

NECTAR SOURCE RECORDS FOR *LIBYTHEANA CARINENTA*
(NYMPHALIDAE: LIBYTHEINAE)**Additional key words:** butterfly gardening, flower color, flower visitation, nectaring, snout butterfly

The American Snout Butterfly, *Libytheana carinenta* (Cramer), is known to feed on water from moist sand and soil (Howe 1975, Iftner et al. 1992, Kawahara 2003, Dirig unpubl.), and at dung, fruits, human perspiration, secretions from aphids, and various flowers (Kawahara 2001, 2006b). Flower nectar is rich in water, monosaccharides, and amino acids (Watt et al. 1974), and butterflies use nectar as an immediate energy source, or store it as fat (Opler & Krizek 1984). Female butterflies assimilate these nutrients for egg maturation (Stern & Smith 1960), and sugars can increase the longevity of adult Lepidoptera (Norris 1934).

Shields (1972, 1985) summarized flower visitation records for *L. carinenta*, but many additional nectaring observations were discovered during a recent review of the biology and natural history of the Libytheinae (Kawahara 2006a, b). Shields (1985) reported 19 flowering plants in 14 families that were used as nectar sources for *L. carinenta*; while we report 66 plants in 27 families (Table 1). Many of our records are from publications that appeared after Shields' work, but there are also numerous reports that were not included in his studies. We supplement published records with Harry Pavulaan's personal observations in Maryland and Virginia; and with Robert Dirig's personal observations at Cape May (Cape May County), New Jersey, and in the Finger Lakes Region (Tompkins and Schuyler Counties) in New York.

We also expanded upon Shields' studies by determining flower color for each record. Saunders (1932) and Opler & Krizek (1984) reported flower color preference for many butterflies, but their reports did not include *L. carinenta*. The purpose of this publication is threefold: (1) to provide a list of flower visitation records for *L. carinenta*; (2) to update all plant records to follow a modern classification of flowering plants; and (3) to determine the color of flowers visited. We did not examine floral color variation within this butterfly's geographic distribution because many published sources did not specify where observations were made.

Butterfly taxonomy follows a recent revision of the Libytheinae (Kawahara, accepted), plant names accord to Kartesz & Kartesz (1980), and plant family classification follows APG II (2003). Flower color was determined using Gray's Manual of Botany (Fernald

1987), in addition to regional floral guides (Kearney & Peebles 1960, Long 1971, Scoggan 1978, Taylor 1998, Jones 2005). Many flowers listed in our studies have one or more color variants, and we were unable to determine the specific color for some of the flowers visited. We are therefore including all possible color variants for each plant unless we had specific information on the color of the flower from which the butterfly was recorded.

We recorded 17 flowering plant species of the Asteraceae (25.8%), 7 of the Rosaceae (10.6%), 4 of the Apiaceae (6.1%), 4 of the Fabaceae (6.1%) and 4 of the Lamiaceae (6.1%); the remaining plant families were each represented by less than 3 species (< 4.6%). These results are consistent with floral visitation records obtained for butterflies in central Illinois, which indicated that the five most butterfly-visited plant families are Apiaceae, Asteraceae, Fabaceae, Lamiaceae, and Rosaceae (Robertson 1928, Tooker et al. 2002).



FIG. 1. *Libytheana carinenta* nectaring at Buttonhead Goldenrod (*Euthamia tenuifolia*, Asteraceae) at Higbee Beach, Cape May Co., N.J., 7 Oct. 2004, photo by R. Dirig.

Our results are also consistent with flower visitation records of nymphalines and pierids, which are known to favor white or yellow flowers (Opler & Krizek 1984). Twenty-eight of our flower visitation records were on white flowers (42.4% of flowers recorded were truly white), 10 (15.2%) were yellow, 4 (6.1%) were purple, 1 (1.5%) was pink, and 1 (1.5%) was red. Due to color variants, flower visitation records may constitute up to 46 (69.7%) plant species that are white or partially

TABLE 1. Flower visitation records for *Libytheana carinenta*, and the typical flower color for each plant. Taxa are listed alphabetically.

Plant family	Plant genus & species	Flower color	Reference
Acanthaceae	<i>Avicennia germinans</i> (L.) L.	White or yellow	Heitzman & Heitzman (1972)
Amaranthaceae	<i>Gomphrena globosa</i> L.	White or red	Dirig (pers. obs., NJ)
Anacardiaceae	<i>Rhus copallina</i> L.	Yellow	May (1987), Dirig (pers. obs. NJ)
Apiaceae	<i>Cicuta maculata</i> L.	White	Robertson (1928)
	<i>Daucus carota</i> L.	White	Iftner et al. (1992)
	<i>Pastinaca sativa</i> L.	Yellow	Robertson (1928)
	<i>Sium suave</i> Walt.	White	Robertson (1928)
Apocynaceae	<i>Apocynum cannabinum</i> L.	White	Opler & Krizek (1984)
	<i>Asclepias incarnata</i> L.	Pink or red	Robertson (1928)
	<i>Asclepias syriaca</i> L.	Pink or purple	Iftner et al. (1992)
			Robertson (1928), Dirig (pers. obs., NY)
Asteraceae	<i>Aster pilosus</i> Willd.	White and yellow	Iftner et al. (1992)
	<i>Aster vimineus</i> Lam.	White or pink	Opler (1998)
	<i>Baccharis glutinosa</i> (Ruiz & Pavon) Pers.	White	Dirig (pers. obs., NJ)
	<i>Baccharis halimifolia</i> L.	White	Shields (1985)
	<i>Baccharis sarothroides</i> Gray	White	Floridata (2006)
	<i>Bidens alba</i> var. <i>radiata</i> Schultz-Bip. ^a	White and yellow	Iftner et al. (1992)
	<i>Bidens aristosa</i> (Michx.) Britt.	Yellow	Dirig (pers. obs., NY)
	<i>Centaurea maculosa</i> Lam.	Purple	Dirig (pers. obs., NJ)
	<i>Chrysanthemum</i> sp.	Yellow and pink	Pyle (1981)
	<i>Chrysothamnus nauseosus</i> (Pallas) Britt.	Yellow	Sedman & Hess (1985)
	<i>Cirsium arvense</i> (L.) Scop.	Purple	Floridata (2006)
	<i>Eupatorium fistulosum</i> Barratt	Pink or purple	Iftner et al. (1992)
	<i>Eupatorium perfoliatum</i> L.	White	Dirig (pers. obs., NJ)
	<i>Euthamia tenuifolia</i> (Pursh) Greene	Yellow	Shields (1985)
	<i>Senecio douglasii</i> DC.	Yellow	Pavulaan (pers. obs., MD, VA)
	<i>Solidago canadensis</i> L.	Yellow	Opler & Krizek (1984), Dirig (pers. obs., NJ)
	<i>Solidago</i> sp. ^b	Yellow	Neck (1984)
	<i>Verbesina encelioides</i> (Cav.) Benth & Hook f. ex Gray	Yellow	Gable & Baker (1922)
Basellaceae	<i>Anredera cordifolia</i> (Ten.) Steenis	White	Shields (1985)
	<i>Anredera leptostachys</i> (Moq.) Steenis	White	Hernández (2004)
Boraginaceae	<i>Cordia</i> sp.	White, pink or red	Hernández (2004)
	<i>Tournefortia hirsutissima</i> L.	White	Iftner et al. (1992)
Brassicaceae	<i>Berteroa incana</i> (L.) DC.	White	Opler & Krizek (1984)
Clethraceae	<i>Clethra alnifolia</i> L.	White or pink	Pyle (1981)
Cornaceae	<i>Cornus</i> sp.	White, pink or purple	Shields (1972)
Euphorbiaceae	<i>Croton</i> sp.	White	Gable & Baker (1922)
Fabaceae	<i>Eysenhardtia polystachya</i> (Ortega) Sarg. ^c	White	Neck (1983)
	<i>Eysenhardtia texana</i> Scheele	White or yellow	Shields (1985)
	<i>Melilotus alba</i> Medic.	White	Wauer (2002)
	<i>Prosopis glandulosa</i> Torr.	White or yellow	

TABLE 1. Continued

Plant family	Plant genus & species	Flower color	Reference
Lamiaceae	<i>Mentha arvensis</i> L.	White or pink	Dirig (2005)
	<i>Origanum vulgare</i> L.	White	Pavulaan (pers. obs., MD, VA)
	<i>Pycnanthemum flexuosum</i> (Walt.) B. S. P.	White or purple	Robertson (1928)
	<i>Salvia guaranitica</i> A. St.-Hil.	Purple	Dirig (pers. obs., NJ)
Lobeliaceae	<i>Lobelia cardinalis</i> L.	Red	Ross (1990)
Loganiaceae	<i>Buddleja davidii</i> Franch.	White	Dirig (pers. obs., NJ)
Malvaceae	<i>Tilia</i> sp.	White	Shields (1985)
Oleaceae	<i>Ligustrum vulgare</i> L.	White	Shields (1985)
	<i>Heteropogon contortus</i> (L.) Beauv. ex Roemer & Schultes	White or yellow	Bailowitz & Brock (1991)
Poaceae	<i>Sorghum</i> sp.	White or yellow	Parman (1926)
Polygonaceae	<i>Eriogonum</i> sp.	White, yellow or pink	Shields (1972)
Ranunculaceae	<i>Clematis drummondii</i> Torr. & Gray	White	Neck (1984)
	<i>Clematis vitalba</i> L.	White	Shields (1985)
Rhamnaceae	<i>Condalia</i> sp.	Yellow	Gilbert (1985)
Rosaceae	<i>Potentilla fruticosa</i> L.	Yellow	Iftner et al. (1992)
	<i>Prunus americana</i> Marsh.	White	Ajilvsgi (1990)
	<i>Prunus caroliniana</i> (P. Mill.) Ait.	White	Shields (1985)
	<i>Prunus persica</i> (L.) Batsch	Pink	Pyle (1981)
	<i>Rubus fruticosus</i> L. ^d	White	Bubna (1897)
	<i>Rubus idaeus</i> L.	White	Scudder (1889)
	<i>Spiraea latifolia</i> (Ait.) Borkh.	White or pink	Landry (1987)
Rubiaceae	<i>Cephalanthus occidentalis</i> L.	White	Iftner et al. (1992)
Sapotaceae	<i>Bumelia lanuginosa</i> (Michx.) Pers.	White	Ajilvsgi (1990)
Saxifragaceae	<i>Philadelphus coronarius</i> L.	White	Shields (1985)
Verbenaceae	<i>Aloysia</i> sp.	White or pink	Gilbert (1985)
	<i>Lantana</i> sp.	White, yellow, orange, pink, red, or purple	Opler (1998)
	<i>Verbena bonariensis</i> L.	Purple	Floridata (2006)

^a Kartesz and Kartesz (1980) treat *Bidens alba* var. *radiata* as *B. pilosa* var. *radiata*, but we recognize *B. alba* var. *radiata* because *B. pilosa* is a junior synonym of *B. alba*, according to a recent study in Florida (Wunderlin and Hansen, 2003).

^bSince “*Solidago* sp.” may represent *Solidago canadensis* or any other *Solidago* species, we exclude this taxon from the statistical analyses of this study.

^cGable & Baker (1922) listed *Eysenhardtia amorphoides* Kunth as a nectar source. According to McVaugh (1987), *Eysenhardtia amorphoides* is a junior synonym of *E. polystachya*.

^dKartesz and Kartesz (1980) did not include *Rubus fruticosus*, or list this as a synonym for any other plant species. We therefore maintain the record of Bubna (1897).

white, 20 (30.3%) that are yellow or partially yellow, and 14 (21.2%) that are pink or partially pink. Up to nine records may be purple (13.6%), and red and orange flowers combined constitute less than 10% of all flower visitation records.

While it appears that *L. carinenta* favors white and yellow flowers, we were unable to test specifically for preference, as controlled choice experiments were beyond the scope of this project. Experiments on color preference in butterflies have been limited to several

model butterflies, all non-libytheine species - Papilionidae: *Papilio troilus* L. (Swihart 1970) and *Papilio demoleus* L. (Ilse & Vaidya 1956); Nymphalidae: *Agraulis vanillae* (L.), and *Junonia coenia* Hübner (Weiss 1991), and *Heliconius charithonius* (L.) (Swihart & Swihart 1970). Butterflies are also known to learn different colors during nectar foraging, which can influence color preference (Goulson & Cory 1993, Weiss 1995, Weiss & Papaj 2003). Controlled experimental studies on flower coloration that test for preference and learning should be a focus of future studies on libythine biology.

We thank Laurie C. Alexander, Robert F. Denno, Gina M. Wimp, and Isaac S. Winkler for comments (all are affiliated with the University of Maryland, College Park). David C. Iftner and Harry Pavulaan reviewed an earlier draft which improved the quality of the manuscript. Martha R. Weiss (Georgetown University, Washington, D.C.) also provided helpful suggestions.

LITERATURE CITED

- AJILVSGI, G. 1990. Butterfly gardening for the south. Taylor Publishing, Dallas. 348 pp.
- APG II. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnean Society 141: 399-436.
- BAILOWITZ, R. A. & J. P. BROCK. 1991. Butterflies of southeastern Arizona. Sonoran Arthropod Studies, Tucson. ix, 342 pp.
- BUBNA, M. 1897. Entomology at Cleveland, Ohio. Entomological News 8(5): 97-99.
- DIRIG, R. 2005. The American Snout in central New York, pp. [54-55]. In: Fiore, T., & K. Wallstrom (compilers), New York State Butterfly Records for 2004, Bronx, New York: New York Chapter of the North American Butterfly Association. [56] pp.
- FERNALD, M. L. 1987. Gray's manual of botany, 8th edition. American Book Company, New York. Reprinted from 1950 edition, with corrections by Dioscorides Press, Portland, Oregon. lxiv, 1632 pp.
- FLORIDATA. 2006. Online website. <http://www.floridata.com/tracks/butterfly/snout.cfm>
- GABLE, C. H. & W. A. BAKER. 1922. Notes on a migration of *Libytheana bachmanii* Kirtl. Canadian Entomologist 54: 265-266.
- GILBERT, L. E. 1985. Ecological factors which influence migratory behavior in two butterflies of the semi-arid shrublands of south Texas. Contributions in Marine Science (supplement) 27: 724-747.
- GOULSON, D. & J. S. CORY. 1993. Flower constancy and learning in foraging preferences of the green-veined white butterfly *Pieris napi*. Ecological Entomology 18: 315-320.
- HEITZMAN, J. R. & R. L. HEITZMAN. 1972. New butterfly records for the United States (Hesperiidae & Libytheidae). Journal of Research on the Lepidoptera 10(4): 284-286.
- HERNÁNDEZ, L. R. 2004. Field guide of Cuban-West Indies butterflies. Ediluz, Maracaibo. 269 pp., 31 pls.
- HOWE, W. H. 1975. The butterflies of North America. Doubleday and Co., Garden City. xiii, 633 pp.
- IFTNER, D. C., J. A. SHUEY & J. V. CALHOUN. 1992. Butterflies and skippers of Ohio. Ohio Lepidopterist's Research Report, 3. Ohio State University College of Biological Sciences, Columbus. 170 pp.
- ILSE, D. & V. G. VAIDYA. 1956. Spontaneous feeding responses to colours in *Papilio demoleus* L. Proceedings of the Indian Academy of Sciences 43: 23-31.
- JONES, R. L. 2005. Plant life of Kentucky: An illustrated guide to the vascular flora. University Press of Kentucky, Lexington. xvi, 834 pp.
- KARTESZ, J. T. & R. KARTESZ. 1980. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Vol. 2, the biota of North America. University of North Carolina Press, Chapel Hill. xlviii, 498 pp.
- KAWAHARA, A. Y. 2001. Systematics of the snout butterflies (Lepidoptera: Nymphalidae: Libytheinae), with and emphasis on the morphology and phylogeny. Honors Thesis. Cornell University, Ithaca, New York. xiii, 162 pp.
- . 2003. Behavioral observations of adult *Libytheana carinenta* Cramer. News Lepid. Soc. 47: 107-108.
- . 2006a. Biology of the snout butterflies (Nymphalidae: Libytheinae). Part 1: *Libythea* Fabricius. Transactions of the Lepidopterological Society of Japan 57(1): 13-33.
- . 2006b. Biology of the snout butterflies (Nymphalidae: Libytheinae). Part 2: *Libytheana* Michener. Transactions of the Lepidopterological Society of Japan 57(3): 265-277.
- . (accepted). Revision of the extant and fossil snout butterflies (Lepidoptera: Nymphalidae: Libytheinae). Thomas Say Publications in Entomology, Monographs. Entomological Society of America, Lanham.
- KEARNEY, T. H. & R. H. PEEBLES. 1960. Arizona flora. University of California Press, Berkeley. viii, 1085 pp.
- LANDRY, L.-P. 1987. Capture du *Libytheana bachmanii* (Kirtland) (Lepidoptera: Libytheidae) dans la division de recensement de Champlain, Québec. Fabriques 13: 57-58.
- LONG, R. W. 1971. A flora of tropical Florida; a manual of the seed plants and ferns of southern peninsular Florida. University of Miami Press, Coral Gables. xvii, 962 pp.
- MAY, R. 1987. [untitled]. News of the Lepidopterists' Society 29(1): 5.
- MCVAUGH, R. 1987. Flora Novo-Galiciana, Vol. 5, Leguminosae. University of Michigan Press, Ann Arbor. 786 pp.
- NECK, R. W. 1983. Causal analysis of a migration of the snout butterfly, *Libytheana bachmanii* larvata (Strecker) (Libytheidae). Journal of the Lepidopterists' Society 37(2): 121-128.
- . 1984. On the origin of snout butterflies (*Libytheana bachmanii* larvata, Libytheidae) in a 1978 migration in southern Texas. Journal of the Lepidopterists' Society 38(4): 319-322.
- NORRIS, M. J. 1934. Contributions towards the study of insect fertility III. Adult nutrition, fecundity, and longevity in the genus *Ephestia* (Lepidoptera, Phycitidae). Proceedings of the Zoological Society of London 1934: 333-360.
- OPLER, P. A. 1998. A field guide to western butterflies. Second ed., Peterson field guide series. Houghton Mifflin, Boston. 540 pp.
- OPLER, P. A. & G. O. KRIZEK. 1984. Butterflies east of the Great Plains: an illustrated natural history. Johns Hopkins University Press, Baltimore. xvii, 294 pp., 54 pls.
- PARMAN, D. C. 1926. Migrations of the long-beaked butterfly, *Libythea bachmani* Kirtland (Lepid.: Libytheidae). Entomological News 37: 101-106.
- PYLE, R. M. 1981. Audubon Society field guide to North American butterflies. Alfred Knopf, New York. 916 pp.
- ROBERTSON, C. 1928. Flowers and insects: lists of visitors of four hundred and fifty-three flowers. Carlinville. 221 pp.
- ROSS, E. S. 1990. Butterfly photography, pp. 121-126. In: Xerces Society/Smithsonian Institution, Butterfly gardening: creating summer magic in your garden, Sierra Club Books, San Francisco, xvi + 192 pp.
- SAUNDERS, A. A. 1932. Butterflies of the Allegany State Park. New York State Museum Handbook, 13. The University of the State of New York, Albany. 270 pp.
- SCOGGAN, H. J. 1978. The flora of Canada. Part 3: Dicotyledoneae (Saururaceae to Violaceae). National Museum of Natural Sciences, Ottawa. 568 pp.
- SCUDDER, S. H. 1889. The Butterflies of the eastern United States and Canada with special reference to New England. Published by the author, Cambridge, Mass. 3 vols., 1958 pp., 89 pl.
- SEDMAN, Y. & D. F. HESS. 1985. The butterflies of west central Illinois. Western Illinois University Series in the Biological Sciences No. 11. Western Illinois University, Macomb. 120 pp.
- SHIELDS, O. 1972. Flower visitation records for butterflies (Lepidoptera). Pan-Pacific Entomologist 48(3): 189-203.
- . 1985. Flower visitation records for snout butterflies (Libythei-

- dae). *Journal of the Lepidopterists' Society* 39: 340-341.
- STERN, V. M. & R. F. SMITH. 1960. Factors affecting egg production and oviposition in populations of *Colias eurytheme*. *Hilgardia* 29: 411-454.
- SWIHART, S. L. 1970. The neural basis of colour vision in the butterfly, *Papilio troilus*. *Journal of Insect Physiology* 16: 1623-1636.
- SWIHART, C. A. & S. L. SWIHART. 1970. Colour selection and learned feeding preferences in the butterfly, *Heliconius charitonius* Linn. *Animal Behaviour* 18: 60-64.
- TAYLOR, W. K. 1998. *Florida wildflowers in their natural communities*. University Press of Florida, Gainesville. xiv, 370 pp.
- TOOKER, J. F., P. F. REAGEL, & L. M. HANKS. 2002. Nectar sources of day-flying Lepidoptera of central Illinois. *Annals of the Entomological Society of America* 95(1): 84-96.
- WATT, W. B., P. C. HOCH, & S. G. MILLS. 1974. Nectar source use by *Colias* butterflies. Chemical and visual aspects. *Oecologia* 14: 353-374.
- WAUER, R. H. 2002. *Butterflies of west Texas parks and preserves*. Texas Tech University Press, Lubbock. 78 pp.
- WEISS, M. R. 1991. Floral colour changes as cues for pollinators. *Nature* 354: 227-229.
- . 1995. Associative colour learning in a nymphalid butterfly. *Ecological Entomology* 20: 298-301.
- WEISS, M. R. & D. R. PAPAJ. 2003. Colour learning in two behavioural contexts: how much can a butterfly keep in mind? *Animal Behaviour* 65: 425-434.
- WUNDERLIN, R. P. & B. F. HANSEN. 2003. *Guide to the vascular plants of Florida*, Second Edition. University Press of Florida, Gainesville. 787 pp.

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Received for publication xxxxxxxx revised and accepted xxxxxxxx.