Malus

International Ornamental Crabapple Society

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International Ornamental Crabapple Society

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Malus

International Ornamental Crabapple Society Bulletin

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Malus is the official publication of the International Ornamental Crabapple Society and is published twice annually. The Society is a non-profit organization.

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International Ornamental Crabapple Society
c/o David Allen
The Holden Arboretum
9500 Sperry Road
Kirtland, OH 44094

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Deadline for inclusion of articles in the Spring issue is March 1st and for articles in the Fall issue is September 1st.

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Front Cover Photo: *Malus* 'Prairie Maid' with its prolific flower display at the Longenecker Gardens in the University of Wisconsin-Madison Arboretum, Madison, Wisconsin. (Photo by Dr. Edward Hasselkus)

Rear Cover Photo: (Top left) The fruit of *Crataegus viridis* 'Winter King' in late November at the Longenecker Gardens in the University of Wisconsin-Madison Arboretum. (Photo by Dr. Edward Hasselkus) (Top right) A close-up photo of *Malus* Lollipop™ at Lake County Nursery in Perry, Ohio. (Bottom right) Robert Simpson considered *Ilex verticillata* 'Winter Red' to be one of his finest plant introductions due, in part, to its annual production of large crops of orange-red fruits. (Photo by Dr. Edward Hasselkus) (Bottom left) A specimen of *Malus* Lollipop™ at Lake County Nursery in Perry, Ohio.

President's Corner

Dear Members:

The crabapple world is alive and well. Anyway, that is the conclusion I have drawn after attending the IOCS Crabapple Symposium and board meeting at The Holden Arboretum in early September. It was a fine gathering of crabapple admirers, both new and old, and a great deal of good information was shared. Our sincere thanks to Dr. Ed Hasselkus, Bill Hendricks and Jim Chatfield for their interesting and informative contributions to the program.

It has been some years since I had attended a previous crabapple symposium. My previous attendance dated back to the founding years of the IOCS and some significant changes have occurred over the years. One of the biggest changes I have noticed is the large number of new cultivar and variety names that are being spoken about these days. Indeed, the evidence indicates a more intensive level of crabapple breeding, naming and introduction than we have seen in more recent years.

In like manner, the report and recommendations of the Crabapple Evaluation Committee given during the board meeting indicates the presence of a whole new generation of promising crabapples that need to be evaluated. The Board of Directors, of course, approved the recommendations to begin removal of well tested trees from the evaluation plots to make room for the promising new upstarts.

The symposium also served to intensify the emphasis on year round aesthetic appeal, especially with respect to evaluation. It is a broader concern, very much in line with our original emphasis on disease evaluation and rating. Our compliments go out to the Secrest Arboretum in Wooster, Ohio, for renewing this charge, originally put forward by Dr. Thomas Green.

Equally, we are thankful to Peter Bristol and his staff for hosting the crabapple symposium. Even more so, we appreciate The Holden Arboretum's significant contribution to the IOCS by providing housing and staff for our organization's use. We were in safe and capable hands.

Sincerely,

Norbert Kinen
Senior Vice-president
J. Frank Schmidt & Son Co.

Editor's Note: This article is the second and final part of the interview of Robert Simpson. The first part was published in the Spring, 1998 issue of Malus (Volume 12, Number 1). Again some of the videotaped version of the interview is included along with the written text where it served to illuminate the text portion.

The same questions were given by then IOCS president, John Pair, in a videotaped interview recorded by his son, Tom Simpson. Copies of the videotape are available for $6.00 plus shipping and handling. Please send your requests for a copy of the video directly to Tom Simpson at the address listed below or call him at (812)882-2441.

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Robert C. Simpson Revisited: An Interview with a Plantsman (Part II)

by Robert C. Simpson (Edited by David Guthery)

Why do you view crabapples as superior landscape plants?

Disease resistant crabapples are superior landscape plants because there are selections tailored for many uses. Crabapples are one of the smaller ornamental trees, which are adapted to a variety of soils, climates and moisture conditions in both urban and suburban sites. Many also have three seasons of value - blossom color in spring, good foliage all summer, ornamental fall fruit and some have good fall foliage color. Others have distinctive forms or branching habits when mature such as *Malus hupehensis* and *M. sargentii* 'Candymint'.

Crabapples should be used more in urban landscapes for the reasons previously stated. Unfortunately early cultivars gave crabapples a bad reputation due to premature loss of foliage and too large, messy fruits which littered sidewalks and patios. The large fruits were also a temptation for children to throw.

What nursery production techniques did you use to propagate crabapples?

Originally we used seedling understocks which had the advantage of normally being virus free. Unfortunately not enough is know to select seedling sources for understock as pertaining to hardiness, vigor and degree of suckering.

A great deal of work has been done on clonal rootstocks. With apples, delayed incompatibility has been noted with certain understocks, as well as initial incompatibility in other cases. Clonal understocks must be maintained virus free or all the resulting grafted crabapples may be infected. However, the results are

more predictable and some understocks result in a relative freedom from suckering.

Some crabapples root readily from softwood cuttings. Special attention must be given to the post-care of rooted cuttings to prevent development of a shallow horizontal root system which will inadequately support the tree. I understand deep, "milk-carton" type containers have helped direct roots downward. Undoubtedly this will vary with individual cultivars.

The "best" production method may vary with the individual nursery and their facilities. For rooting softwood cuttings, contract rooting is one possibility. For clonal understocks one would need to produce his own or purchase from a nursery specializing in such production.

I feel the trend will be strongly toward own-root or clonal understocks. Own-rooted cultivars may still sucker objectionably; however, they will not be from seedling apple understock.

How did you store your crabapples?

We put them in a cellar and watered them. They were then let dry in between waterings. I felt we had better results than providing continuous high humidity as we had less disease problems.

Could you tell us about your other introductions, not including crabapples?

***Crataegus viridis* 'Winter King'** - I have always been interested in anything with colorful fruit displays. I originally saw the parent tree in a field 1/4 mile away and I could not understand why a tree still had fall leaves on when everything else had dropped. Well it ended up being the parent tree for *Crataegus viridis* 'Winter King'. In fact, it was not the leaves at all, but rather masses of orange-red fruits which made it visible from a distance. The local tree was estimated to be 50 to 100 years of age when I discovered it in 1950. The branches of 'Winter King' were relatively free of thorns and the the thorns present were shorter and more slender than most other species. Juvenile wood may revert to some degree of thorniness. We produced 'Winter King' by chip budding it onto Washington hawthorn understock.

***Crataegus* x 'Vaughn'** - This selection, first made by Henry Schnitzius of New Augusta Nursery in Indianapolis, Indiana, had been used in a local landscape planting. A landscape architect, Fred Schreiner of Indianapolis, called the tree to my attention. He had spotted the original tree in a row of Washington hawthorn seedlings. He had then planted it at the doorway of a home of people by the name of Vaughn, thus the name. It was judged to be a hybrid between Washington hawthorn and cockspur hawthorn.

Our nursery named it and introduced 'Vaughn' because of its vigor and its excellent glossy foliage with fine fall color. However, we primarily introduced 'Vaughn' for its masses of glossy orange-red fruits which were somewhat larger than 'Winter King'. Because of thorniness, I feel it is best grown as a high standard which later becomes strongly horizontally branched with age. Pruning easily maintains it as a low rounded specimen with an annual eye-stopping fruit display. Its fruit persists, still attractive long after Washington hawthorn. The fruit is relished by birds in late fall or early winter. The fruits do not retain their color as long as 'Winter King' whose fruits remain attractive until February.

***Crataegus* x 'Hooks'** - No one promoted until we did. It is certainly worthy, but few seemed interested. The fruit drops in fall similar to *Crataegus crus-galli* and it has glossy leaves.

***Pyrus calleryana* 'Earlyred'** - It is a chance seedling of 'Bradford'. Originally five promising seedlings were selected, but all the others were eventually seriously injured by fireblight. However, no fireblight has ever seriously damaged a large, old specimen of 'Earlyred'; although a couple branches were affected, but have never been cut out. I selected it for its excellent fall foliage color and early fall leaf drop, while 'Bradford' was still green.

How did you first get interested in deciduous hollies?

Again I was always interested in plants with small, ornamental fruit which persisted.

Can you discuss your deciduous holly introductions?

'Red Cascade' - It was the best of several *Ilex decidua* seedlings sent from Warren Nursery in Oklahoma City, OK. It was selected for its excellent glossy summer foliage, long lasting and large, glossy red fruits, unusually showy silvery winter branches and its distinctly undulating, spreading branching habit. The wavy-horizontal branching makes it less bush-like; however, its size limits its uses. In fact, we have a specimen 20-25 feet out in our nursery.

'Sentry' - It was selected from a lot of seedlings sent from Forest Keeling Nursery in Elsberry, MO. I picked it originally for its distinctively narrow columnar form. It is a berry producing female. A more northern type, it defoliates earlier than others.

'Red Escort' - A good selected male, it was chosen from among a batch of Warren Nursery seedlings. Its excellent glossy, dark green foliage made it a great escort for *Ilex decidua* females.

'Bonfire' - Originally purchased as a seedling of *Ilex serrata*, it was later determined by the National Arboretum to be a hybrid with *Ilex verticillata*. It was named because of its vigor and its annual, blazing masses of small red fruits over a long period. The fruits are even effective before leaf drop.

'Afterglow' - I selected it for its excellent foliage and its slow growing, rounded habit. It is so named due to its long lasting display of orange-red, good sized fruits. It is effective as a compact glossy-leaved shrub all summer and then in fall is eye-catching with its fruit display, from early September through mid-winter. It is one of the last spots of color in early to mid-winter.

'Winter Gold' - A color mutation of 'Winter Red'. Two canes of a nearly mature plant of 'Winter Red' produced abundant, striking golden orange fruits. It is identical in all other respects to its parent, although the foliage is slightly lighter green. A vigorous grower.

'Winter Red' - Selected out of the same seedling batch as 'Afterglow' and 'Sunset', it is probably the finest of all the cultivars of *Ilex verticillata*. 'Winter Red' has done well from Missouri to Michigan, east to Boston and south to the Carolianas, Alabama and Louisiana. It has also done well in Seoul, South Korea. It has excellent dark green foliage in both summer and fall. The fruits are medium sized and are an intense orange-red color. Upright in youth, 'Winter Red' becomes more spreading with age due to unusually heavy, annual crops of fruit which retain color effectively later than any other deciduous holly I know, sometimes into March. It was selected from a group of 500 seedlings from Tingle Nursery in 1954. I noticed it was the heaviest fruiting plant of the group in it second year in the field.

'Sunset' - It was a distinctly different plant than any other of the seedlings from which 'Winter Red' also came. It was not named until plants sent out for trial attracted a lot of attention. 'Sunset' is different than most deciduous hollies with larger fruit, larger leaves and a spreading growth habit. The foliage color is darker green than most. It is so named because of the fruit display which is later than most other ornamental shrubs.

'Stoplight' - It arrived as a chance seedling from among several rows of *Ilex verticillata* in the nursery of Harry Hopperton of Warsaw, KY. I must have admired it in particular when visiting, because two years later the plant was dropped off, balled and burlapped in full leaf, by another nursery Harry had sent; without comment I might add. I put it in the shadehouse bed for observation. Obviously a northern type, it is early blooming and dwarf, but with especially fine, dark green foliage. It is among the earliest coloring deciduous holly with dark red fruits, which are nearly as large as those of 'Red Sprite'.

Initial reports indicate that it may be one of the best yet. I chose the name for sales appeal and to indicate excellence.

'Southern Gentleman' - It was selected from a group of males which bloomed with 'Winter Red'.

'Jim Dandy' - A male which bloomed early and over a long time.

I also helped popularize several deciduous hollies including: 'Red Sprite, 'Sparkleberry'. 'Autumn Gold' (whose fruits unfortunately fade badly) and 'Christmas Cheer' (which needs *Ilex serrata* to pollinate it). I consider 'Winter Red' to be the greatest plant I was responsible for introducing.

Are there any "plant people" who you knew or had experiences with who you can reflect on?

Donald Wyman - I knew him since about the time I finished college through both ASHS and the International Plant Propagator Society. He gave me personal permission to name and introduce their AA-328 crabapple ('Red Barron') at one of the state nursery meetings, where he was on the program. We also had personal correspondences.

Donald Egolf - I corresponded with him over a period of years regarding crabapples and other plants sent to us as cooperators. He took me on a tour of his field plants, especially promising crabapples and named crepemyrtles. I think his introduction, 'Adirondack, is very interesting.

Polly Hill - We have corresponded for many years. I frequently talked with her at many Holly Society of America annual meetings. It never ceased to amaze me the diversity of her interests as well as her important introductions.

Father John Fiala - My regret is that I never took the time to visit him and his crabapple breeding program. It was certainly my loss that we never met.

Luther Burbank - He was one of my most admired people due to my father, who had spent a day or two at his home.

Roy Nordine - I knew him quite well and considered him a friend. He was at the Morton Arboretum and later at the Bickelhaupt Arboretum.

Les Nichols - He visited us at Vincennes only once, but we were in frequent contact by both mail and phone. His early ratings were based solely on the susceptibility of crabapple varieties to scab, not on the resulting defoliation or their overall aesthetic effectiveness. Later, he conceded that some scab could be acceptable, if it did not seriously detract from the foliage appearance.

Arie den Boer - He visited us at Vincennes several times. He was very helpful and informative. In a few cases, we were not in agreement as to a plant's identity as one or the other had started with incorrectly named varieties. I greatly valued

his friendship.

Other people I knew and considered as personal friends:

Harrison Flint (Purdue University) - A friend for many years and author of Landscape Plants of Eastern North America.

David Leach - Plantsman, breeder and explorer. I supplied him with all of our *Ilex verticillata* and *Ilex decidua* cultivars many years ago.

Fred Galle - A friend for many years, he is a noted plantsman and author.

Theodore Klein - Nurseryman, plantsman, propagator and lecturer on unusual trees. A personal friend for over 50 years from Crestwood, KY.

Michael Dirr - A personal friend for many years, he is an outstanding plantsman and nationally know horticultural writer.

Dr. Gourley - Chief of Horticulture at Ohio State University (OSU) and was a friend of my fathers from the days when we were in the fruit business.

Elton Smith - OSU personal friend for many years and a wonderfully versatile person.

Emmet Cole - President of Cole Nursery.

Bill Collins - Horticulturist for Cole Nursery. Bill was later a horticultural consultant.

Ferris Miller - He was a banker and founder of the Chollipo Arboretum in South Korea. We supplied him with most of our *Ilex verticillata* cultivars. 'Winter Red' has done especially well for him. He is also a personal friend.

Elizabeth White - A pioneer American holly grower and originator of many of the best commercial varieties. I spent a day and a night at her home.

L.C. Chadwick - A friend since his early days at OSU.

Mark Cathey - A friend for many years, he is a work renown lecturer, plantsman and administrator.

John Wister - Director of the Scott Arboretum at Swarthmore College, I supplied him many of our best crabapple varieties as well as deciduous hollies.

Ralph Shay - A pathologist at Purdue University, he directed their breeding program for scab resistant, commercial apples. He was later the head of horticulture at Washington State University. He was a family friend while he was with Purdue and is responsible for all of my crabapple breeding work.

Richard Lighty - Director of the Mt. Cuba Center in Greenville, DE, he is an expert on plants native to the Piedmont area. He was a personal friend for years.

Peter Bristol - Horticulturist at The Holden Arboretum and an outstanding plantsman, he was a long time friend.

Bill Hendricks - Owner of Klyn Nursery in Perry, OH, he is an outstanding plantsman, commercial nurseryman and propagator. He is doing research on seed sources. He also is a personal friend for many years.

Gene Eisenbeiss and Ted Dudley - Both of the National Arboretum, the latter is a plant explorer and taxonomist. Both friends for many years.

Susyn Andrews - Kew Gardens in England. She is a charming person and both a taxonomist and plant explorer. We have worked with her on the introduction of deciduous holly cultivars into England. I also supplied her with cut branches of *Ilex verticillata* for national exhibits in England in 1993. She was a guest speaker at the Great Rivers Chapter of the Holly Society of America and a national meeting of the Holly Society of America in 1993 as well.

Tom Green - A pathologist at the Morton Arboretum, he specialized in diseases of crabapples. He was an organizer and the "spark plug" for the IOCS. A long time personal friend and consultant.

Ralph Synnestvedt, Sr. - Synnestvedt Nurseries in Round Lake, IL. He was a personal friend for many years and cooperated in testing *Ilex opaca* and deciduous hollies in the Chicago area. He often visited us at Vincennes.

Have you received any awards over the years?

In 1973, I received the Indiana Association of Nurserymen - Award of Merit for outstanding service and contribution to horticulture. On October 14, 1987, I was awarded the Holly Society of America's Joseph C. McDaniel Award for outstanding contribution and dedication to the Great Rivers Chapter of the Holly Society of America. On November 30, 1990, I received the William F. Kosar Award for outstanding work in the development and distribution of new deciduous holly cultivars. Finally in January, 1992, I received an Honorary Membership in the Kentucky Association of Nurserymen for many years of services to the nursery industry of Kentucky. In 1995, I received the Indiana Nurseryman of the Year by the Indiana Association of Nurserymen.

What advice would you give future plant breeders?

Always test thoroughly before introducing. Plan for 20 years to make crosses, growing on, secondary test blocks, observation and trial in other areas. Do not overlook promotion for sales and above all set goals,

When selecting parent varieties for crosses, select plants with strong disease resistance, annual flowers, good size of bloom, color , double blossoms, tree size and form, foliage color, hardiness and good vigor. Certain varieties may be better adapted to specific areas of the country as in the case of apples.

Any suggestions for future breeding work?

I would suggest *M. zumi* var. *calocarpa* as one parent, or 'Adirondack', with either 'Indian Magic', 'Pink Satin', 'Van Eseltine', a good weeper such as 'Louisa', Red Jewel®, or 'Prairifire' for consideration for future crosses.

Any final comments or observations?

The nursery business will change a great deal as it has done throughout its history with more and more appreciation for fine plants in the landscape. Arboretums and Botanical Gardens are the display windows. Landscape architects and designers must become better informed as to the availability and suitability of fine plants for their particular region as well as where they can be used. This means the nursery industry must make an effort to both educate individual homeowners and those who design the plantings as to what is new and fine, as well as a plant's special requirements and after-care for success. Merchandising will be very important. Service to the buyers and the "know how" is where smaller nurseries have a great advantage over mass merchandisers; whose emphasis is on "always the lower price", but have untrained salespersons.

Plants with a great future potential include native plants and their hybrids. Marked variability means greater opportunities for good selections. More importance now is attached to insect and disease resistance. Also reliability in urban conditions will be important including - soil and air pollution, soil compaction as well as limited space. Plants might be expected to succeed in their native regions.

Editor's Note: This article was previously published in the August, 1998 issue of HortScience, Vol. 33(5) and has reprinted with permission. The article has been slightly altered to fit the format of Malus. IOCS members will be pleased to know that the crabapples used in this study were part of the NCEP/NCIP trial plots.

Role of Foliar Phenolics in Host Plant Resistance of *Malus* Taxa to Adult Japanese Beetles

by Amy F. Fulcher, Thomas G. Ranney, James D. Burton, James F. Walgenbach and David A. Danehower

Japanese beetles (JB) are highly polyphagous insects, feeding on nearly 300 plant species including a wide diversity of landscape plants (Fleming, 1972; Johnson and Lyon, 1991). Rosaceous plants can be particularly susceptible to foliar feeding by adult JB (Fleming, 1972). However, significant variation in resistance can be observed among closely related taxa. For example, Ranney and Walgenbach (1992) found that defoliation by adult JB varied from 0% to 83% among 33 taxa of crabapples (*Malus* spp.). Spicer et al. (1995) found similar and consistent variation in feeding damage among many of the same cultivars.

Host plant resistance is attributed to many factors, including the presence and concentration of allelochemicals. Japanese beetles are attracted to certain plant volatiles (kairomones)some of which are now commonly used as JB lures (Ahmad, 1982; Ladd and McGovern, 1980; Loughrin et al., 1996a). Recent work has demonstrated that feeding-included odors may also facilitate host plant location by JB (Loughrin et al., 1995). However, in a study comparing volatile compounds from crabapple cultivars differing in susceptibility to JB, Loughrin et al, (1996b)found that attractiveness of cultivars, as determined in pitfall bio-assays, was not related to plant susceptibility in the field. They further proposed that beetles appear to be attracted to certain plant volatiles in search of potential hosts, but that nonvolatile factors ultimately determine host plant suitability.

Some plants contain strong antifeedants (allomones) that can be important in host plant resistance to JB. Nerifolin, a cardiotonic glycoside found in yellow oleander [*Thevetia thevtiodes* (HBK) K. Schum.] was identified as an effective antifeedant for JB (Reed et al., 1982). Patton et al. (1997) found that prunasin, herniarin and coumarin were potent antifeedants for JB and important factors in Host plant resistance of *Prunus* L. taxa to JB.

Plants in the genus *Malus* have a diverse complement of phenolic compounds (Williams, 1960). Levels of total and individual phenolics, including chlorogenic acid, rutin, quercitrin, phloridizin and phloretin, can var considerably in the foliage of different *Malus* taxa (Garcia et al., 1995). Phloridzin, in particular, is a principal phenolic constituent in the foliage of *Malus* taxa and occurs in concentrations as high as 6.75% of leaf dry mass(Hunter et al., 1994). Phenolics can be important defense chemicals (Bernays and Chapman, 1994); however, Fulcher et al. (1996) did not find a significant relationship between total phenolic content in foliage of crabapple cultivars and resistance to JB feeding. Measurement of total phenolic content may overlook differential effects of specific phenolic compounds on insect feeding. Individual phenolic compounds varied considerably in their antifeedant properties for apple maggot (*Rhagoletis pomonella* Walsh.) when tested in artificial diets (Pree, 1977); suggesting that quantifying individual phenolic

compounds may be required in order to elucidate their potential role in host plant resistance.

Our objectives were to determine natural resistance to Japanese beetle among selected *Malus* taxa and to evaluate the role of specific phenolic compounds in host plant resistance.

Materials and Methods

No-choice feeding assay. Japanese beetle feeding assays were performed on 10 *Malus* taxa representing a range of natural resistance based on prior observations. These taxa were: *M. baccata* 'Jackii', *M.* 'Baskatong', *M.* Brandywine®, *M. transitoria* Golden Raindrops™, *M.* Harvest Gold®, *M.* 'Naragensett', *M.* 'Radiant', *M.* 'Red Splendor' and *M.* 'Robinson'. Trees were grown in a randomized complete block design, n=3, at the Mountain Horticultural Crops Research Station, Fletcher, N.C., and were planted between March, 1990 and March, 1991, at a spacing of 6.1 x 4.6 m. Fescue (*Festuca* spp. L) was planted between rows, leaving strips of base soil 2.4 m wide within the rows.

Feeding assays were conducted in July 1995, during the peak flight period of the adult JB. Adults were collected from smartweed (*Polygonum* sp. L) and held in clear plastic containers with moist paper towels and ventilation holes. Beetles were placed in a growth chamber (I-35LL, Percival, Boone, Iowa) with constant light from fluorescent lamps (photosynthetically active radiation 75-80 $\mu mol \bullet m^2/s$) at 25° C and starved for 24 hours before commencing the feeding trials. The following morning three branches of a given replicate of each taxa were collected and kept with the cut ends in water. The leaves for the feeding study were removed, measured for leaf area (FIN DIAS System #2, Decagon Devices, Pullman Wash.), and placed in a petri dish with the leaf petiole in a water-filled vial. One female beetle was added to each petri dish, which was then set randomly in the growth chamber. Vials were checked periodically and water was replaced as needed. After 24 hours, the beetles were removed and leaf area re-measured. Leaves for chemical analysis were removed, frozen at -80°C (Revco ULT; Rheem Mfg. Co., Ashville, N.C.), freeze dried (255RC; VirtisCo., Gardiner, N.Y.), and stored at -80°C until needed.

Choice feeding assay. The choice feeding study was conducted on field-grown trees (as described previously) and utilized a natural beetle population. Defoliation was rated by two independent observers on August 14, 1995, following the peak flight period of adult JB. Observers estimated percentage defolation using an 11-point, arcsin pretransformed scale (Little, 1985), and data were averaged among observers.

Artificial diet assays. Beetles were collected and maintained as described previously. Artificial diets were prepared, following methods of Hsiao and Fraenkel (1968), containing sucrose, cellulose, agar and one of eight test compounds: phloridzin, phloretin, naringenin, kaempferol, rutin, quercetin, catechin and chlorogenic acid (Sigma Co., St. Louis) at 0, 1.0, 3.2, 10.0, 31.6 and 100.0 mM. Given its high cost, kaempferol was not tested at 100mM. Ten replications of each compound were used at each concentration. One female beetle was placed in each petri dish with a plug of diet set randomly in the growth chamber. After 24 hours, beetles were removed, feces were collected, dried for 24 hours at 70°C (Isotemp Oven 665F; Fischer Scientific, Pittsburgh, PA), and weighed.

Foliar analysis. Endogenous levels of individual phenolics were analyzed by a reversed-phase HPLC method adapted from Hunter et al. (1994). Freeze-dried tissue (300 mg)was extracted in 3 mL of 85% methanol, homogenized and centrifuged for 10 minutes. The supernatant was decanted and collected. The homogenizer was rinsed with an additional 3 mL of 15% methanol, the pellet was re-suspended with the rinsate and re-centrifuged.The supernantant was decanted and mixed with the first supernatant. Samples were diluted 10-fold before injection. Standard curves were prepared of phloridzin, phloretin, kaempferol, naringenin, chlorogenic acid and catechin from standards (Sigma). An isocratic solvent system of 25% methanol plus 0.1% phosphoric acid : 75% water was use. The column was an Absorbosphere C18,250x4.6 mm (Alltech Associates, Deerfield, IL). Compounds were detected at 254 nm with a UV detector (Millipore Corp., Bedford, MA). Concentration on a fresh mass basis was calculated from fresh mass : dry mass ratios of each sample.

Data for feeding intensity and concentration of phenolics were subjected to analysis of variance with least significant differences tested at $P \leq 0.05$. Dose : response curves for individual compounds were evaluated using linear and nonlinear regression analyzes (TableCurve 2D; Jandel Scientific, San Rafael, CA). Regression models were ranked and selected based on the significance of the F-statistic, provided that the model and all individual terms of the model were significant ($P \leq 0.05$). Dose : response curves for individual compounds were evaluated using linear and nonlinear regression analyzes (TableCurve 2D; Jandel Scientific, San Rafael, CA). Regression models were ranked and selected based on the significance of the F-statistic and the degree-of-freedom adjusted R^2 statistic, provided that the model and all individual terms of the model were significant ($P \leq 0.05$). The effective doses required to reduce feeding by 25% (ED_{25}) and 50% (ED_{50}) were estimated based on regression equations. The influence of endogenous

phenolic constituents on host plant resistance was evaluated using stepwise multiple regression analysis.

Results and Discussion

No-choice feeding assay. Leaf area consumption ranged from 1.0 to 7.6 $cm^2 \cdot d^{-1}$ (Table 1). Even under these conditions of intense feeding pressure, *M. baccata* 'Jackii', *M.* Harvest Gold®, *M. transitoria* Golden Raindrops™ were highly resistant, with less than 2 $cm^2 \cdot d^{-1}$ consumed. Six other taxa were intermediate and *M.* 'Radiant' was most susceptible with 7.6 $cm^2 \cdot d^{-1}$ consumed.

Choice feeding assay. Feeding intensity on crabapples varied from averages of 0% to 73% defoliation (Table 1). Eight taxa were resistant, with <10% defoliation. *M.* 'Red Splendor' was intermediate with 26% defoliation, and *M.* 'Radiant' was highly susceptible with 73% defoliation. Although feeding intensity was higher in prior years, the field evaluation data were generally consistent with those of Spicer et al. (1995) and Ranney and Walgenbach (1992). Results from no-choice and choice assays provided similar rankings for resistance with the exception of *M.* 'Baskatong' which was more susceptible to feeding under no-choice than under choice conditions.

Artificial diet assays. Phloridzin, and its aglycone phloretin, were highly effective at deterring JB feeding. The ED_{25} for phloridzin was 3.2mM and the ED_{50} was 7.1mM (Fig. 1A). Phloretin had an ED_{25} of 2.9 and an ED_{50} of 9.3 (Fig. 1B). Naringenin also reduced feeding, with an ED_{25} of 17.2 and an ED_{50} of 32.9 (Fig. 1C). Catechin only deterred feeding at high concentrations (Fig, 1D). Conversely, rutin was a phagostimulant, increasing feeding to 174% of the control at the 100mM concentration (Fig. 1E). Quercetin also stimulated feeding at higher concentrations (Fig. 1F). Chlorogenic acid was mildly stimulating at intermediate concentrations, but deterred feeding at higher concentrations (Fig. 1G). Kaempferol had no effect on feeding (Fig. 1H).

Table 1: Resistance to Japanese beetle as measured by leaf area consumption and field defoliation among ten crabapple taxa (*Malus* spp.)

Taxon	No-choice Test Leaf Area consumed ($cm^2 \cdot d^{-1}$)	Choice Test Defoliation (%)
M. Golden Raindrops™	0.99	1
M. baccata 'Jackii'	1.07	0
M. Harvest Gold®	1.83	1
M. Brandywine®	3.29	1
M. floribunda	3.61	0
M. 'Naragansett'	3.63	3
M. 'Robinson'	4.19	2
M. 'Red Splendor'	4.84	26
M. 'Baskatong'	5.05	9
M. 'Radiant'	7.62	73
$LSD_{0.05}$	2.01	10

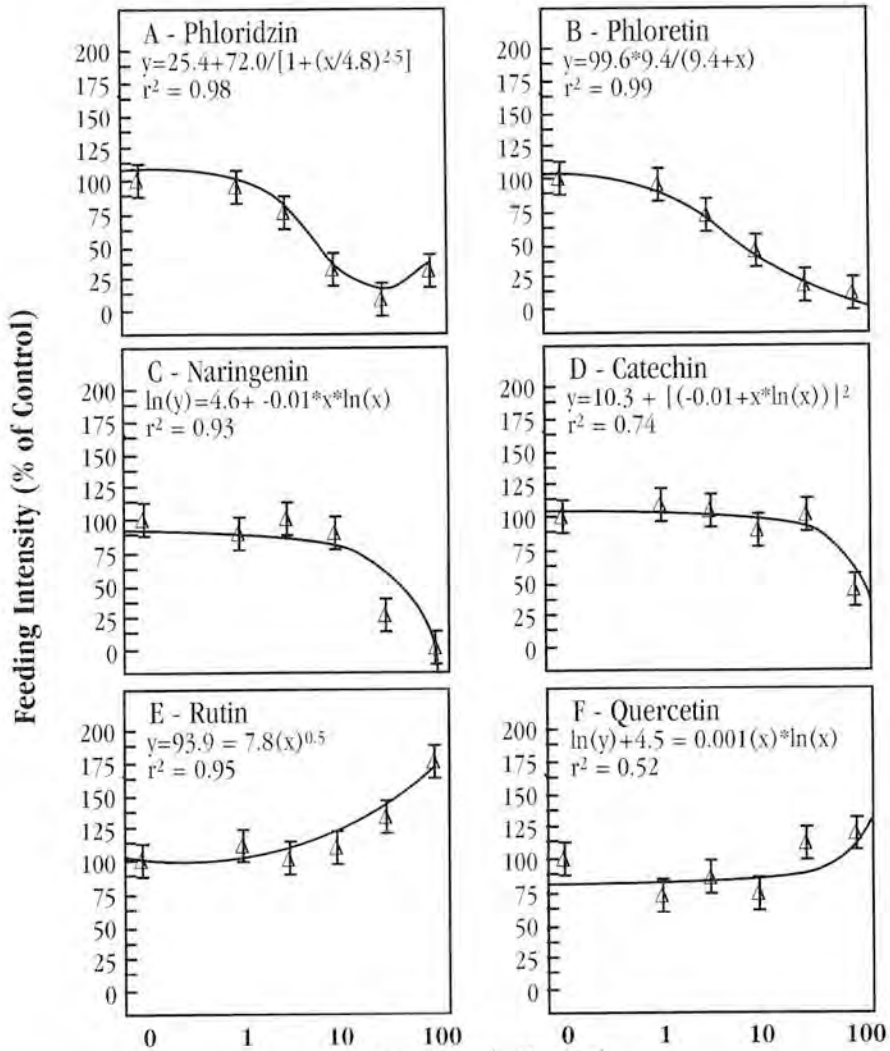
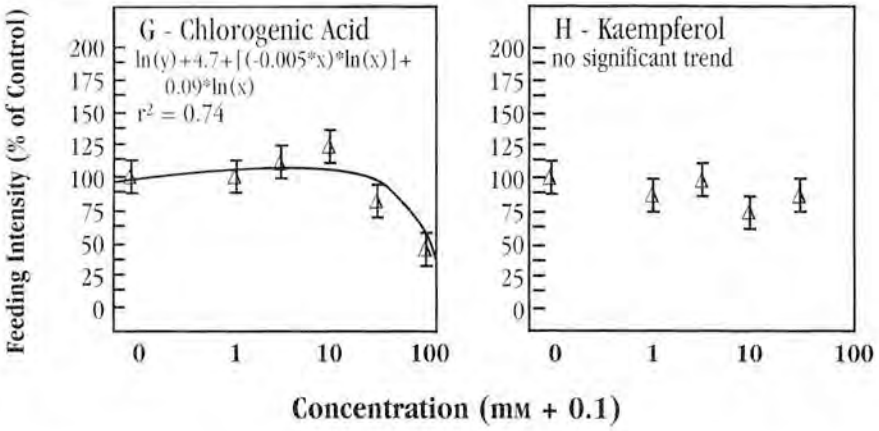


Fig. 1 (A-H) Feeding intensity (fecal dry mass) of adult Japanese beetles in response to different concentrations of individual phenolics tested in artificial diets. Symbols represent means, n=10±1SEM.



Foliar analysis. The concentrations of endogenous phenolics differed widely among taxa. In general, concentrations of phloridzin, phloretin and catechin were highest but varied significantly among taxa. (Table 2). Variations in individual phenolic constituents among these plants may explain why Fulcher et al. (1996) did not find a significant relationship between total phenolic levels and feeding intensity. This is particularly important when considering the range or responses from the artificial diets. Using stepwise multiple regression analysis, phloridzin was the only endogenous phenolic significantly related to percent defoliation from choice feeding assays and to leaf area consumption from no-choice assays ($P \leq 0.05$). Further regression analysis showed that phloridzin was a more effective deterrent under choice conditions than under no-choice conditions (Fig. 2A and B). Endogenous levels of feeding stimulants were not measured in this study. Outliers such as *M.* 'Robinson', which had high levels of phloridzin, yet only had intermediate resistance under no-choice tests (Tables 1 and 2; Fig. 2B), may contain higher levels of feeding stimulants that counterbalanced existing feeding deterrents.

Research by Hunter et al. 1994) did not implicate phloridzin as a feeding deterrent for the tufted apple bud moth (*Playnota idaeusalis* Walker). Instead, they found that diets containing phloridzin decreased larval development time and increased larval mass, suggesting the diets were actually beneficial to the insect. This many occur because the tufted apple bud moth is a pest well adapted to the genus *Malus*, whereas JB is a generalist herbivore and may not have adapted to specific defense chemicals such as phloridzin.

Using plants with natural resistance to insect pests is an important component of integrated pest management that can contribute to development of more sustainable landscapes. This research identified a number of *Malus* taxa with natural resistance to JB and further indicated that phloridzin is an important chemical factor in host

plant resistance of *Malus* to JB. In addition to identifying resistant germplasm, information on the chemical nature of pest resistance may aid in further selection and improvement of plants for greater pest resistance.

Table 2: Concentration of individual phenolics (fresh mass basis) among 10 crabapple taxa (*Malus* spp.).

Taxon	Phenolic concn (mmol•kg^{-1})				
	Phloridzin	Phloretin	Naringenin	Chlorogenic acid	Catechin
M. Golden Raindrops™	154	27	11.5	0.41	66
M. baccata 'Jackii'	144	15	5.7	0.36	62
M. Harvest Gold®	143	26	6.9	1.02	146
M. Brandywine®	177	10	0.5	0.46	35
M. floribunda	146	20	5.0	0.46	75
M. 'Naragansett'	80	6	4.0	0.30	55
M. 'Robinson'	170	32	11.2	0.65	67
M. 'Red Splendor'	34	21	5.5	0.31	48
M. 'Baskatong'	96	9	4.3	0.39	59
M. 'Radiant'	34	21	3.4	0.31	50
$LSD_{0.05}$	36	9	4.3	0.21	38

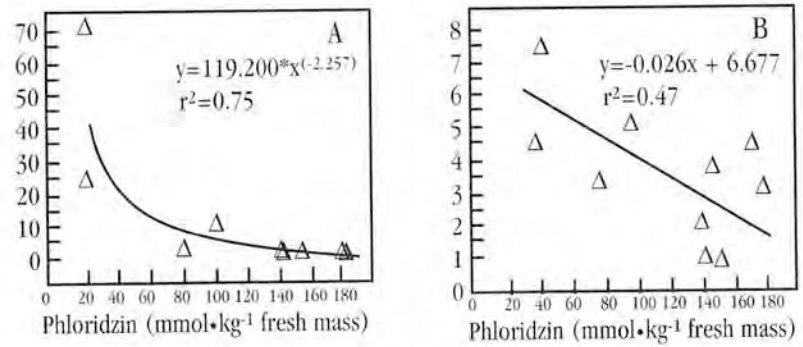


Fig. 2. Relationship between endogenous phloridzin concentration and (A) percent defoliation from a choice feeding assay and (B) leaf area consumption from a no-choice feeding assay. Symbols represent means, n=3 (each with three subsamples).

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Lollipop™ Crabapple (*Malus* 'Lollizam')

by Maria Zampini Pettorini

To the eye this flowering crabapple crabapple is distinct from all other crabapple forms and one of my favorite among my father's crabapple selections. Lollipop™ crabapple is most notable for its neat and tidy form, and true to its name forms a perfect, tightly trimmed "ball" or "lollipop", especially when offered as a small top grafted tree.

A prolific bloomer, the brilliant white flowers brighten up the landscape in May. The attractive, single flowers are small, yet abundant, literally covering the branches with sweetly smelling blossoms. Later in the season, the small leaves emerge a light, fresh green, darkening later to a rich green. The leaves remain crisp and virtually disease free all season.

Come fall the tightly knit branches are laden with tiny round crabapples, each hanging like a gold jewel and making a particularly stunning fall display.

Nothing beats this tree for small gardens. Lollipop™ is naturally petite in size, growing to a mature height of only 10 feet with an equal spread. Awarded the designation of a Streamlined Carefree Maintenance™ tree at our nursery, it has merited this distinction by exhibiting a superior branching structure that requires little to no trimming or pruning to maintain its natural symmetrical form.

Lollipop™ is suitable for planting in large containers and easily adapts to being trained into special forms. The petite size and form of Lollipop™ make it an ideal specimen plant for entryway plantings or for planting in small areas, found so often in today's contemporary landscapes.

When selecting new improved crabapple cultivars, we strive for disease resistance, prolific and abundant flowers, persistent showy fruit and carefree maintenance structures. Lollipop™ meets all of the above criteria.

Our crabapple selections are made by a process of natural selection in the field. Crabapple cultivars are open pollinated by bees in the field. The fruits are then

collected in the fall and immediately planted in field beds. After spring germination the seedlings are kept under constant observation for possible new selections. Only seedlings that continue to show superior traits after one year are planted out in spaced field rows.

Final selections are propagated in small numbers for further observation for a period of 3-5 years or more. This process of weaning out superior selections continues for a total of timeframe of 15 to 25 years.

This technique has proven to be extremely successful at our nursery, and is a method that was highly recommended by the late Dr. Egolf, who encouraged my father, Jim Zampini, to apply the selection method to other plant genera.

Despite its cute, compact form, the original selection of Lollipop™ did not seem desirable, and after 10 years of observation, the tree was almost discarded after it failed to produce flowers. Fortunately, first impressions are not always lasting and after grafting several trees an abundant crop of flowers appeared on these one-year-old trees.

We are currently producing Lollipop™ crabapple on four foot standards, using a new summer grafting procedure which we have developed, with favorable production results.

Aesthetic and Apple Scab Ratings: NCEP Plot at Boerner Botanical Gardens

by David E. Guthery

On August 8, 1998, I evaluated the National Crabapple Evaluation Program plot at Boerner Botanical Gardens in Hales Corners, Wisconsin for both aesthetic and apple scab ratings. I subsequently followed this up on September 20, 1998, with a second evaluation.

To be consistent with the work Dr. Thomas Green did in evaluating the plots, I utilized his rating system for evaluating for both the aesthetic qualities of crabapples as well as for apple scab. They are as follows:

Aesthetic Rating

0 = Perfect Tree: A crabapple that is without serious flaws and has something a little extra such as superior habit, vivid fruit display, etc...

1 = Highly Ornamental: Nearly perfect foliage or some scab may be present,

the fruit abundant but perhaps less vivid, form still attractive.

2 = Ornamental: An acceptable tree but less than perfect; leaves with slight to severe scab, some insect or mite injury, fruit not abundant or particularly ornamental.

3 = Barely Ornamental: This is a plant with very little ornamental value. Fruit may be dull, too large and/or not persistent. Foliage may be moderately infected with scab, cedar/apple rust or damaged by insects or mites, but tree is still relatively green.

4 = Undesirable: This tree is undesirable at this time because of defoliation from disease, ugly or messy fruit and/or poor form.

5 = Unacceptable: Consider replacing this crab with another selection. Trees may have very messy fruit and/ or be totally defoliated due to scab.

Apple Scab

0 = No Disease: No evidence of symptoms from scab.

1 = Slight: Scab detectable, usually not found on most leaves.

2 = Moderate: Scab readily found on most leaves; no or very little defoliation (0-10%).

3 = Severe: Scab abundant and found on nearly all leaves; causing defoliation (10-50%).

4 = Very Severe: Tree nearly defoliated (50-80%).

5 = Extremely Severe: Tree totally defoliated (80-100%).

As you will notice scab was very abundant and actually some trees started to defoliate in June in the Milwaukee, Wisconsin metro area where this plot is located. In addition, this particular plot receives only mowing with little or no additional care. Not surprisingly you will notice that the weeping or horizontally spreading trees, such as 'Mary Potter', *M. sargentii* and Molton Lava®, which are not closely mown around were in much better condition than others in the plot. Finally, due to replication included within the plot, many of the ratings represent an average for the crabapples present.

Aesthetic and Scab Evaluations for Boerner Botanical Gardens' NCEP Plot

Taxa	Aesthetic 8/8/98 Rating	Aesthetic 9/20/98 Rating	Scab 8/8/98 Rating	Scab 9/20/98 Rating
M. 'Adams'	1.5	1.67	2	3.67
M. baccata 'Jackii'	1	0	0	0
M. 'Beverly'	1	0.5	0	0
M. 'Bob White'	2	1	0	0
M. Camelot® *	-	-	0	1
M. 'Canary'	3	2	0	4
M. Christmas Holly	2	0.5	0	0
M. 'David'	2	2	1	1
M. 'Dolgo'	0	1	0	0
M. 'Donald Wyman'	2.67	2.3	2	2.67
M. 'Doubloons'	2.5	2	0.5	1
M. floribunda	3.5	3	2	3
M. Golden Raindrops™ c	2	1	0	0
M. Harvest Gold®	2	2	1	1
M. 'Henningi'	3	2	1	1
M. 'Hopa'	5	5	4	5
M. 'Indian Magic'	1.67	2	2.3	4.67
M. 'Jewelberry' d	3	3	2	2
M. Lancelot® *	-	-	0	1
M. 'Liset'	3	1	1	1
M. 'Louisa' *	-	-	0	0
M. 'Mary Potter'	2	0	0.33	0
M. Molton Lava®	0.67	0	0.67	1
M. 'Morning Sun'	2	2	1	1
M. 'Ormiston Roy' s	2	1.67	0.67	1.67
M. 'Prairie Maid'	1	2	0	0
M. 'Prairifire' c	1	1	0	0
M. 'Pink Satin'	3	1.5	1	1.5
M. 'Professor Sprenger' f	3	2	0	0.67
M. 'Profusion'	3	2	2	2.5
M. 'Purple Prince'	1	1	0	0
M. 'Ralph Shay' s	2.5	2	.5	1

Taxa	Aesthetic 8/8/98 Rating	Aesthetic 9/20/98 Rating	Scab 8/8/98 Rating	Scab 9/20/98 Rating
M. 'Red Barron'	3	4	2	4
M. 'Red Jade' s	3	3	2	3.5
M. Red Jewel®	2	0.5	0	0
M. 'Red Splendor' s	4	4	4	5
M. 'Robinson s	3.67	2.67	3	4.3
M. 'Royalty'	3	4	3	4
M. sargentii	1.67	0.67	0	0
M. sargentii 'Candymint'	2	2	0.5	1
M. 'Selkirk'	3	3	2	2
M. 'Sentinel'	2	1	0.67	1
M. 'Silver Drift'	2	1	0	0.5
M. 'Silver Moon'	2	1	0	0
M. 'Sinai Fire'	1	1	0	0
M. 'Snowdrift'	5	3.67	4.33	4.67
M. Sugar Tyme®	2	1.3	0.67	0.67
M. 'Strawberry Parfait'	3	2	0	1
M. Velvet Pillar™	4	5	4	5
M. Weeping Candied Apple®	3	4	2	4
M. 'Winter Gem'	3	2	2	3
M. x *zumi* var. *calocarpa* s	2	.5	1	1

* Too small a specimen to fairly evaluate for an aesthetic rating.

s - Scab on fruit which somewhat or significantly decreases the aesthetic rating.

f - Frog Eye Leaf Spot present which has caused some defoliation to affected tree.

c - Symptoms of chlorosis present on foliage.

d - Dieback due to either winter injury or other factor observed on tree.

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