	$(TC)_{15}$	220-236	Hex-CGAAAGATGGA CTTCCATGAC (SEQ ID NO: 17) CAAGTTGAGAT TCTTCCTGCAA (SEQ ID NO: 18)	60	9	0.74	0.68	0.72	0.04	3R	B662	Gurcan et al. 2010
B671	$(AG)_6NN(GA)_{17}$	221-249	Hex-TTGCCAGT GCATACTC (SEQ ID NO: 19) ACCAGCTCTG GGCTTAACAC (SEQ ID NO: 20)	60	13	0.86	0.88	0.84	−0.01	9S, 9R	B671	Gurcan et al. 2010

TABLE 6-continued

Primers, annealing temperatures, and characterisitics for the 24 microsatellite marker loci used to fingerprint 'Burgundy Lace' and other hazelnut cultivars.

Locus	Repeat Motif	Allele sizes	Primers (5'-3') (forward above, reverse below)	Tm (° C.)	n	He	Ho	PIC	r	LG	Locus	Reference
B709	$(GA)_{21}$	219-233	Ned-CCAAGCACGA ATGAACTCAA (SEQ ID NO: 21) GCGGGTTCTC GTTGTACACT (SEQ ID NO: 22)	60	8	0.74	0.76	0.70	−0.01	5S, 5R	B709	Gurcan et al. 2010
B733	$(TC)_{15}$	161-183	Ned-CACCCTCTTC ACCACCTCAT (SEQ ID NO: 23) CATCCCCTGT TGGAGTTTTC (SEQ ID NO: 24)	60	8	0.68	0.68	0.63	0.00	7S, 2R	B733	Gurcan et al. 2010
B741	$(GT)_5(GA)_{12}$	176-194	Fam-GTTCACAGGC TGTTGGGTTT (SEQ ID NO: 25) CGTGTTGCTC ATGTGTTGTG (SEQ ID NO: 26)	60	10	0.77	0.78	0.74	0.00	5S, 5R	B741	Gurcan et al. 2010
B749	$(TC)_{12}$	200-210	Hex-GGCTGACAAC ACAGCAGAAA (SEQ ID NO: 27) TCGGCTAGGG TTAGGGTTTT (SEQ ID NO: 28)	60	6	0.60	0.64	0.51	−0.03	1R	B749	Gurcan et al. 2010
B751	$(GA)_{15}$	141-153	Fam-AGCTGGTTCT TCGACATTCC (SEQ ID NO: 29) AAACTCAAATAA AACCCCTGCTC (SEQ ID NO: 30)	60	7	0.80	0.78	0.77	0.01	7S, 2R	B751	Gurcan et al. 2010
B767	$(TC)_{15}(AT)_7$	198-238	Fam-CCACCAACTG TTTCACACCA (SEQ ID NO: 31) GCGAAATGGA GCTCTTGAAC (SEQ ID NO: 32)	60	16	0.87	0.80	0.86	0.04	8S, 8R	B767	Gurcan et al. 2010
B774	$(AG)_{15}$	195-213	Ned-GTTTTGCGAG CTCATTGTCA (SEQ ID NO: 33) TGTGTGTGGTC TGTAGGCACT (SEQ ID NO: 34)	60	8	0.80	0.80	0.77	0.00	5S, 5R	B774	Gurcan et al. 2010
B795	$(TC)_8Ns(CT)_7Ns(CT)_{10}Ns(TC)_5$	296-332	Fam-GACCCACAAACA ATAACCTATCTC (SEQ ID NO: 35) TGGGCATCAT CCAGGTCTA (SEQ ID NO: 36)	60	12	0.76	0.74	0.74	0.01	NA	B795	Gurcan et al. 2010

TABLE 6-continued

Primers, annealing temperatures, and characterisitics for the 24 microsatellite marker loci used to fingerprint 'Burgundy Lace' and other hazelnut cultivars.

Locus	Repeat Motif	Allele sizes	Primers (5'-3') (forward above, reverse below)	Tm (° C.)	n	He	Ho	PIC	r	LG	Locus	Reference
C115	$(TAA)_5(GAA)_{12}$	167-225	Fam-CATTTTCCGCAGATAATACAGG (SEQ ID NO: 37) GTTTCCAGATCTGCCTCCATATAAT (SEQ ID NO: 38)	60	10	0.84	0.90	0.82	−0.035	4S, 4R	C115	Bassil 2005b; Gokirmak et al. 2009
KG807	$(TAAA)AA(TAAA)_2A(TAAA)_2$	226-248	AAGCAAGAAAGGGATGGT (SEQ ID NO: 39) Fam-CTTACAGATAAATGGCTCAAA (SEQ ID NO: 40)	54	4	0.67	0.78	0.60	−0.07	11	KG807	Gurcan and Mehlenbacher, 2010
KG809	$(AGG)_6$	333-345	GGAAGGTGAGAGAAATCAAGT (SEQ ID NO: 41) Hex-AGGCATCAGTTCATCCAA (SEQ ID NO: 42)	55	5	0.66	0.64	0.60	0.01	4	KG809	Gurcan and Mehlenbacher, 2010
KG811	$(GA)_{17}$	240-278	GAACAACTGAAGACAGCAAAG (SEQ ID NO: 43) Ned-AAGGCGGCACTCGCTCAC (SEQ ID NO: 44)	58	12	0.83	0.82	0.81	0.01	2	KG811	Gurcan and Mehlenbacher, 2010
KG827	$(CT)_{13}AA(CA)_7$	264-282	Fam-AGAACTCCGACTAATAATCCTAACCCTTGC (SEQ ID NO: 45) GAGGGAGCAAGTCAAAGTTGAGAAGAAA (SEQ ID NO: 46)	67	9	0.78	0.84	0.75	−0.04	9	KG827	Gurcan and Mehlenbacher, 2010
KG830	$(CT)_{14}GTATT(CA)_8$	279-311	Ned-TGGAGGAAGTTTTGAATGGTAGTAGAGGA (SEQ ID NO: 47) AAAGCAACTCATAGCTGAAGTCCAATCA (SEQ ID NO: 48)	67	9	0.79	0.78	0.76	0.00	9	KG830	Gurcan and Mehlenbacher, 2010

Primers fluorescent tags are FAM, HEX and NED
Tm annealing temperature (° C.); n number of alleles; He expected heterozygosity;
Ho observed heterozygosity; PIC polymorphism information content;
r estimated null allele frequency; LG linkage group; NA = not yet assigned
Reference for development and characterization

TABLE 7

Allele sizes in 'Burgundy Lace' and 12 other hazelnut cultivars at 24 microsatellite loci.

Marker	Burgundy Lace	Cutleaf	Gasaway	Rode Zeller	Tonda G.d. Langhe	Barcelona	Yamhill	Dorris	Wepster	McDonald	York	Felix	Theta
A640	372/372	368/372	362/368	355/355	355/368	355/374	355/368	372/374	368/374	362/368	363/374	368/372	362/368
B662	232/232	228/232	232/238	232/232	232/232	232/232	232/232	228/232	232/232	232/232	232/232	232/232	228/232
KG809	339/339	339/339	339/348	342/345	339/342	339/339	348/348	339/348	342/342	339/339	339/348	339/348	339/348
B774	207/213	207/213	203/209	203/207	203/211	203/207	203/211	203/207	203/207	203/213	203/209	203/213	203/213

TABLE 7-continued

Allele sizes in ‘Burgundy Lace’ and 12 other hazelnut cultivars at 24 microsatellite loci.

Marker	Burgundy Lace	Cutleaf	Gasaway	Rode Zeller	Tonda G.d. Langhe	Barcelona	Yamhill	Dorris	Wepster	McDonald	York	Felix	Theta
B619	158/158	158/166	172/176	168/178	150/166	158/172	158/172	158/166	166/172	158/172	158/166	158/166	158/166
B767	214/240	212/214	214/214	212/216	214/218	214/240	214/238	214/218	200/242	200/214	236/238	214/214	212/214
B617	289/293	291/293	291/295	281/291	285/295	285/289	289/295	287/295	293/295	293/293	287/289	287/287	281/285
A614	152/158	152/152	143/158	150/150	125/135	125/132	132/158	132/158	135/158	135/158	124/158	138/143	138/158
B749	205/209	205/205	207/209	207/209	207/209	209/209	209/209	207/207	207/209	207/209	209/209	207/207	209/209
B733	167/167	167/167	175/175	175/175	173/175	173/175	181/185	173/181	173/175	173/175	173/181	175/181	163/181
B709	223/229	223/229	229/229	229/229	229/229	227/235	229/229	229/229	229/235	227/229	229/233	229/233	229/229
KG830	293/303	297/305	291/305	303/303	291/295	291/295	291/295	295/297	295/305	291/295	295/295	293/303	297/297
A616	144/156	152/156	150/150	144/148	150/152	144/152	150/150	150/152	152/160	150/160	144/152	150/152	132/134
C115	216/216	216/216	216/219	194/216	174/174	174/194	197/216	194/216	183/194	174/197	197/197	197/216	197/216
KG827	274/282	272/272	272/282	272/282	268/278	282/284	268/282	272/284	270/282	272/284	268/272	272/284	270/272
B671	241/251	225/237	237/249	249/249	239/243	225/229	225/243	229/249	239/249	229/237	243/249	229/237	229/249
A613	161/179	179/179	161/163	153/167	153/153	153/161	153/163	151/169	167/167	153/169	159/179	151/153	167/179
KG811	257/257	255/257	257/261	255/257	257/267	261/267	251/261	257/267	257/257	245/267	257/257	251/267	257/257
B751	146/152	146/152	144/144	148/152	150/154	144/154	152/152	144/152	144/144	144/144	152/154	152/154	144/152
B741	178/184	184/184	186/188	178/184	176/184	178/186	178/186	178/186	176/186	178/188	178/186	186/186	184/186
KG807	242/252	242/252	242/252	238/238	238/252	238/252	230/252	242/252	252/252	252/252	242/252	238/242	252/252
B795	333/333	333/333	317/319	317/333	315/333	333/333	333/333	333/333	333/333	317/333	333/333	321/333	299/333
B634	228/228	228/228	222/234	220/240	228/228	228/228	236/236	228/228	228/228	222/228	228/236	228/236	228/236
B657	223/227	223/227	225/229	211/227	219/227	219/223	219/229	211/227	227/227	211/219	221/223	219/227	219/223

SEQUENCE LISTING

```
<160> NUMBER OF SEQ ID NOS: 48

<210> SEQ ID NO 1
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 1

cacacgcctt gtcactcttt                                                  20


<210> SEQ ID NO 2
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 2

cccctttcac atgtttgctt                                                  20


<210> SEQ ID NO 3
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 3

tggcagagct ttgtcagctt                                                  20


<210> SEQ ID NO 4
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer
```

-continued

<400> SEQUENCE: 4

gcagtggagg attgctgact 20

<210> SEQ ID NO 5
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 5

cactcatacc gcaaactcca 20

<210> SEQ ID NO 6
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 6

atggcttttg cttcgttttg 20

<210> SEQ ID NO 7
<211> LENGTH: 29
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 7

tgcctctgca gttagtcatc aaatgtagg 29

<210> SEQ ID NO 8
<211> LENGTH: 25
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 8

cgccatataa ttgggatgct tgttg 25

<210> SEQ ID NO 9
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 9

tccgtgttga gtatggacga 20

<210> SEQ ID NO 10
<211> LENGTH: 19
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 10

tgtttttggt ggagcgatg 19

<210> SEQ ID NO 11

-continued

<211> LENGTH: 19
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 11

agtcggctcc cctttctc 19

<210> SEQ ID NO 12
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 12

gcgatctgac ctcatttttg 20

<210> SEQ ID NO 13
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 13

cctgcatcca ggactcatta 20

<210> SEQ ID NO 14
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 14

gtgcagaggt tgcactcaaa 20

<210> SEQ ID NO 15
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 15

gagagtgcgt cttcctctgg 20

<210> SEQ ID NO 16
<211> LENGTH: 19
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 16

agcctcacct ccaacgaac 19

<210> SEQ ID NO 17
<211> LENGTH: 21
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

-continued

<400> SEQUENCE: 17

cgaaagatgg acttccatga c 21

<210> SEQ ID NO 18
<211> LENGTH: 22
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 18

caagttgaga ttcttcctgc aa 22

<210> SEQ ID NO 19
<211> LENGTH: 21
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 19

ttgccagtgc atactctgat g 21

<210> SEQ ID NO 20
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 20

accagctctg ggcttaacac 20

<210> SEQ ID NO 21
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 21

ccaagcacga atgaactcaa 20

<210> SEQ ID NO 22
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 22

gcgggttctc gttgtacact 20

<210> SEQ ID NO 23
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 23

caccctcttc accacctcat 20

<210> SEQ ID NO 24

-continued

<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 24

catcccctgt tggagttttc 20

<210> SEQ ID NO 25
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 25

gttcacaggc tgttgggttt 20

<210> SEQ ID NO 26
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 26

cgtgttgctc atgtgttgtg 20

<210> SEQ ID NO 27
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 27

ggctgacaac acagcagaaa 20

<210> SEQ ID NO 28
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 28

tcggctaggg ttagggtttt 20

<210> SEQ ID NO 29
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 29

agctggttct tcgacattcc 20

<210> SEQ ID NO 30
<211> LENGTH: 23
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

-continued

<400> SEQUENCE: 30

aaactcaaat aaaaccccctg ctc 23

<210> SEQ ID NO 31
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 31

ccaccaactg tttcacacca 20

<210> SEQ ID NO 32
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 32

gcgaaatgga gctcttgaac 20

<210> SEQ ID NO 33
<211> LENGTH: 20
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 33

gttttgcgag ctcattgtca 20

<210> SEQ ID NO 34
<211> LENGTH: 21
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 34

tgtgtgtggt ctgtaggcac t 21

<210> SEQ ID NO 35
<211> LENGTH: 24
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 35

gacccacaaa caataaccta tctc 24

<210> SEQ ID NO 36
<211> LENGTH: 19
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 36

tgggcatcat ccaggtcta 19

<210> SEQ ID NO 37

-continued

<211> LENGTH: 22
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 37

cattttccgc agataataca gg 22

<210> SEQ ID NO 38
<211> LENGTH: 25
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 38

gtttccagat ctgcctccat ataat 25

<210> SEQ ID NO 39
<211> LENGTH: 18
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 39

aagcaagaaa gggatggt 18

<210> SEQ ID NO 40
<211> LENGTH: 21
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 40

cttacagata aatggctcaa a 21

<210> SEQ ID NO 41
<211> LENGTH: 21
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 41

ggaaggtgag agaaatcaag t 21

<210> SEQ ID NO 42
<211> LENGTH: 18
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 42

aggcatcagt tcatccaa 18

<210> SEQ ID NO 43
<211> LENGTH: 21
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

-continued

```
<400> SEQUENCE: 43

gaacaactga agacagcaaa g                                               21


<210> SEQ ID NO 44
<211> LENGTH: 18
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 44

aaggcggcac tcgctcac                                                   18


<210> SEQ ID NO 45
<211> LENGTH: 30
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 45

agaactccga ctaataatcc taaccettgc                                      30


<210> SEQ ID NO 46
<211> LENGTH: 28
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 46

gagggagcaa gtcaaagttg agaagaaa                                        28


<210> SEQ ID NO 47
<211> LENGTH: 29
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 47

tggaggaagt tttgaatggt agtagagga                                       29


<210> SEQ ID NO 48
<211> LENGTH: 28
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 48

aaagcaactc atagctgaag tccaatca                                        28
```

We claim:

1. A new and distinct cultivar of *Corylus* plant as herein illustrated and described.

* * * * *

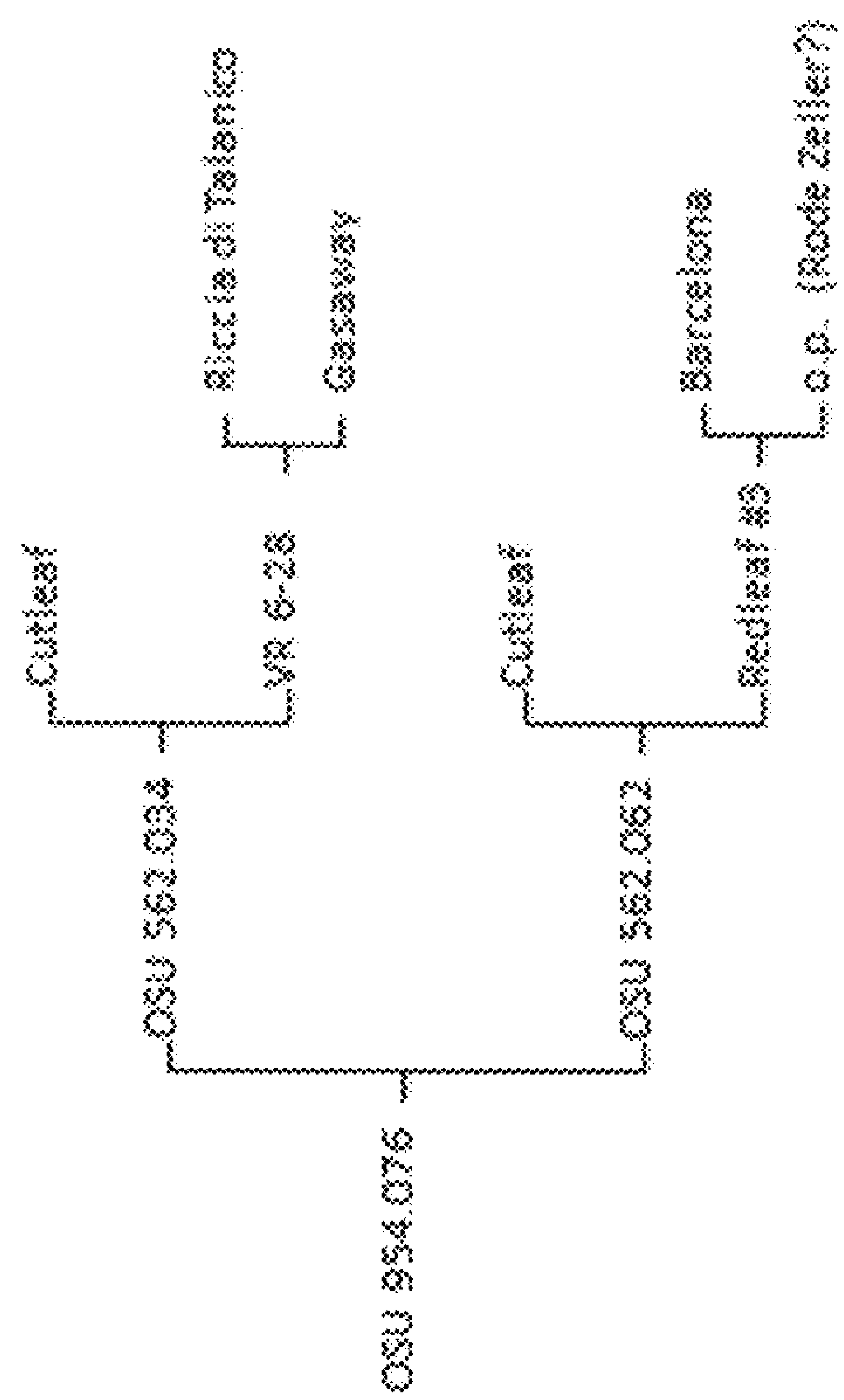

OSU 954.076
OSU 562.034
OSU 562.062
Cutleaf
VR 6-28
Cutleaf
Redleaf #5
Riccia di Talanico
Gasaway
Barcelona
o.p. (Rode Zeller?)

FIG. 1

FIG. 2

			Jan						Feb						March			
Genotype	24-Dec	30-Dec	4-Jan	8-Jan	15-Jan	20-Jan	25-Jan	30-Jan	5-Feb	10-Feb	15-Feb	19-Feb	25-Feb	28-Feb	7-Mar	11-Mar	18-Mar	27-Mar
Redleaf Cutleaf																		
954.076										25	90	-90			Gr tip		no BB as of 3/22	
R100.33									Rd	Rd-2/11	b3	b3/18			MS			
										Red					Black			
																	BB	
Greenleaf Cutleaf														1st	10	25	50	
372.029										Rd1/1-2/18	b2/18	MS			MS		MS	
small female flowers										Red		Bright Red			Red		Dark	

Bottom (12/2013 - 3/2014)

			Jan						Feb						March			
Genotype	24-Dec	30-Dec	4-Jan	8-Jan	15-Jan	20-Jan	25-Jan	30-Jan	5-Feb	10-Feb	15-Feb	19-Feb	25-Feb	28-Feb	7-Mar	11-Mar	18-Mar	27-Mar
Redleaf Cutleaf																		
OSU 954.076							1st	80		30-40*	50-60	done			gr tip		BB Mar 21	
RL/OL						Rd-1st				Rd-3	Rd-3S	RdB-3/S	b2/6-3					
catkins look good										Red		Red	dk/blk					
Greenleaf Cutleaf											1	5	20		30	gr tip	BB Mar 18	
OSU 372.029											RdB	RdB-2/S	MS			MS		
small females											Red	Red	Red			Red/dark		
Barcelona				1st	30	55	90-8	-70		-90	done		gr tip		BB Mar 5			
(1,2)		Rd	Rd-2	Rd-2/8				b3		b3		b3						
			Red					dk		dk/red		black						

$ indicate abundance of flowers in each stage

Green = Pollen shed (a minus sign in front of the number indicates the percent of catkins that have already shed out);

Red = Female flowers; red, blk (black), dk (dark, not quite red, not yet black).

FIG. 3

FIG. 4

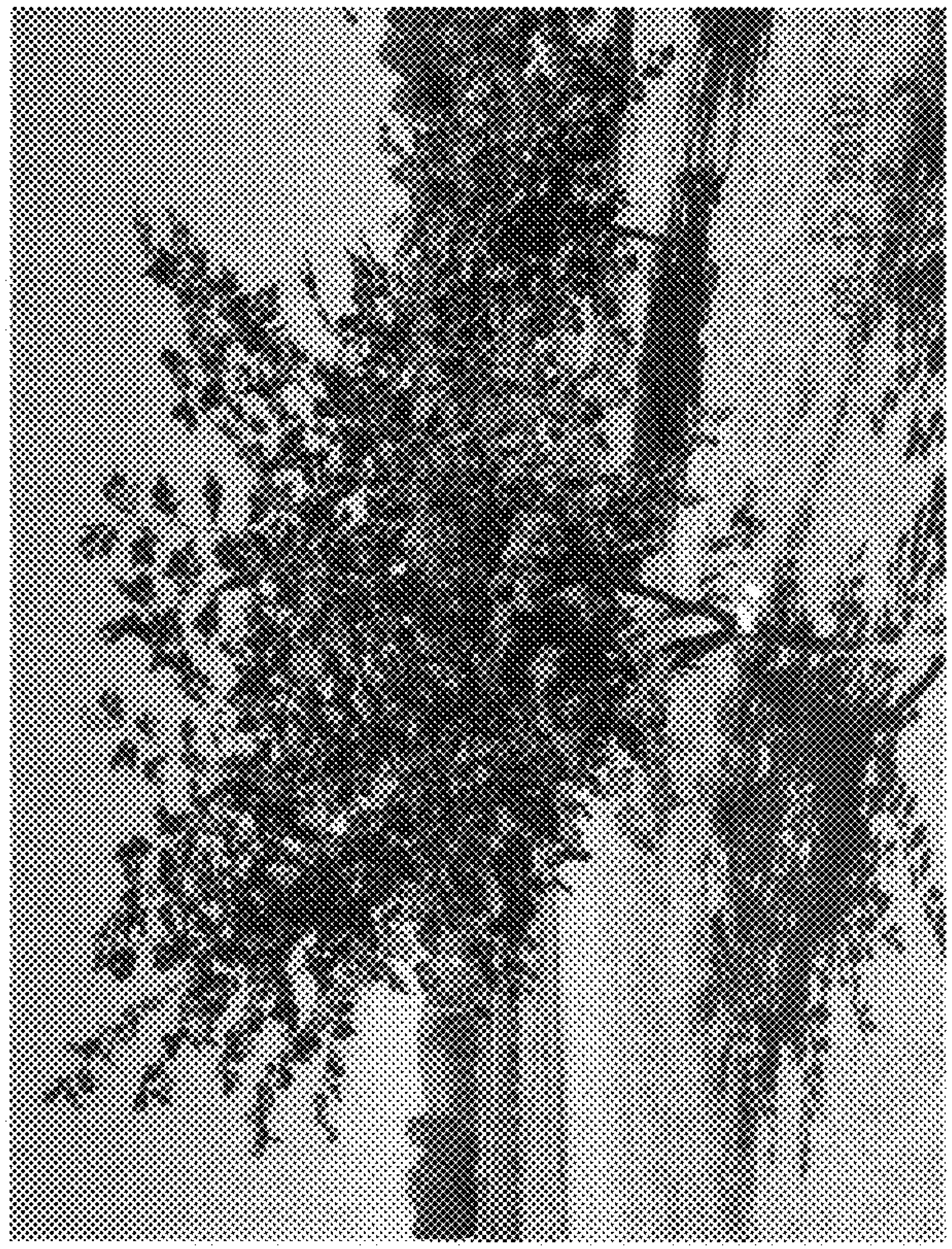


FIG. 6

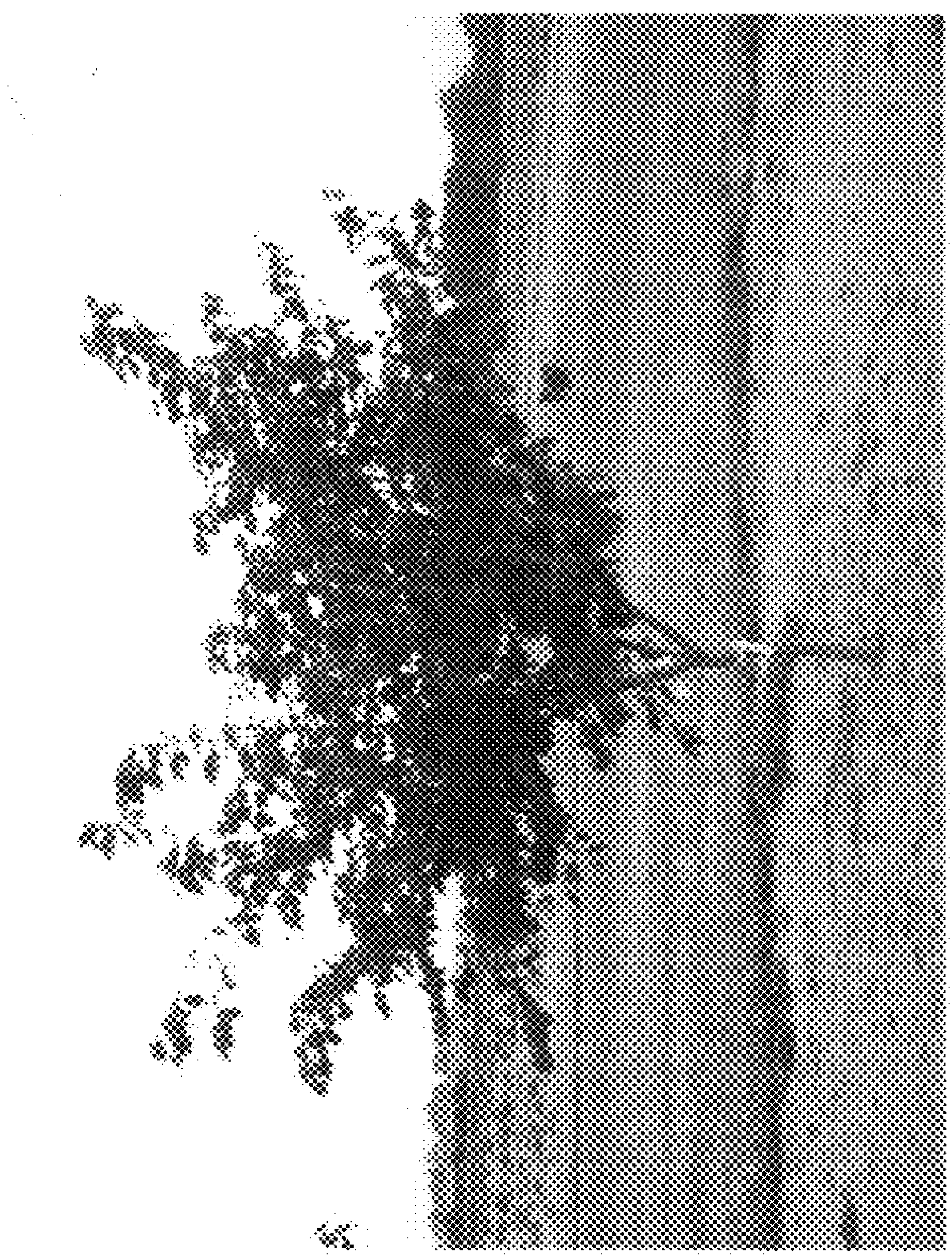


FIG. 5

FIG. 8

FIG. 9

FIG. 7

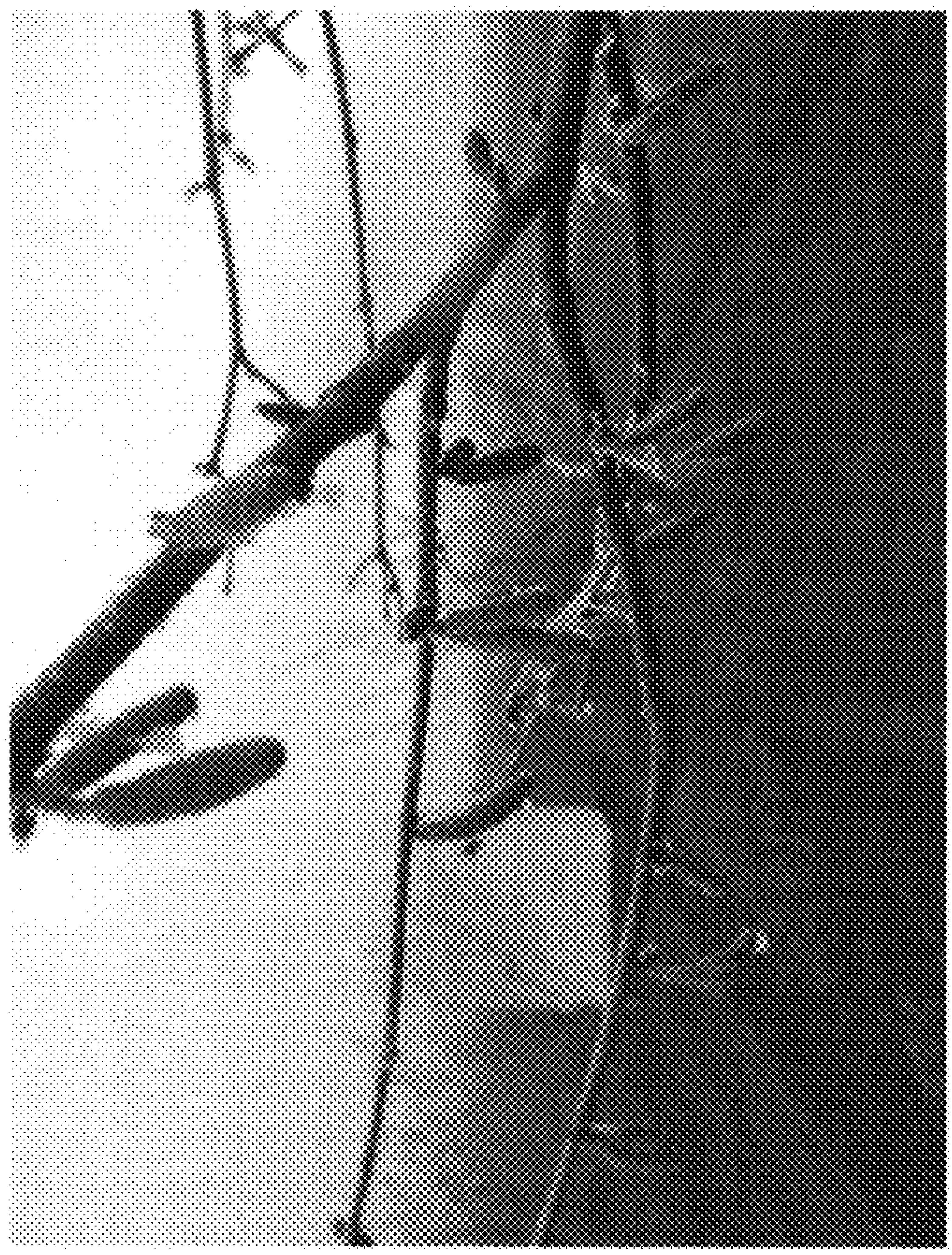


FIG. 11

FIG. 10

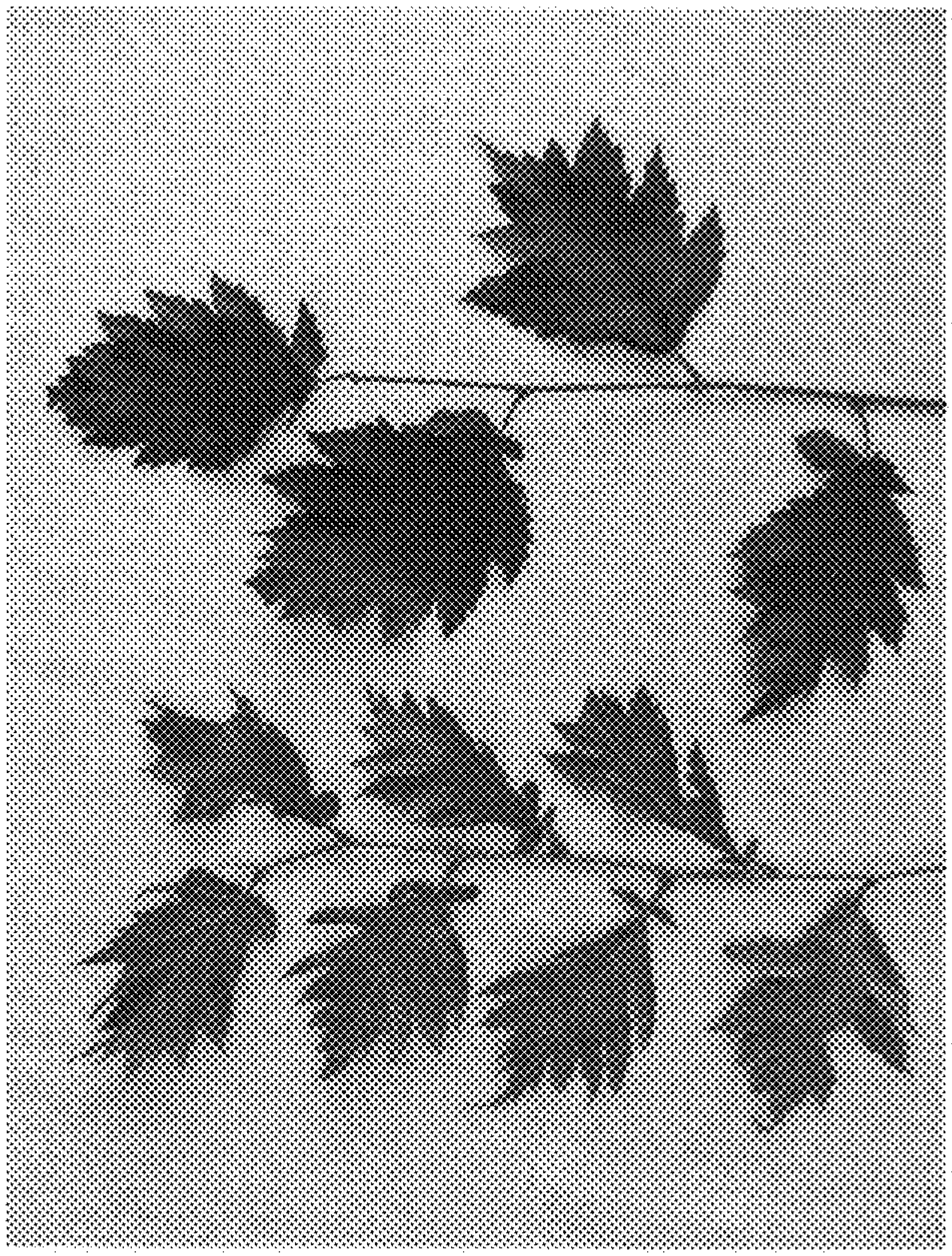


FIG. 13

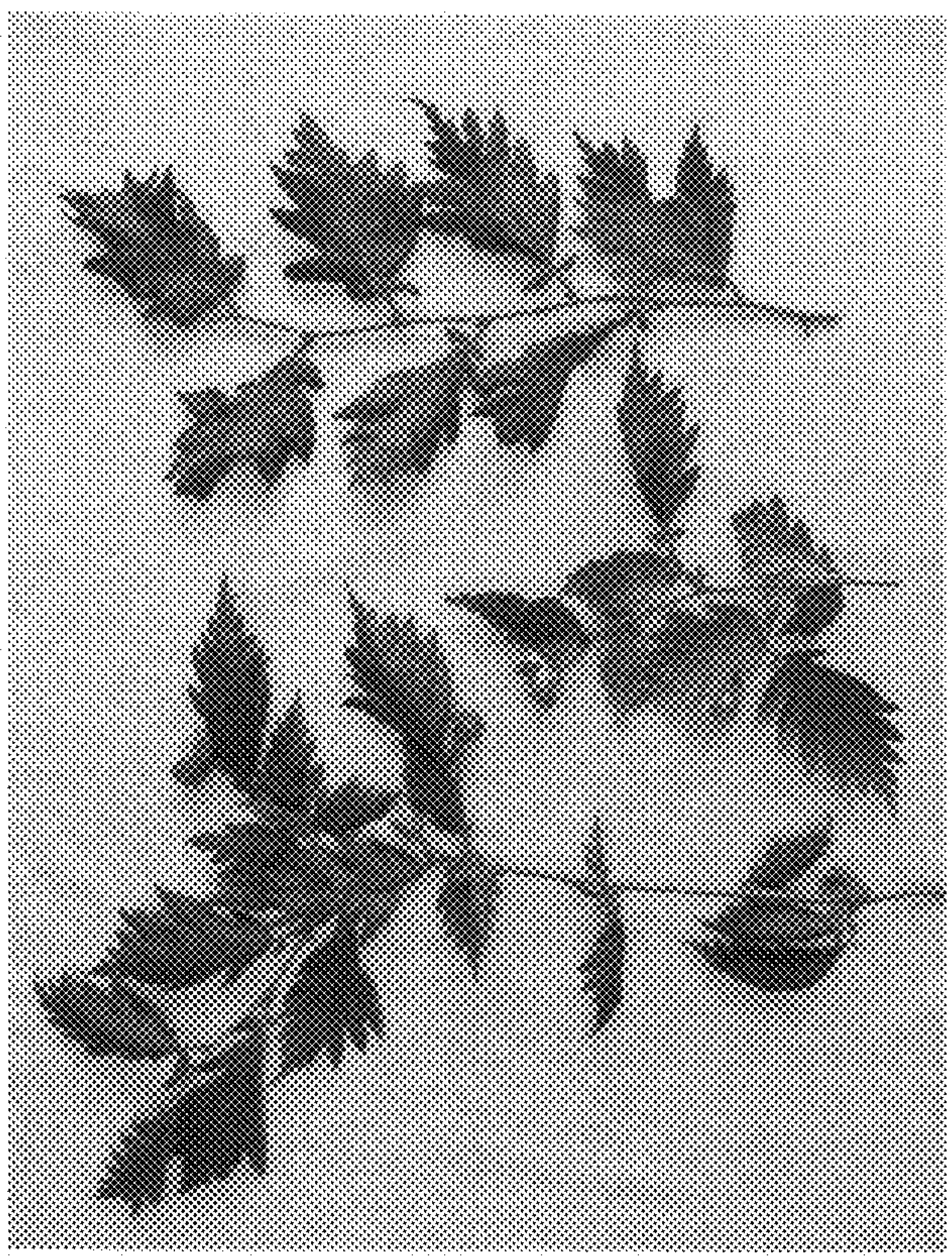
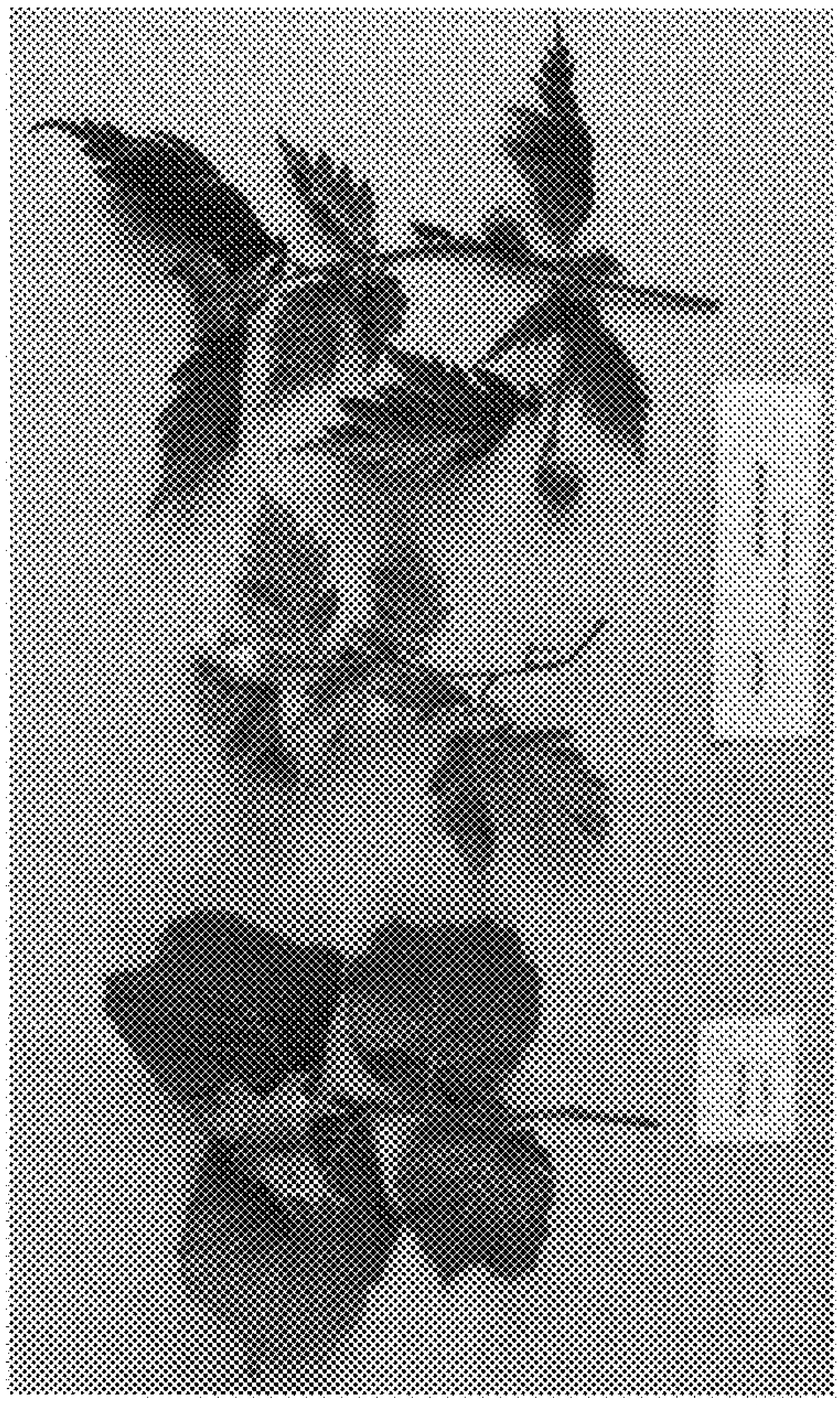


FIG. 12



'Barcelona' 'Cutleaf' 'Burgundy Lace'

FIG. 14

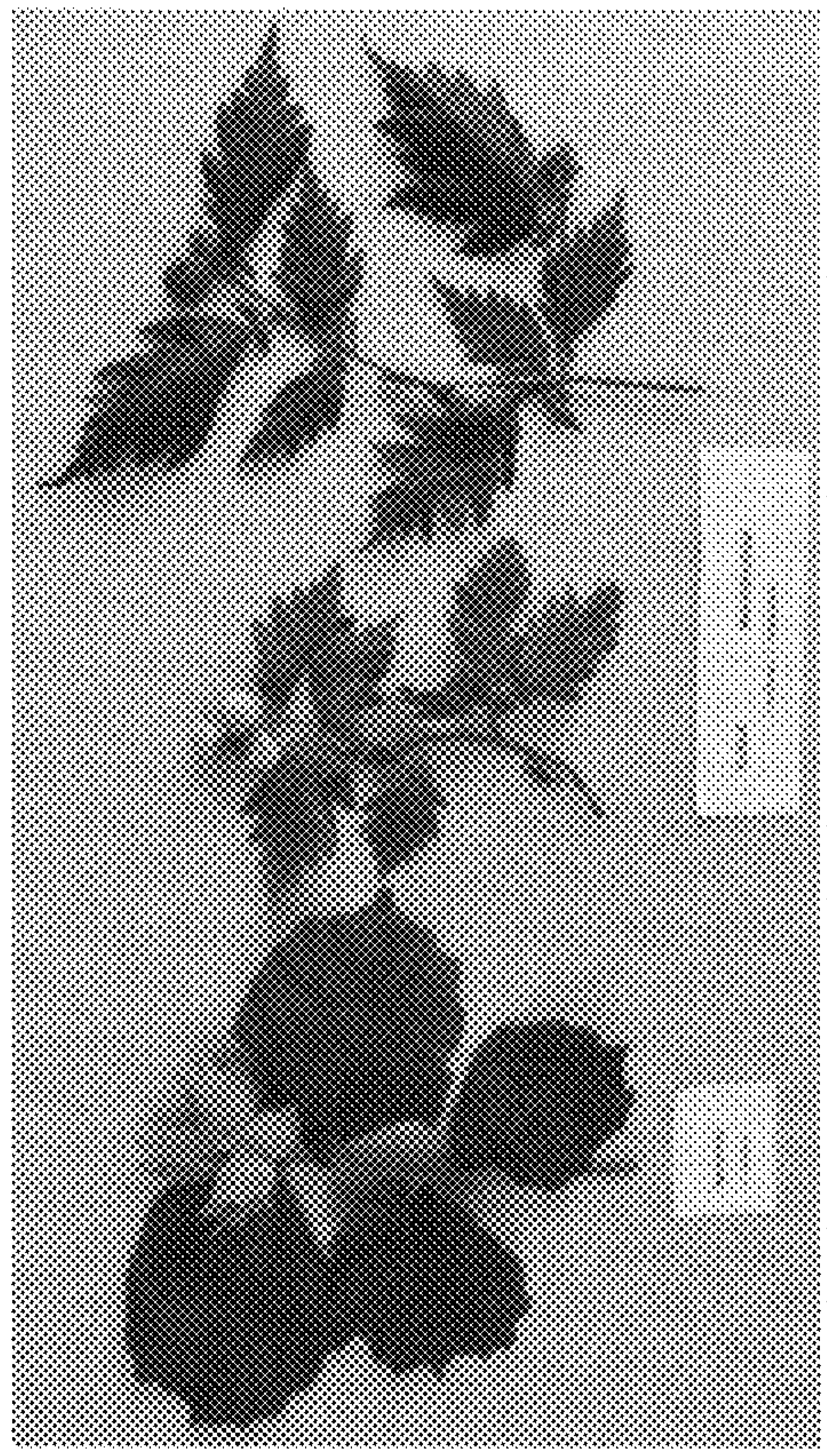


FIG. 15

Barcelona

'Cutleaf'

'Burgundy Lace'

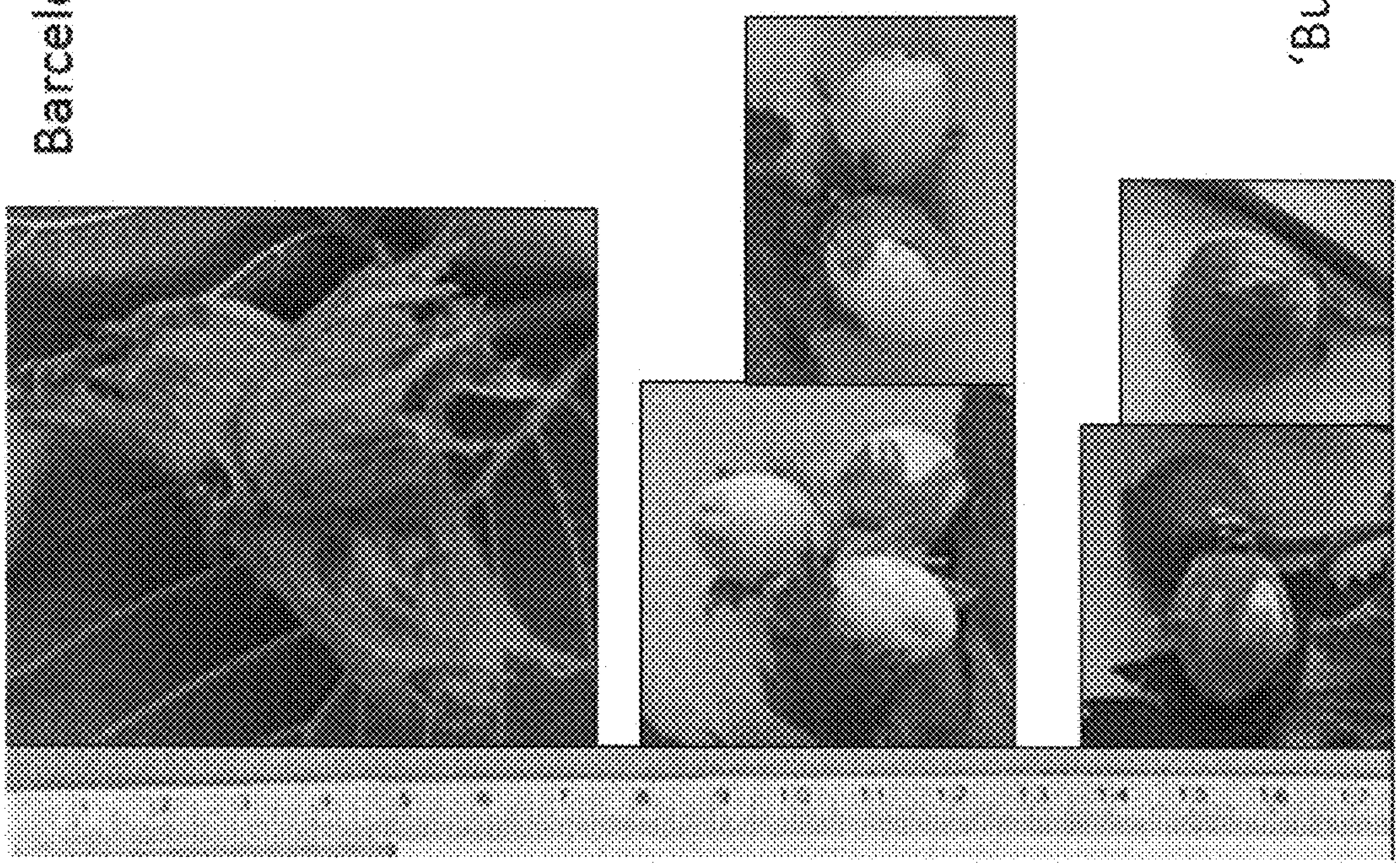


FIG. 16