A Hybrid of *Buddleja davidii* var. *nanhoensis* ‘Nanho Purple’ and *B. lindleyana*

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Additional index words. *Buddleja davidii*, *Buddleja lindleyana*, butterfly bush, Buddlejaceae, Loganiaceae, Scrophulariaceae, breeding, hybrids, RAPD analysis

Abstract. A controlled cross between *Buddleja davidii* var. *nanhoensis* (Chitt.) Rehd. ‘Nanho Purple’ and *B. lindleyana* Fort. ex Lindl. produced a hybrid. Pollen viability, male fertility, and the floral and vegetative characters are presented with a Latin diagnosis. *Buddleja* × *luteolufauca* Elliott and Fantz is proposed as the name for this hybrid. Hybridity was confirmed using RAPD analysis.

Buddleja L. (orthogr. syn. *Buddleia*) consists of ≈100 species (Griffiths, 1994). The genus has been placed in several families including Scrophulariaceae Juss. (Rogers, 1986) and Loganiaceae Mart. (Griffiths, 1994) as well as its own family Buddlejaceae K. Wilh. (Bhattacharyya and Johri, 1998). Most species are tropical or subtropical shrubs originating in Asia, South Africa, and North and South America. *Buddleja* has a number of qualities that make it a desirable ornamental shrub. Plants exhibit extended flowering periods and produce long panicles of flowers that attract butterflies and bees. *Buddleja* are widely adaptable, tolerating poor soil, heat and drought, and suffer from few pest problems, the exceptions being nematodes (Dirr, 1998) and spider mites (Gillman, 1998).

Garden use of *Buddleja* has been limited primarily to *B. davidii* Franch. However, there are some notable exceptions. ‘Lochin’ is an offspring of hybridization between *B. davidii* and *B. fallowiana* Balf., and possesses the silvery-gray foliage of *B. fallowiana*, and the hardiness, habit and panicle size of *B. davidii*. ‘Honeycomb’ and ‘Sungold’, both hybrids of *B. globosa* Hope and *B. davidii*, have the yellow flower color of *B. globosa* and foliar character and plant habit intermediate between these two species (Dirr, 1998).

To date, hybridization of the Asian species *B. davidii* and *B. lindleyana* Fort. ex Lindl. has not been reported in literature. *Buddleja lindleyana* possesses characteristics that would be desirable to incorporate into *B. davidii*. It has evergreen to semi-evergreen foliage in zones 7 to 9, produces purple-colored panicles that are considerably longer than *B. davidii*, and can be encouraged to grow on a trellis or to weave through the canopy of a tree, where its long drooping panicles can be displayed with maximal effectiveness. Also, *B. lindleyana* is considered to be more mite resistant

(Dirr, 1998). A successful interspecific hybrid of *B. davidii* var. *nanhoensis* (Chitt.) Rehd. ‘Nanho Purple’ and *B. lindleyana* has been made. The objectives of this work described herein are to verify the hybrid status of the seedling produced, characterize the floral and vegetative characters of the hybrid, and to validate a name for the hybrid taxon.

Materials and Methods

Numerous controlled crosses between *B. davidii* var. *nanhoensis* ‘Nanho Purple’ and *B. lindleyana* were made, resulting in a single hybrid seedling (herein referred to as the hybrid). ‘Nanho Purple’ was used as the female parent. This seedling was grown in the N.C. State University Horticultural Science greenhouse in Raleigh, and stem cuttings were made of this individual plant for further testing.

In Spring 2001, three vegetatively propagated specimens each of the hybrid, *B. davidii* ‘Nanho Purple’ and *B. lindleyana* were transplanted outdoors at the Horticultural Field Laboratory in Raleigh and grown under standard cultural conditions. Characterization of floral and vegetative characters of the hybrid and both parents were made for two consecutive years. Winter leaf defoliation was assessed visually in January 2003.

Color was assessed by observation using the *Royal Horticultural Society Colour Chart* (Royal Horticultural Society, 1986). Color designations (e.g., reddish-brown) represent the author’s personal perceptions, while the color value designations (e.g., RHS 174A) refer to corresponding RHS color chips.

Self- and cross-fertility of the hybrid and both parents were assessed by making controlled self- and cross-pollinations in the greenhouse. Cross-pollinations were made using standard hybridization procedures. For each pollination, panicles containing flowers one to two days before anthesis were selected. The flowers were emasculated and fresh pollen of the male parent was applied with a camel’s hair brush to the stigmatic surface of each flower immediately after emasculation. Pollinations were performed over a four-month period of time, from July through November 2000.

In total, 511 flowers were self-pollinated on 11 inflorescences of the hybrid. In total, 774 flowers on 11 inflorescences of *B. davidii* ‘Nanho Purple’ were self-pollinated. Four panicles of *B. lindleyana* were self-pollinated, resulting in a total of 189 flowers.

Fertility of the hybrid relative to both parents was assessed by crossing all three taxa as male parents to *B. fallowiana* and to *B. davidii* cultivars ‘White Ball’, ‘Black Knight’, and ‘Dartmoor’, using the hybrid and both parents as the pollen source. Between 7 and 13 inflorescences were pollinated for each combination, with total flowers pollinated ranging from 430 to 1664 flowers per combination. Seed capsules were harvested at maturity, as defined by their dried appearance and the beginning of dehiscence. The seed capsules were placed in paper envelopes, dried for an additional 2 to 3 d at room temperature, and stored at 4 °C until they were sown. For germination, seeds were sown on sterile media (Fafard # 4) and placed under intermittent mist. The number of germinated seedlings for each cross combination was counted after 3 to 5 weeks.

Pollen fertility of the hybrid and both parents was determined by culturing pollen obtained from newly opened flowers on germination media (Brewbaker and Kwack, 1963). A fine camel’s hair brush was used to remove pollen from the anthers of several flowers representing several inflorescences of the same plant. Three petri dishes containing media were made for each taxa. Pollen was placed on the media and allowed to germinate for 3 h. Pollen germination was measured by examining the pollen under 100× magnification. Germination was defined as the pollen tube being at least as long as the diameter of the pollen grain. This procedure was replicated three times over the course of 5 weeks. Pollen fertility of the hybrid and both parents was compared using a repeated measures ANOVA, with data composed of arcsine transformation of the percent pollen germination.

Randomly amplified polymorphic DNA (RAPD) reactions were performed on leaf samples of the hybrid and each parent to confirm hybridity. RAPD primers OPAV11, OPW-16, OPX-18, OPAA-11, (AC)8CA, (AC)8CT, (AC)8TT and (AG)8CC were used in accordance with previously reported procedures (Chaparro et al., 1994).

Vouchers in flower of *B. davidii* ‘Nanho Purple’ (6611 and 6613, NCSC; 6612, NA), *B. lindleyana* (6614 and 6616, NCSC; 6615, NA) and the hybrid (6617 and 6619, NCSC; 6618, NA) were collected by Fantz and Elliott. Vouchers sent to the United States National Arboretum (NA) included 6612, 6615, and 6618, and the remaining vouchers were deposited at the NCSU Herbarium (NCSC).

Results and Discussion

Morphological comparison of taxa. The hybrid resembles both parents in having angulate stems, opposite green leaves, purple-violet corolla lobes, glabrous ovules, and four stamens. The inflorescence of each taxa is an indeterminate thyrses. Fruits are capsules. A summary of distinguishing characters compar-

Received for publication 21 Jan. 2004. Accepted for publication 27 Mar. 2004. The authors appreciate the contributions of W.E. Kloos for generating thought; L. Snelling, for support of this project; J. Chaparro for conducting the RAPD reactions; and J. Dietz for statistical consultation.

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Table 1. A comparison of the hybrid characters with those of the parents *Buddleja davidii* ‘Nanho Purple’ and *B. lindleyana*.

Characteristic	<i>B. davidii</i> ‘Nanho Purple’	Hybrid	<i>B. lindleyana</i>
Stems			
Color older stem	165A-B Dark brown	174A, 175A-B Reddish-brown	172A, 174A Reddish-brown
Suckering	No	No	Yes
Leaves			
Petiole length (mm)	(0) 2–4	0–3 (5)	(2) 3–6 (7)
Length/width ratio	3.1–5.6	2.3–3.4	1.4–2.2 (2.6)
Shape	Lanceolate, oblong, oblanceolate, linear	Lanceolate, oblong, elliptical	Ovate-lanceolate
Margin	Serrate-crenate	Serrate	Entire (crenate)
Lower surface color	194A-195A-196A Silver-white	148C, 147B (194A) Pale green	147A, 147B, 147C Pale green
Lower surface pubescence	White tomentose	Pale tan on midrib of young leaves	Brown pubescence on young leaves
Upper surface	Dull color	Dull color	Shiny
Winter leaf defoliation	80%	15%	25%
Inflorescence			
Rachis length (mm)	63–110 (125)	(5) 85–212 (383)	(132) 185–400 (450)
Grouping	3, 5, 7	3	3
Flowers			
Flower length (mm)	13.1–16.9 (18.5)	16.4–21.8	(13.6) 14.3–18.7
Total number flowers	(39) 48–90	(26) 53–133	161–280
Number open flowers	(34) 41–90	3–27 (34)	(1) 3–11
Odor	Fragrant	Nonfragrant	Nonfragrant
Calyx			
Width (mm)	0.9–1.6	1.3–2.2	1.8 – 2.3
Corolla			
Shape	Salverform Straight	Salverform Mostly straight, a few curved	Tubular Curved
Pubescence	Sparse	Dense	Dense
Lobe/tube width	4.1–7.6	3.0–5.6	1.6–2.8
Color–tube	80B-C	88D	84C, 85A
Tube width (mm)	0.8–1.7	0.9–2.6	1.6–3.0
Lobe width (mm)	(5.1) 5.5–8.4	(5.4) 6.1–9.1	4.1–6.1
Color–throat	25A (edge), 28A, 31A Orange-yellow	158A, 20C Creamy yellow	84C, 85C Purplish-white
Stamen			
Length (mm)	12	12	7
Anther color	162A Muddy yellow	166A Dark brown	164A Medium red-brown
Filament color	156B Green-gray	166D, 199B Taupe	Clear, match throat
Seed capsules			
Length (mm)	6–12	6–12	4–6
Width (mm)	(0.9) 1.3–2.1	1.9–2.9 (3.4)	2.2–3.6
Length/width	4.6–8.3 (10.8)	(2.8) 3.6–4.7 (5.3)	1.1–2.4

ing the hybrid and both parents is presented (Table 1).

The hybrid resembles *B. davidii* ‘Nanho Purple’ in several ways. The leaves have a similar shape, lanceolate to oblong-elliptical, with serrated edges and dull color. Petioles are rather short. Also, flowers of the hybrid resemble *B. davidii* in shape, in broad lobe width, and stamen length. Seed capsules are similar in length. There is no evidence of suckering in either the hybrid or ‘Nanho Purple’.

The hybrid resembles *B. lindleyana* in several ways. The color of the older stems is similar. The underside of the leaf is similar in pubescence and is almost concolorous. There is very little winter leaf defoliation. Flowers are similar to *B. lindleyana* in that they are grouped in sets of three, lack fragrance, have broader calyxes, and the outer corolla tube is densely pubescent and sparkles when the light hits the hairs.

The hybrid displays characteristics intermediate between the two parents. The length to width ratios of the leaves and of the seed capsule are intermediate. The leaf undersides of *B. davidii* are tomentose, even canescent. The leaf undersides of *B. lindleyana* have brown pubescence

in juvenile leaves, with less obvious brown pubescence limited to the veins on mature leaves. The undersides of the leaves of the hybrid are tomentulose on juvenile leaves, and have pale tan pubescence on the midrib. The panicles of *B. lindleyana* are elongate and arch downward, with flowers occurring in sets of three, with only a few (3 to 11) flowers in the panicle open at one time. The inflorescence of ‘Nanho Purple’ is more compact, with denser sets of flowers (sets of 3, 5, or 7) and flowers generally blooming simultaneously (41 to 90). The inflorescence of the hybrid is intermediate in length, with 3 to 27 flowers open at one time (Fig. 1). The individual corolla tube length of the hybrid flower is greater than either parent. The ratio of the width of the corolla lobe to the width of the tube is intermediate. The color of the hybrid’s throat is a creamy yellow, whereas the throat of *B. lindleyana* is the same pale purple color of the tube, and the throat of *B. davidii* has an orange-yellow eye.

Fertility. The hybrid is fertile as a male parent, generally similar to *B. davidii* ‘Nanho Purple’, based on the number of viable seed produced per pollinated flower on selected cultivars of *B. davidii* female parents. Both the hybrid and *B.*

lindleyana produced viable seed after self-pollination, unlike *B. davidii* ‘Nanho Purple’ which lacked self-seed production. Crosses between the hybrid and *B. fallowiana* were more successful than crosses of *B. fallowiana* with either parent (Table 2). Pollen viability of the hybrid is similar to that of *B. lindleyana* (Table 3). Field observations reveal considerable hybrid seed set, suggesting high female fertility as well.

Analysis of the RAPD reactions confirms hybrid origin. RAPD primers OPAV-11, OPW-16, and OPX-18 amplified clear, reproducible bands that show hybrid origin (Fig. 2). *Buddleja lindleyana* is a diploid species, possessing 38 chromosomes whereas *B. davidii* is a tetraploid species with 76 chromosomes (Moore, 1947). A successful hybridization between these two species might be expected to result in a triploid hybrid, unless *B. lindleyana* produces unreduced (2x) gametes, resulting in a tetraploid. The fertility of the hybrid suggests that it is a tetraploid, and suggests that *B. lindleyana* produces unreduced gametes.

Culture. The hybrid is easy to root from softwood and semi-hardwood stem cuttings. Flowers are formed on new growth, thus prun-

Fig. 1. Inflorescence of *Buddleja davidii* x *B. lindleyana* hybrid.

ing before spring growth is recommended. The hybrid seems to grow best under cooler temperatures, as compared to *B. davidii*, and extends the flowering season into fall. It appears to be more shade tolerant than many *Buddleja*.

Availability. Currently, the hybrid is not in general commerce. Propagules can be obtained from Dennis Werner, Department of Horticulture, N.C. State University, Raleigh.

Conclusion

The hybrid exhibits characteristics of both parents, as well as a number of intermediate traits. Flowers tend to be larger than either parent with an extended blooming period. The hybrid grows better in cooler temperatures, loses fewer leaves in winter, and is more floriferous. Therefore, it will be a useful addition for landscape plantings. The hybrid is successful in producing viable seed from controlled crosses with other *Buddleja* species, in contrast with limited fertility of *B. lindleyana* in such cases. The hybrid can provide stock material for introducing desirable characteristics of the diploid

B. lindleyana for cultivar improvement in the tetraploid *B. davidii*.

Hybrid nomenclature and morphology. *Buddleja* x *luteolufaucia* Elliott and Fantz { *Buddleja davidii* var. *nanhoensis* (Chitt.) Rehd. x *Buddleja lindleyana* Fort. ex Lindl. } distinguish inflorescentia thyryo laxo; floribus ternatis, purpureis, nonodoriferis; corolla tubo elongato, pubescenti denso et lucenti, cum fauce flavo cremeo.

Shrub, low mounding, currently to 1.1 m tall x 2 m wide. Stems angulate, slightly winged; older stems reddish-brown (174A, 175 A–B). Leaves are opposite, lanceolate, acute to acuminate, cuneate to attenuate, serrate, dull green above (147A) and paler green below (147B, 148C), 32 to 83 mm long and 10 to 30 mm wide; pale tan pubescence on lower surface ribs of young leaves; petiole 0 to 3 mm. Inflorescence is an indeterminate thyrses with flowers in groups of 3; rachis to 383 mm long. Flowers are odorless, salverform; calyx 3.1 to 5.8 mm long, 1.3 to 2.2 mm wide with fine hairs; corolla densely pubescent and glistening, soft bluish-violet (80 to 81A, 82A, 87B) with throat creamy yellow (158A, 20C), 16 to 22 mm long, lobes 6 to 9

Fig. 2. RAPD banding patterns of *Buddleja davidii* (lane 2), *B. lindleyana* (lane 3), and the *B. davidii* x *B. lindleyana* hybrid (lane 4) using primer OPAV-011. Lane 1 = 1 kb molecular marker. Top arrow shows a 0.8 kb band found in only *B. lindleyana* and the hybrid. The bottom band shows a 0.74 kb band found only in *B. davidii* and the hybrid.

mm wide; stamens four, 12mm long; ovary glabrous. Seed capsule 8 to 12 mm long, 1.9 to 3.4 mm wide. Holotype: *Fantz and Elliott 6617* (NCSC); Paratypes: *Fantz and Elliott 6618* (NA) and *6619* (NCSC).

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Table 2. Male fertility of a *Buddleja davidii* ‘Nanho Purple’ x *B. lindleyana* hybrid and both parents as measured by the average number of viable seeds produced per pollinated flower after controlled hybridization of each to three cultivars of *B. davidii* (‘White Ball’, ‘Black Knight’, and ‘Dartmoor’) and to *B. fallowiana* ‘Alba’.

Male parent	Female parent			
	White Ball	Black Knight	Dartmoor	<i>B. fallowiana</i>
<i>B. davidii</i> ‘Nanho Purple’	0.43	6.69	2.49	1.18
Hybrid ^a	0.58	4.57	3.43	2.36
<i>B. lindleyana</i>	0.0016	0.0027	0.0031	0.0054

^aF₁ hybrid of *B. davidii* var. *nanhoensis* ‘Nanho Purple’ x *B. lindleyana*.

Table 3. Pollen viability of the hybrid and both parents as determined by in vitro pollen germination.^a

Taxa	Percent germination			
	Time 1	Time 2	Time 3	Mean ^b
<i>B. davidii</i> ‘Nanho Purple’	5	6	1	4 a
Hybrid ^a	35	44	10	25 b
<i>B. lindleyana</i>	23	63	16	37 b

^aViability determined as percentage germination after 3 h of incubation on Brewbaker and Kwack (1963) media.

^bMeans followed by different letters are significantly different at *P* = 0.05 (LSD test).

^cF₁ hybrid of *Buddleja davidii* ‘Nanho Purple’ x *B. lindleyana*.