

The Quarterly Journal of the Florida Native Plant Society

# Palmetto



*Fig. 1*



*Fig. 2*



*Fig. 3*



*Fig. 4*



*Fig. 5*



*Fig. 6*



*Fig. 7*



*Fig. 8*



*Fig. 9*

# Does your pawpaw smell flowery or fermented?

By Katherine Goodrich



FIGURE 1

A. *Asimina reticulata*. B. *Asimina incana*. C. *Asimina angustifolia*. D. *Asimina obovata*.  
Photos by Katherine Goodrich.

## About the Author

Katherine Goodrich's scent study of *Asimina triloba* expanded to cover the floral display (including floral scent) of all species of *Asimina* and *Deeringothamnus*, as well as their close tropical relative, *Annona glabra*. Kate says "The floral display of these plants are of interest to me because they represent extra-tropical genera from a predominantly tropical family (Annonaceae). I am interested in their evolutionary history as they diverged from their closest tropical relatives." Kate is entering her last year of the Ph.D. program at the University of South Carolina, and will graduate in December, 2007.

Communicating attributes of floral scent can be difficult. Most people are familiar with the pleasing floral scent of a rose, a gardenia or a magnolia flower. However, imagine trying to communicate the difference between these floral scents. Words such as "sweet" or "pleasant" describe them all, but it is more difficult to find words which describe the unique qualities of each one. The perfume and wine industries employ researchers and technicians who have fine-tuned their scent perception and developed a detailed vocabulary for scent. For those of us outside of these industries, our scent perception and vocabulary is markedly less refined.

Until recently, the scientific study of scent was also relatively confined to the perfume or wine industries. Advances on scent sampling and analysis techniques have broadened the scope of scent study, and plant biologists, insect physiologists and ecologists are increasingly interested in the role that plant scent compounds – especially floral scent compounds – play in plant-animal interactions. Floral scents are also increasingly popular among gardeners, horticulturalists, and florists (Imato, 2005).

My own scent research focuses on the genera *Asimina* and *Deeringothamnus* (Annonaceae), commonly known as pawpaws. Pawpaws present an interesting case study in floral scent. Half the species of *Asimina* have flowers which emit "flowery" scents used frequently in the perfume industry. The other half of *Asimina* species have flowers which emit "fermented" odors – scents produced by microbes during the fermentation process – which have been extensively studied by the wine industry. Many of the scent compounds emitted by pawpaw flowers are well documented and easily identifiable. The two species of *Deeringothamnus* have scents which differ from *Asimina* species and from each other. *D. pulchellus* has a distinctively strong, pleasant scent, while *D. rugelii* has a faint, unpleasant aroma.

Four of the eight *Asimina* species have white flowers and are limited to Florida and southern Georgia and Alabama

(*A. reticulata*, *A. angustifolia*, *A. incana* and *A. obovata*). [Fig. 1] The other four species of *Asimina* have small maroon or maroon and white flowers; two maroon-flowered species occur in Florida (*A. tetramera* and *A. pygmaea*), while the other two have larger ranges extending farther north across the eastern U.S. (*A. triloba* and *A. parviflora*) (Kral, 1960). [Fig. 2] The floral scent of *Asimina* species has an interesting correlation to floral pigmentation. Species with maroon floral pigmentation all share yeasty “fermentation” floral odors, while species with white or cream-colored petals have more varied “sweet”, “soapy/waxy” or “perfumy” floral scents. The reason for this difference is not clearly understood, but it seems that the floral scent of *Asimina* species is integrally tied to the overall floral phenotype of each species.

Chemical analyses show that many of the scent compounds produced by maroon-flowered species of *Asimina* are the same as those produced by active Baker’s yeast (Goodrich et al., 2006; Goodrich & Raguso unpub. data). These fermentation compounds give the flowers a scent similar to red wine or rising bread dough. Although these flowers and Baker’s yeast both produce ethanol, ethyl acetate, methyl butanol and hydroxy-butanone, these compounds are produced in different ratios by the flowers than they are by yeast. However, to human perception the scents are very similar.

Most Floridian species of *Asimina* have large white, droopy flowers and are a common sight in pastures and along frequently-mowed roadsides. The scent of these white-flowered species is typically described as “pleasant,” although it varies more between species than the yeasty scent of maroon-flowered *Asimina*. *A. reticulata* has, in my opinion, the most pleasant floral scent of the genus. It has a sweet, almost fruity odor. *Asimina incana*, on the other



**FIGURE 2**

*A. Asimina tetramera*. B. *Asimina parviflora*. C. *Asimina pygmaea*. D. *Asimina triloba*. Photos A, B, C by Katherine Goodrich. Photo D by Paul Rebmann, [www.wildflphoto.com](http://www.wildflphoto.com).

hand – has a heavy sweet odor with an acrid, soapy note which at high concentrations is almost unpleasant. Chemically, all of the white-flowered species share hydrocarbons and several terpenoid compounds in their floral scent (Goodrich & Raguso, unpub. data).

Three of the four white-flowered species share several aldehydes and alcohols typically found in the scent of lilacs. Other pleasant-smelling compounds found in some white-flowered species include benzaldehyde (pleasant, almond-like odor) and phenyl ethyl alcohol.

The floral phenotypes of *Deeringothamnus* species differ from one another and from species of *Asimina* (Norman, 2003). Both species of *Deeringothamnus* have floral

architecture which differs markedly from *Asimina* species. [Fig. 3]



**FIGURE 3**

*Deeringothamnus pulchellus*. Photo by Paul Rebmann, [www.wildflphoto.com](http://www.wildflphoto.com).

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## Does your pawpaw smell flowery or fermented?

*Deeringothamnus pulchellus*, the beautiful pawpaw, has flowers which are small, white and have a strong, pleasant scent. The scent is dominated by compounds such as benzaldehyde, linalool, methyl benzoate and benzenacetaldehyde which are also found in some white-flowered *Asimina* species. The floral scent of *D. pulchellus* also contains ethyl benzoate and veratrol not found in any *Asimina* species. [Table 1]

*Deeringothamnus rugelii*, Rugel's pawpaw, has small, yellow flowers with a very slight, unpleasant odor. Although to my perception *D. rugelii* smells slightly similar to the maroon-flowered species of *Asimina*, it contains ethyl acetate and no other fermentation compounds identified in *Asimina* species. It also contains a number of "unknown" compounds that I am currently working to identify, not found in other species of *Asimina* or *Deeringothamnus*.

Within *Asimina*, the small maroon flowers with yeasty scents may represent mimics of food substrates or brood sites for pollinating beetles and/or flies. The alcohols, ketones and aldehydes found in *D. pulchellus* and many white-flowered *Asimina* species may mimic the scents of ripe fruit (prior to more unpleasant fermentation and decay odors). These scents may also mimic food substrates of beetles. It is also possible in each of these cases that the odors produced generate a learned response from pollinating insects. Certain insects may learn to identify particular odor compounds with nutritious floral tissues although the odors themselves may not generate an

innate response from a naive insect. Of course, the floral scents of these genera are also likely influenced by factors outside of pollinator selection pressures. Evolutionary history, phylogenetic constraints, neutral genetic variation, and plant nutrition may all play a role in the floral scent produced by each flower.

A great deal of research remains to be done on the floral displays of *Asimina* and *Deeringothamnus*, but floral scent is clearly an important part of this display. A study of floral scent within these genera provides an interesting context in which to ask questions of pollinator attraction, floral evolution and plant biochemistry. As studies of floral scent become more widely published and discussed, our

**Table 1: Distinctive scent compounds found in *Asimina* and *Deeringothamnus***

Compounds listed represent major and/or distinguishing components of the floral scent for each species of *Asimina* and *Deeringothamnus*. Descriptions of scent perception are from personal experience of the author or taken from descriptions provided on [flavornet.org](http://flavornet.org).

DISTINCTIVE CHEMICAL COMPOUND	HUMAN PERCEPTION	<i>Asimina</i> species				<i>Deeringothamnus</i> species				
		maroon or maroon/white flowers		white flowers		RET	INC	ANG	OBO	PUL
FERMENTATION PRODUCTS		TRI	PAR	PYG	TET					
ethanol	sweet, pleasant, solvent*	●	●	●	●					
methyl butanol	whiskey, malt, burnt*	●	●	●	●					
hydroxybutanone	butter, cream*	●	●	●	●					
butanediol	onion*	●		●	●					
ethyl acetate	pineapple*	●	●	●	●				●	
ALIPHATIC COMPOUNDS										
n-tridecane	waxy			●	●	●	●	●	●	
n-pentadecane	waxy			●		●	●	●	●	●
heptadecadiene	waxy					●	●	●	●	
AROMATIC COMPOUNDS										
benzaldehyde	pleasant, almond-like					●	●		●	●
phenyl ethyl alcohol	similar to hyacinth or rose					●	●			
methyl benzoate	prune, lettuce, herb, sweet*			●			●			●
ethyl benzoate	flowery, fruity, celery-like*									●
benzenacetaldehyde	sweet, perfumy odor						●			●
veratrol	sweet, floral odor									● ●
TERPENOID COMPOUNDS										
lilac alcohols and aldehydes	flowery, sweet, herbaceous						●	●	●	
linalool	spicy floral scent, lavender*	●			●	●	●	●	●	● ●
ocimene	herb, citrus, flower*		●	●	●	●	●	●	●	● ●
limonene	lemon, orange			●	●	●		●		
caryophyllene	sharp, herb	●	●	●	●	●	●	●	●	● ●
1,8-cineol	mint, sweet*			●			●		●	

\* Source: Flavornet by Terry Acree & Heinrich Arn, <http://www.flavornet.org>, © Datu Inc., 2004

vocabulary for scent characterization grows, and readers will become more familiar with the language of scent. I hope to help promote this increased awareness of floral scent since it is truly an underappreciated – and integrally important aspect of floral display. 🌿

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#### The purpose of the Florida Native Plant Society

is to conserve, preserve, and restore the native plants and native plant communities of Florida.

#### Official definition of native plant:

For most purposes, the phrase Florida native plant refers to those species occurring within the state boundaries prior to European contact, according to the best available scientific and historical documentation. More specifically, it includes those species understood as indigenous, occurring in natural associations in habitats that existed prior to significant human impacts and alterations of the landscape.



#### The Palmetto

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We welcome articles on native plant species and related conservation topics, as well as high-quality botanical illustrations and photographs. Contact the editor for guidelines, deadlines and other information.

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