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For research assistance send an email request to David Hoxie:

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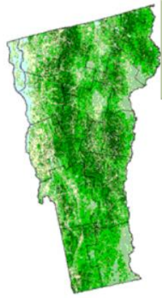

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3. Journal articles provide **detailed in-depth information** on a topic.

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Monarch butterfly - Danaus Plexippas L. (Lepidoptera Danaidae)

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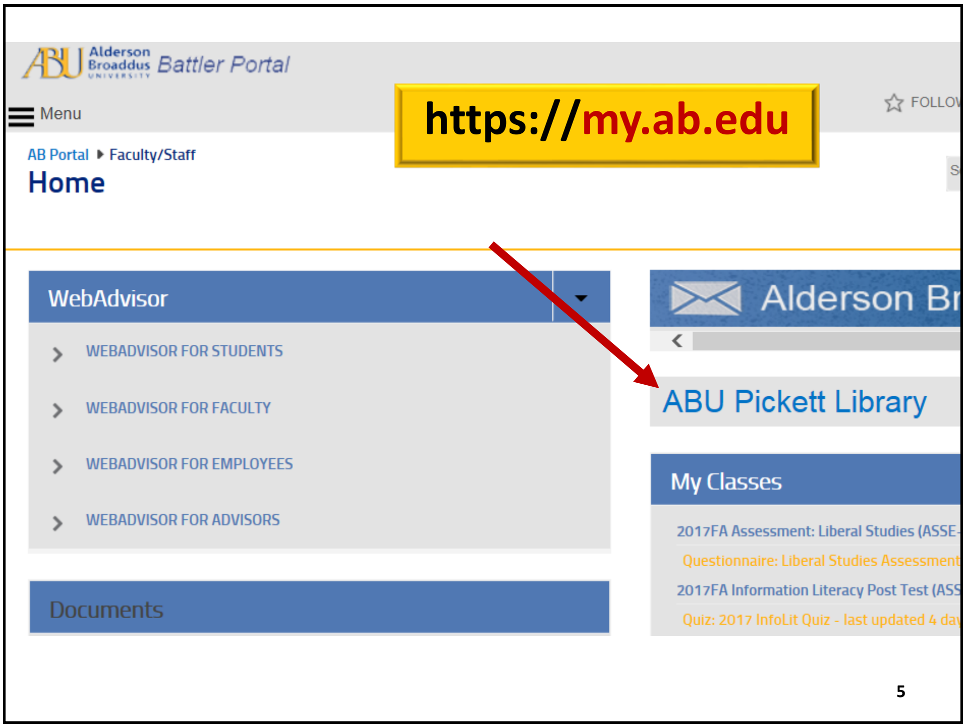
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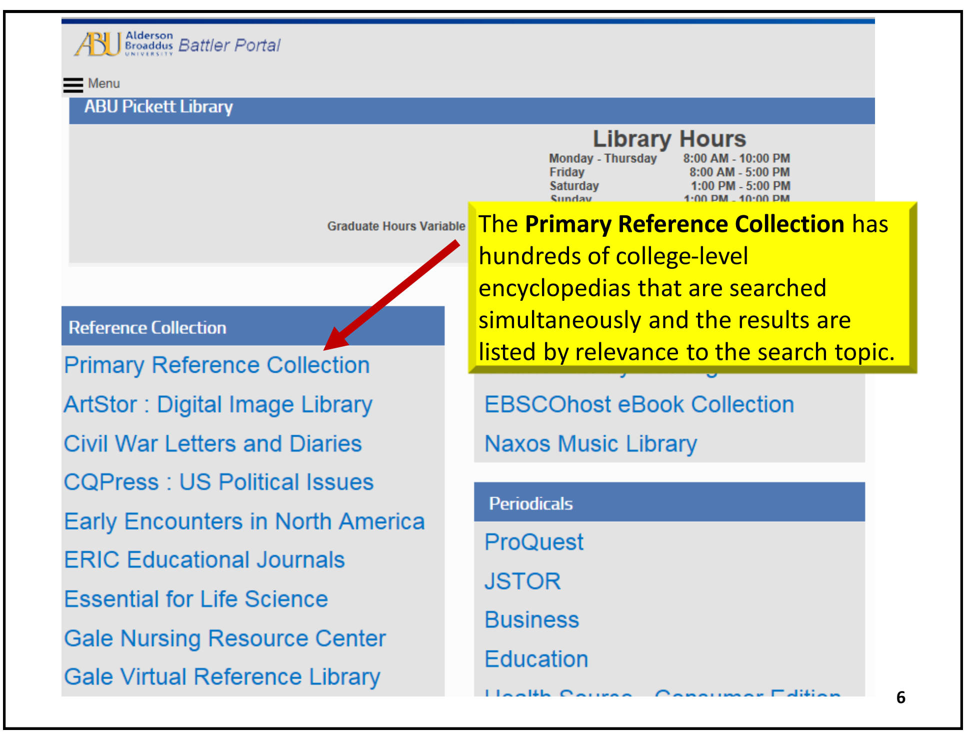
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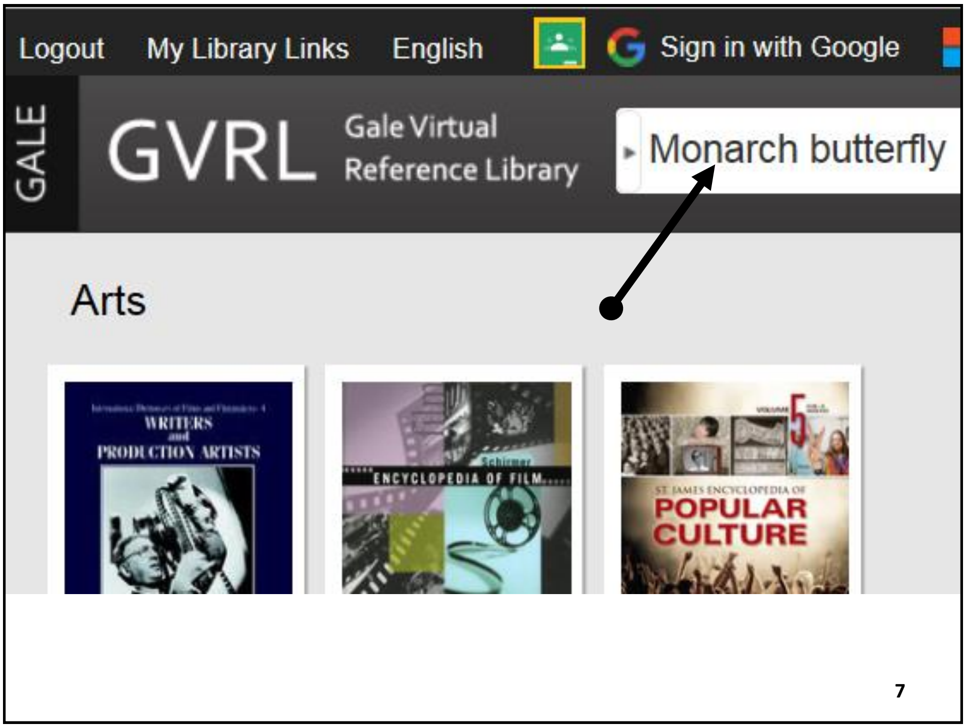
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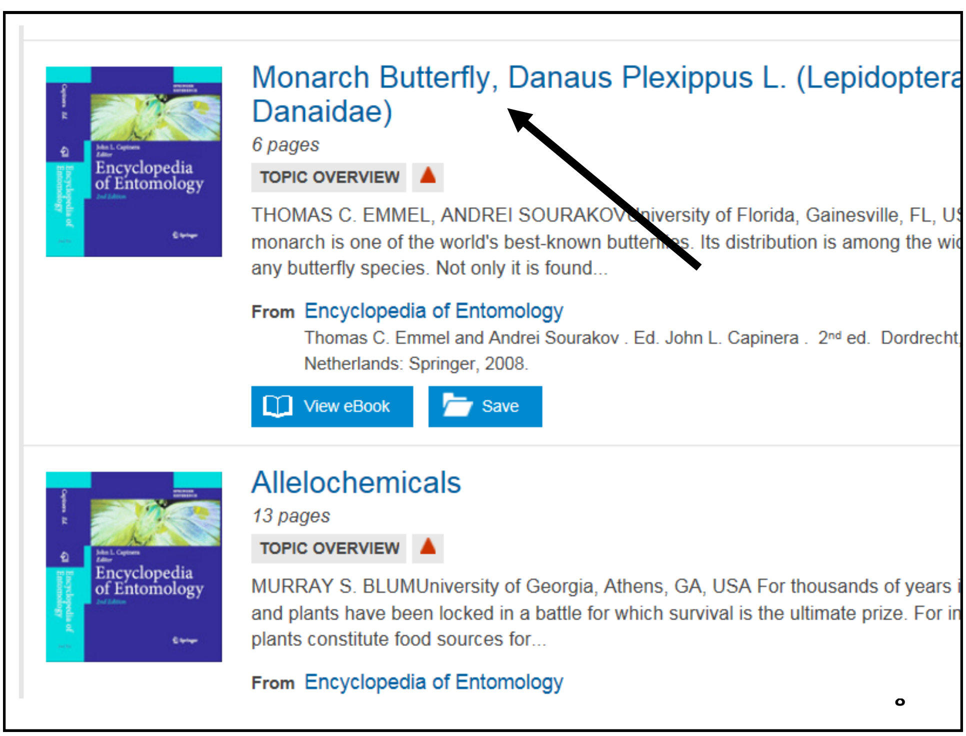
Monarch Butterfly, Danaus Plexippus L. (Lepidoptera Danaidae)
6 pages
TOPIC OVERVIEW
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monarch is one of the world's best-known butterflies. Its distribution is among the wi
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and plants have been locked in a battle for which survival is the ultimate prize. For in
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Encyclopedia of Entomology

Monarch Butterfly, Danaus Plexippus L. (Lepidoptera: Danaidae)

THOMAS C. EMMEL, ANDREI SOURAKOV
University of Florida, Gainesville, FL, USA

The monarch is one of the world's best-known butterflies. Its distribution is among the widest for any butterfly species. Not only it is found throughout the Americas, including the islands of the West Indies, but it reaches as far as Australia and New Guinea, and occasional individuals migrate to Western Europe.

The monarch butterfly is native to tropical America where populations breed throughout the year. These sedentary populations are different from the migratory North American ones and bear separate names. For example subspecies, *megalippe* Hübner is found in Mexico and Central America and southeastern United States. The southern South American subspecies is called *menippe* Hübner. Several subspecies have also been described from the islands in the Caribbean. None of these geographic races are "pure," with occasional individuals of the migratory subspecies phenotype, *D. plexippus plexippus*, found in all of them. It has even been suggested, yet not proven, that sedentary subspecies might indeed prove to be separate sibling species. Due to the versatility of its weedy host plants – the milkweeds – and its ability to cover large distances, this highly adaptable butterfly occupies a variety of ecological zones, but is found mostly in open sunny areas. In Costa Rica, for example, monarchs fly from sea level up to 2,500 meters in elevation and are particularly common above 1,500 meters.

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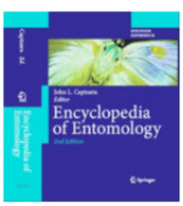

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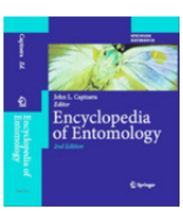

Allelochemicals

13 pages

TOPIC OVERVIEW

MURRAY S. BLUMUniversity of Georgia, Athens, GA, USA For thousands of years i and plants have been locked in a battle for which survival is the ultimate prize. For in plants constitute food sources for...

From Encyclopedia of Entomology

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A World of Allelochemicals

Fruits and vegetables possess characteristic odors and tastes that create desire (preference) for these foods. Significantly, these tastes and smells are not identified with the primary compounds responsible for plant growth and development, such as sugars, fats, and proteins. Therefore, the plant has invested in producing a variety of chemicals that will not help it grow or reproduce. While an onion may possess a distinctive odor and taste for both insects and humans (not necessarily the same odor and taste for both), this fact hardly justifies the onion spending its energy and resources to produce an onion fragrance. On the other hand, if the taste and odor of onions combine to make this vegetable distasteful and repellent to most plant-feeding insects, then these allelochemicals perform a very vital function. In essence, it is generally believed that these secondary compounds are responsible for protecting plants from herbivores and possibly pathogens as well. A brief examination of some well-characterized allelochemicals offers a means of examining these compounds as agents of defense both as toxins and as repellents.

Sequestration and its Consequences

Insects such as the monarch butterfly store compounds in their tissues that render them unpalatable to predators. These compounds, the cardenolides, were ingested by the larvae from their milkweed food plants, and retained in their bodies into the adult stage. The storage of these milkweed compounds is called sequestration, and constitutes a widespread phenomenon among specialists feeding on allelochemical-rich plants. In a sense, sequestration represents the insect's success in utilizing the plant's chemical defenses for its own purposes. Indeed, sequestration can be regarded as a form of detoxication since potentially toxic compounds are removed from the circulation and stored in the tissues.

Sequestration has been detected in at least seven orders of insects including species of toxic grasshoppers, aphids, lacewings, beetles, wasps, butterflies and moths. In general, these insects are brightly (= warningly) colored, a characteristic described as aposematic. Armed with the toxins from their food plants, large insects such as brilliantly colored grasshoppers move very slowly, as if to advertise their poisonous qualities to the world. Obviously the term toxic is relative, since these insects routinely sequester these allelochemicals during normal feeding. However, since these specialists are physiologically adapted for ingesting these compounds, their ability to tolerate these allelochemicals is really not surprising. On the other hand, non-adapted species (e.g., predators) would certainly encounter toxic reactions if they ingested these toxic plant products.

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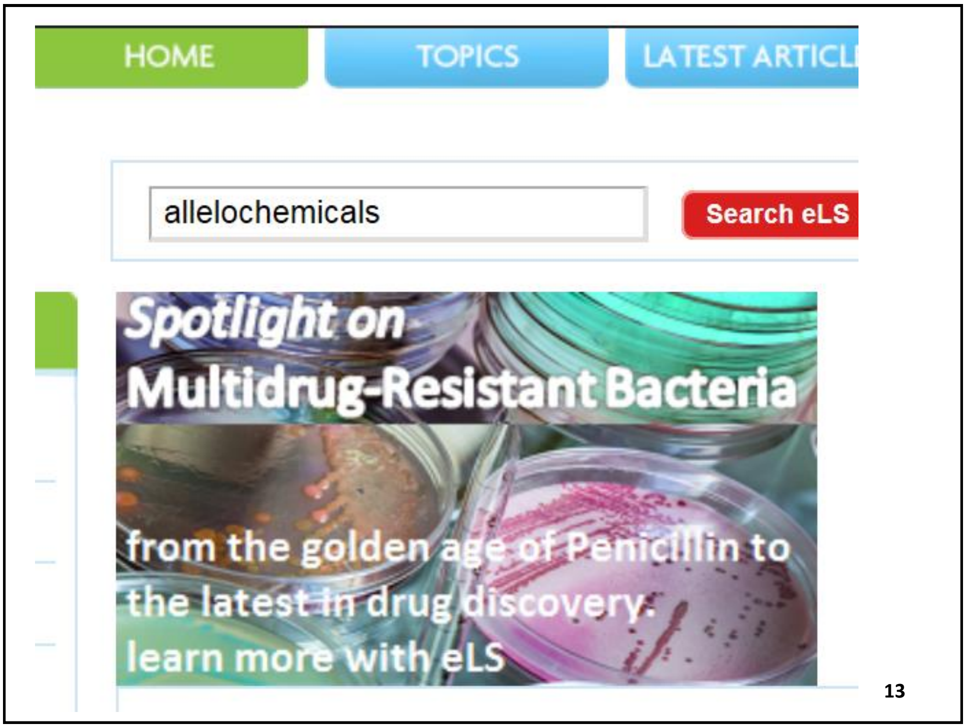
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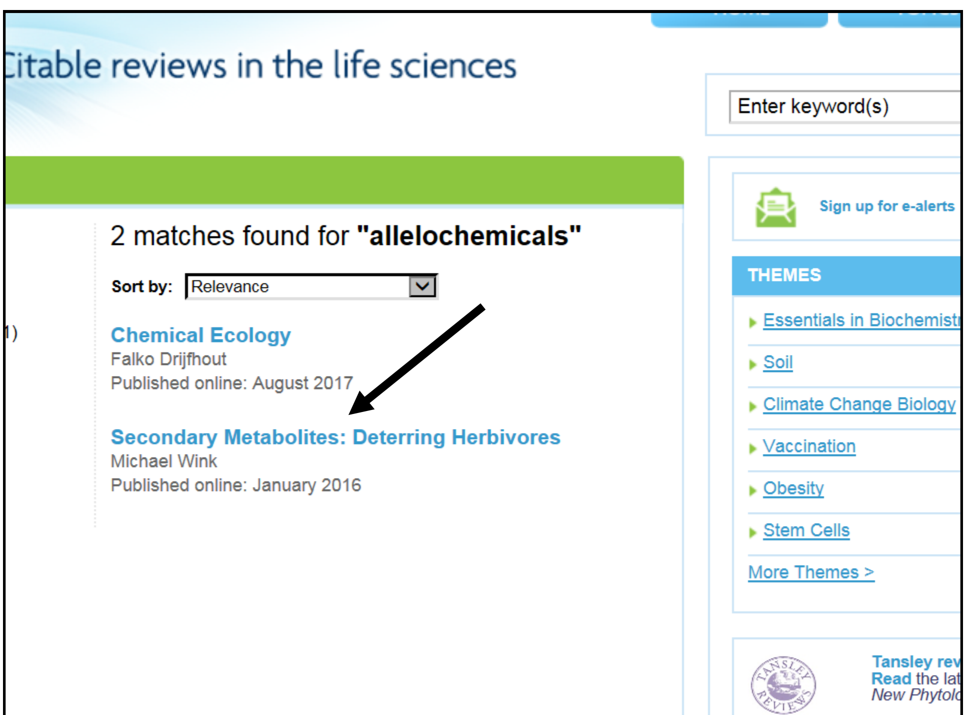
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Michael Wink, Heidelberg University, Heidelberg, Germany

Published online: January 2016

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Abstract

All plants produce and store secondary metabolites (SMs), which are not important for primary or energy metabolism of a plant. However, SMs are not waste products, but important for the ecological fitness and survival of the plants producing them. Apparently, plants have evolved the production and storage of SM as a means to defend themselves against herbivores, bacteria, fungi and viruses, as well as other competing plants. Most SMs can interfere with basic molecular targets of animals or microbes and thus provide plants with an adequate protection against a multitude of enemies. Plants usually produce complex mixtures of SMs, which can work in an additive or even synergistic way. Some defence chemicals address a single target, such as a neurotransmitter receptor or an ion channel; others have a broad-activity spectrum and exhibit pleiotropic activities on several targets. SMs also serve as signal compounds attracting pollinating and fruit-dispersing animals.

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Evolution of Feeding Deterrence

Jump to...

A large body of biological, pharmacological and toxicological experimentation clearly shows that many SMs inhibit the growth of viruses, microbes and competing plants or of herbivorous arthropods, or that they are toxic or even lethal for microbes and animals. In addition, many SMs (e.g. volatile essential oils) have deterrent or repellent properties. These so-called allelochemicals can only serve as chemical defence compounds if they are able to interfere with neuronal signal transmission, or basic molecular targets of cells or the function of organs. A closer analysis clearly shows that most allelochemicals interfere with one or several molecular targets (Wink, 1992, 1993, 2000, 2007, 2008a, 2015a,b). Their structures have been shaped during evolution so that they can mimic the structures of endogenous hormones, neurotransmitters or other ligands; this process can be termed 'evolutionary molecular modelling'. Other metabolites intercalate or alkylate DNA (deoxyribonucleic acid), inhibit DNA- and RNA-related enzymes and protein biosynthesis or disturb membrane stability (Wink, 2008a, 2015a). **See also:** Evolution of Secondary Plant Metabolism

The following targets have been identified (Teuscher and Lindequist, 1994; Roberts and Wink, 1998; Wink, 1993, 2000, 2007, 2008a, 2015a) for some of these compounds. Alkaloids and amines very often affect neuroreceptors as agonists or antagonists, or modulate other steps in neuronal signal transduction, such as ion channels or enzymes that take up or degrade neurotransmitters or second messengers. As alkaloids often derive from the same amino acid precursor as the neurotransmitters acetylcholine, serotonin, noradrenaline, dopamine, GABA (γ-aminobutyric acid), glutamic acid or histamine, their structures can be superimposed on those of neurotransmitters (Wink, 1993, 2000). Other alkaloids intercalate DNA (e.g. sanguinarine, quinine, harmalin, emetine, berberine and ajmaline) or can alkylate them (e.g. pyrrolizidine alkaloids (PAs) after 'detoxification' in the liver; aristolochic acid; cycasin) (Wink and Schimmer, 2010). Most alkaloids are noted for their toxicity to animals and are usually considered as 'poisons' in the human context. It is clear that toxicity of alkaloids is correlated with their interactions with particular molecular targets (Wink, 1993, 2000; Wink and Van Wyk, 2008).

NPAAs can be considered as structural analogues of 1 of the 20 protein amino acids. Very often, NPAAs block the uptake and transport of amino acids or disturb their biosynthetic feedback regulations. Some NPAAs are even incorporated into proteins because tRNA transferases usually cannot discriminate between a protein amino acid and its analogue. Results are defective or malfunctioning proteins (Rosenthal, 1982; Wink and van Wyk, 2008).

Cyanogenic glucosides are stored in the vacuole. When tissue decomposition occurs due to wounding by a herbivore or a pathogen, a β-glucosidase comes into contact with the cyanogenic glycosides, which are split into a sugar and a nitrile moiety that is further hydrolysed to hydrocyanic acid (HCN) and an aldehyde. HCN effectively blocks mitochondrial respiration (and thereby ATP (adenosine triphosphate) production) and functions as a strong poison in most animals (Conn, 1981; Wink and Van Wyk, 2008).

Glucosinolates also function as prefabricated vacuolar defence compounds. When a plant with glucosinolates is wounded, cell

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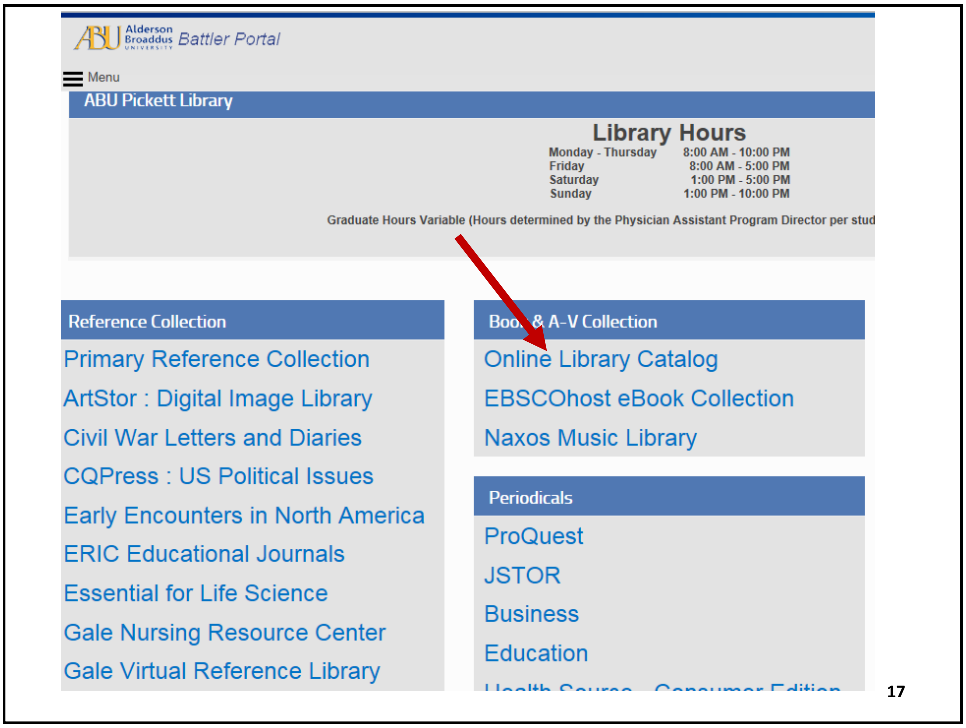
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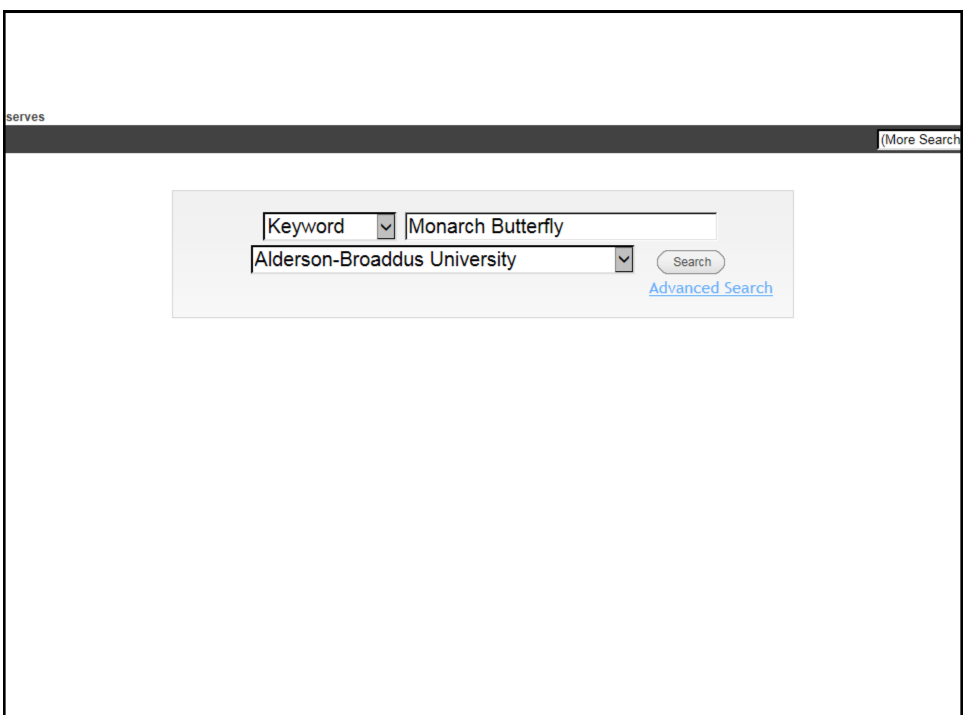
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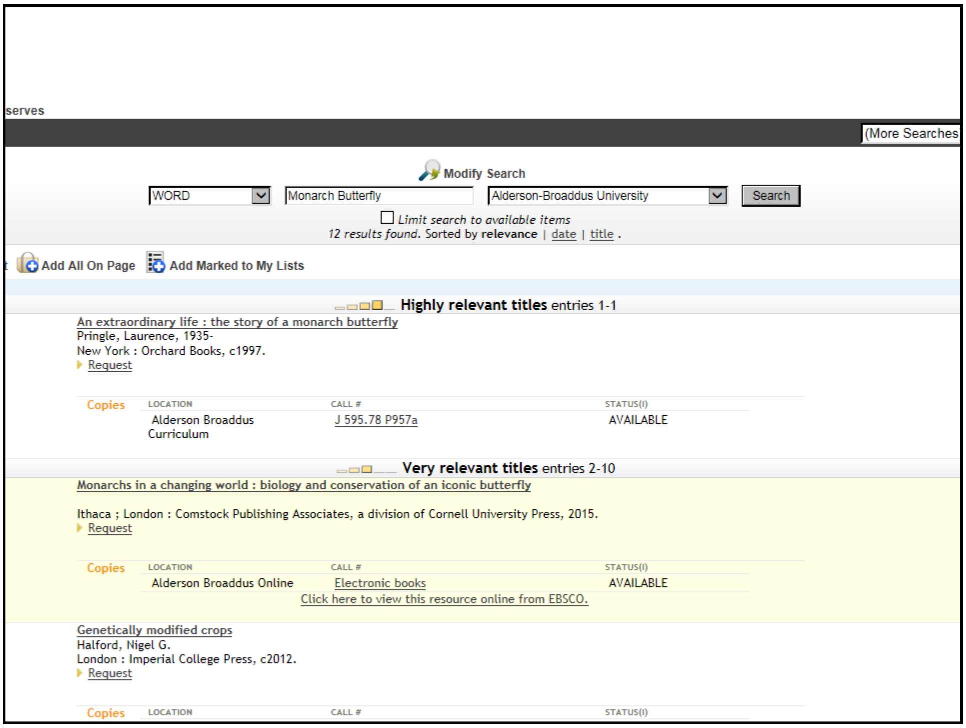

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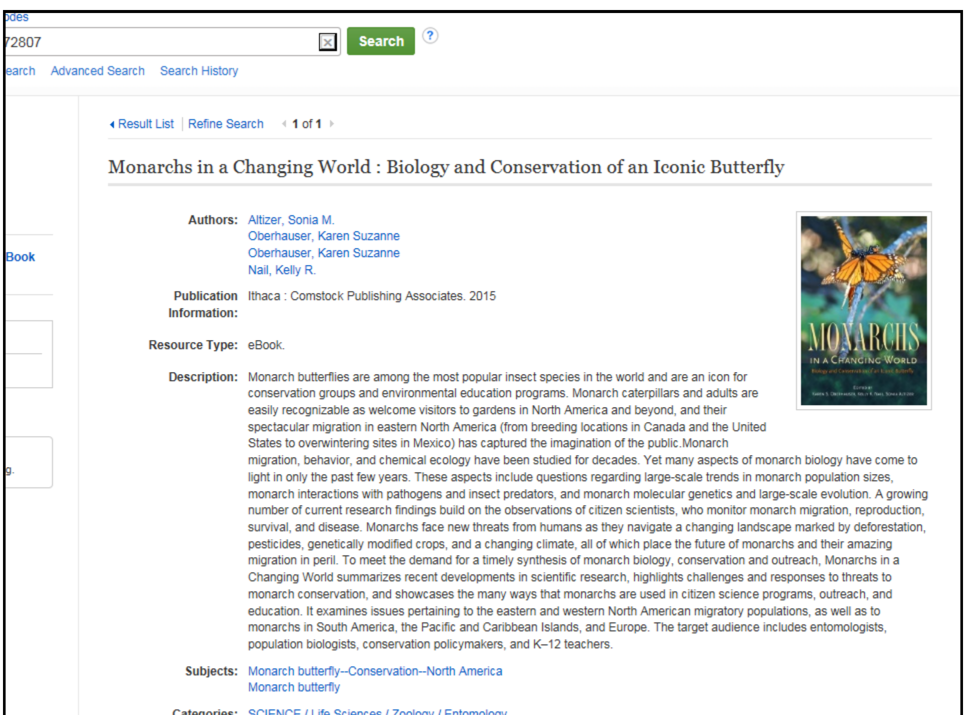

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Monarchs in a Changing World : Biology and Conservation of an Iconic Butterfly

Book

Authors: Altizer, Sonia M.
Oberhauser, Karen Suzanne
Oberhauser, Karen Suzanne
Nail, Kelly R.

Publication Information: Ithaca : Comstock Publishing Associates. 2015

Resource Type: eBook.

Description: Monarch butterflies are among the most popular insect species in the world and are an icon for conservation groups and environmental education programs. Monarch caterpillars and adults are easily recognizable as welcome visitors to gardens in North America and beyond, and their spectacular migration in eastern North America (from breeding locations in Canada and the United States to overwintering sites in Mexico) has captured the imagination of the public.Monarch migration, behavior, and chemical ecology have been studied for decades. Yet many aspects of monarch biology have come to light in only the past few years. These aspects include questions regarding large-scale trends in monarch population sizes, monarch interactions with pathogens and insect predators, and monarch molecular genetics and large-scale evolution. A growing number of current research findings build on the observations of citizen scientists, who monitor monarch migration, reproduction, survival, and disease. Monarchs face new threats from humans as they navigate a changing landscape marked by deforestation, pesticides, genetically modified crops, and a changing climate, all of which place the future of monarchs and their amazing migration in peril. To meet the demand for a timely synthesis of monarch biology, conservation and outreach, Monarchs in a Changing World summarizes recent developments in scientific research, highlights challenges and responses to threats to monarch conservation, and showcases the many ways that monarchs are used in citizen science programs, outreach, and education. It examines issues pertaining to the eastern and western North American migratory populations, as well as to monarchs in South America, the Pacific and Caribbean Islands, and Europe. The target audience includes entomologists, population biologists, conservation policymakers, and K–12 teachers.

Subjects: Monarch butterfly--Conservation--North America
Monarch butterfly

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Monarchs as Herbivores, Prey, and Hosts

An Overview

JACOBUS C. DE ROODE

Monarchs are perhaps best known for their spectacular fall migration, during which millions of individuals migrate from North America to overwinter in Mexico each year (Urquhart and Urquhart 1978). Often overlooked is the fact that only a select few monarchs that set out on their journey south successfully reach Mexico. These are the monarchs that found enough food and avoided predation, avoided or survived parasitism, and survived the toxins ingested from their milkweed host plants during larval development. Like all other organisms, monarchs do not live in isolation, but they are part of a complex network of species with which they can form close relationships. These species include the milkweeds (*Asclepias* spp.) used as larval food, the predators that attack or consume them, and the parasites that infect them. As the following four chapters show, these interacting

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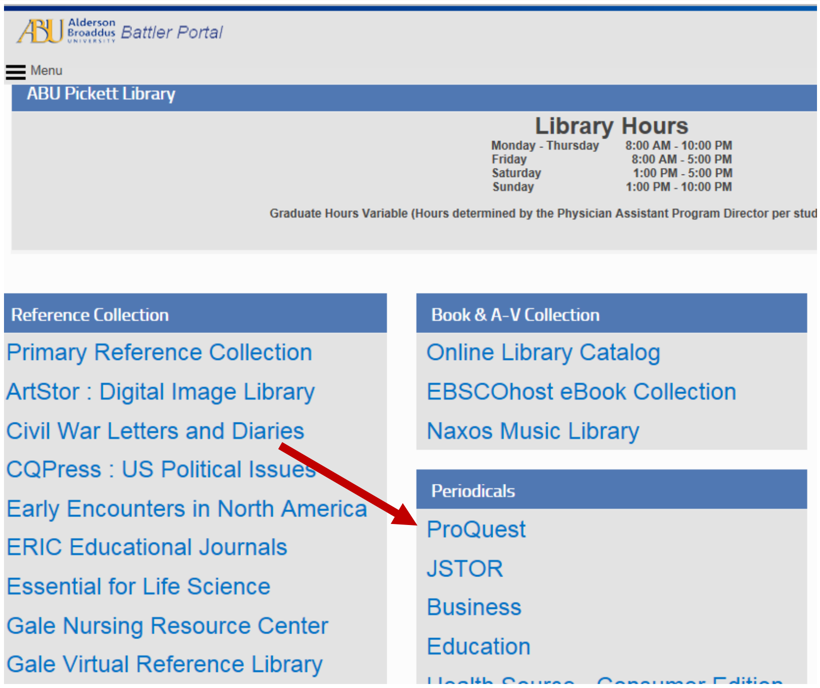

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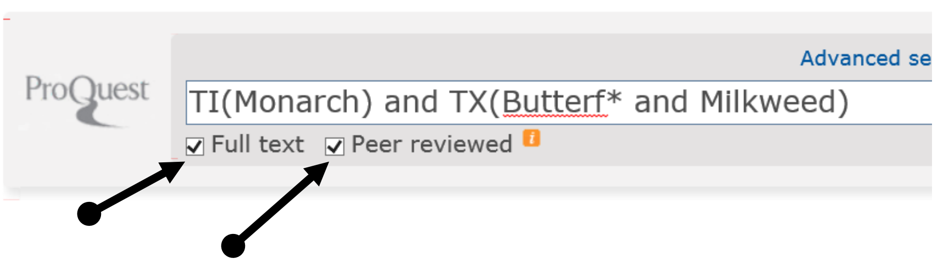

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TX(Butterf* and Milkweed) – search will include either of the words '**Butterflies or Butterfly**' **and** the word '**Milkweed**' in the **text of the article**.

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☐ 5 Plant Latex and First-Instar Monarch Larval Growth and Survival on Three North American Milkweed Species

Zalucki, Myron P; Malcolm, Stephen B. **Journal of Chemical Ecology; New York** 25.8 (Aug 1999): 1827-1842.

...butterfly, Danaus plexippus, a milkweed specialist, generally grew faster and

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☐ 6 Parasitism of Monarch Butterflies (Danaus plexippus) by Lespesia archippivora (Diptera: Tachinidae)

Oberhauser, Karen; Gebhard, Ilse; Cameron, Charles; Oberhauser, Suzanne. **The American Midland Naturalist; Notre Dame** 157.2 (Apr 2007): 312-328.

...milkweeds (Asclepiadaceae) by the monarch butterfly (Danaus plexippus L.) during
...widespread generalist parasitoid whose hosts include monarch butterfly larvae
...milkweed species with varying levels of cardenolides occurred in one area,

Preview

This search, using **'Monarch'** in the **title field** and **'Butterfly '** in the **text field,** produced a list of 28 articles.

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Abstract—First-instar larvae of the monarch butterfly, *Danaus plexippus*, a milkweed specialist, generally grew faster and survived better on leaves when latex flow was reduced by partial severance of the leaf petiole. The outcome depended on milkweed species and was related to the amount of latex produced. The outcome also may be related to the amount of cardenolide produced by the plants as a potential chemical defense against herbivory. Growth was more rapid, but survival was similar on partially severed compared with intact leaves of the high-latex/low-cardenolide milkweed, *Asclepias syriaca*, whereas both growth and survival were unaffected on the low-latex/low-cardenolide milkweed *A. incarnata*. On the low-latex/low-cardenolide milkweed *A. tuberosa*, both growth and survival of larvae were only marginally affected. These results contrast sharply to previous results with the milkweed, *A. humistrata*, in Florida, which has both high latex and high cardenolide. Larval growth and survival on *A. humistrata* were both increased by partially severing leaf petioles. Larval growth rates among all four milkweed species on leaves with partially severed petioles were identical, suggesting that latex and possibly the included cardenolides are important in first-instar monarch larval growth, development, and survivorship.

Key Words—*Asclepias*, cardenolide, *Danaus plexippus*, growth rate, latex, laticifer, milkweed, neonate larvae, plant defense, survival.

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TX((Danaus plexippus) and Milkweed)

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☐ 7 Sequestration of defensive substances from plants by Lepidoptera

Nishida, Ritsuo. **Annual Review of Entomology; Palo Alto** 47 (2002): 57.

...Elements CARDENOLIDES The remarkable story of the monarch butterfly, Danaus
...regardless of the CG concentrations in their hosts, e.g., many African Danaus
...plants, butterflies, and birds (41,42, 133,134, 180,185). Feeding upon milkweed

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☐ 8 Chasing Migration Genes: A Brain Expressed Sequence Tag Resource for Summer and Migratory Monarch Butterflies (Danaus plexippus): e1345

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INTRODUCTION

Butterflies and day-flying moths are among the most fascinating insects, with their brilliant color patterns and graceful fluttering. Their conspicuousness, however, may often be a warning signal to advertise the possession of defense substances in their body. Many of these aposematic Lepidoptera are strongly associated with poisonous plants and sequester the toxic materials from the plants instead of, or in addition to, manufacturing their own toxins. Naturalists in the nineteenth century recognized some aposematic insects to be toxic or unpalatable to predators because of the existence of a spectacular array of mimetic species that imitated the wing patterns of the unpalatable species for their own survival. The phenomena of unpalatability, warning coloration, and mimicry have provided us with an ideal paradigm relating to the process of natural selection.

Pioneered by Miriam Rothschild and Lincoln P. Brower (41, 42, 188, 191), chemical and ecological studies on unpalatable aposematic Lepidoptera have opened up an interdisciplinary research field involving numerous investigators. Table 1 lists classes of plant secondary metabolites sequestered by Lepidoptera,

TABLE 1 Examples of plant allelochemicals sequestered by Lepidoptera (butterflies // moths)

Chemical class of sequestrates	Representative sequesterers

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TABLE 1 Examples of plant allelochemicals sequestered by Lepidoptera (butterflies // moths)

Chemical class of sequestrates	Representative sequesterers
Terpenic metabolites	
Cardenolides (CGs)	Danainae // Arctiidae, Ctenuchidae
Grayanoids (GTs)	// Geometridae
Podocarpaceae norditerpenoids	// Geometridae
Iridoid glycosides (IGs)	Nymphalinae // Geometridae, Sphingidae
Phenolic metabolites	
Lichen phenolics	// Arctiidae
Nitrogen-containing metabolites	
Pyrrolizidine alkaloids (PAs)	Ithomiinae, Danainae // Arctiidae
Tropane alkaloids (TAs)	Ithomiinae // Lymantriidae, Sphingidae
Quinolizidine alkaloids (QAs)	// Pyralidae
β-Carboline alkaloids	Heliconiinae //
Amaryllidaceae alkaloids	// Noctuidae
Phenanthroindolizine alkaloids	Danainae //
Azafuranose/azapyranose	Nymphalinae // Uraniidae
Aristolochic acids (AAs)	Papilionidae //
Cyanogenic glycosides (CNs)	Heliconiinae, Acraeinae // Zygaenidae
Sarmentosin (SA)	Papilionidae // Geometridae, Zygaenidae
Cycasin (CY)	Lycaenidae // Arctiidae
Glucosinolates (GLs)	Pieridae //

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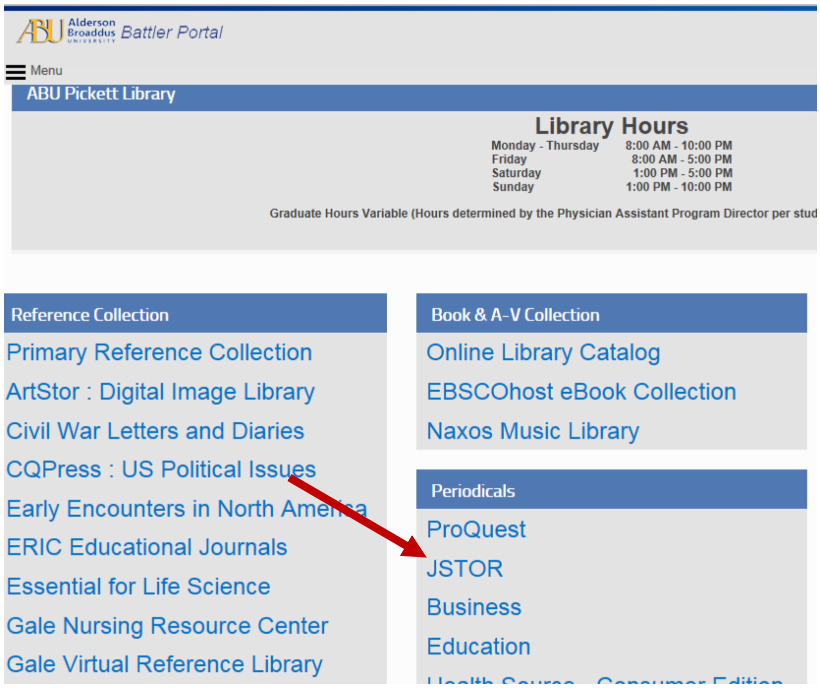
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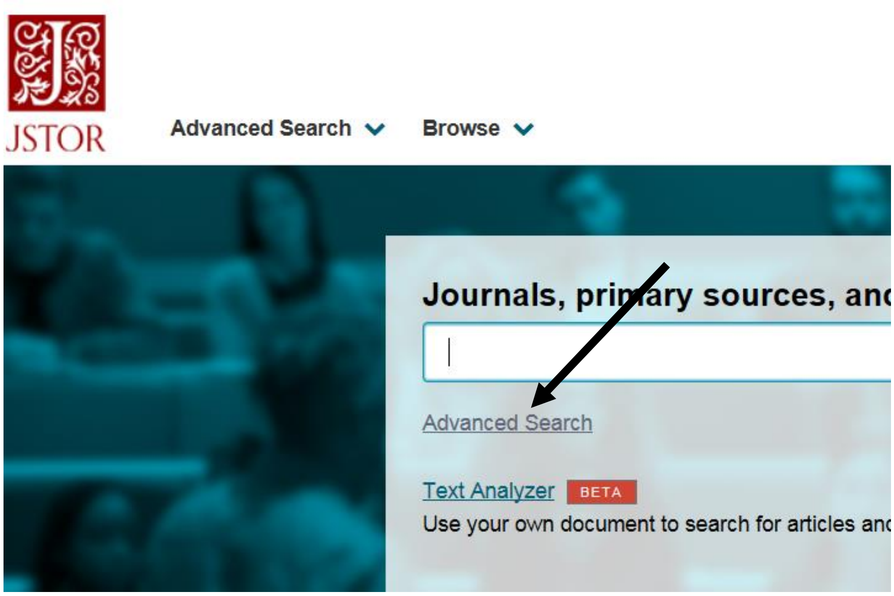
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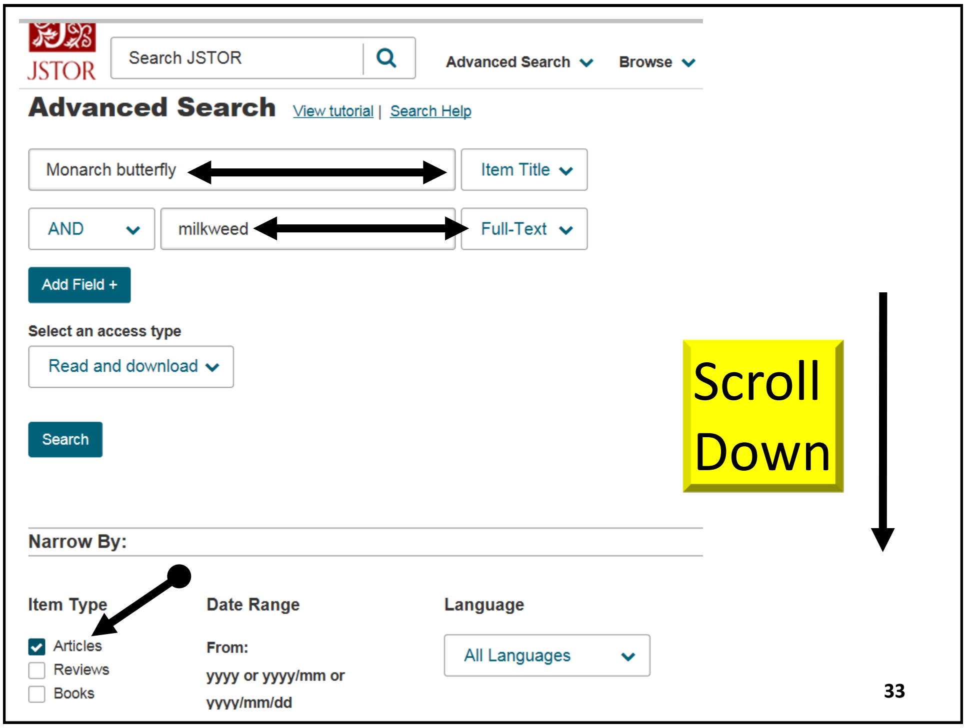
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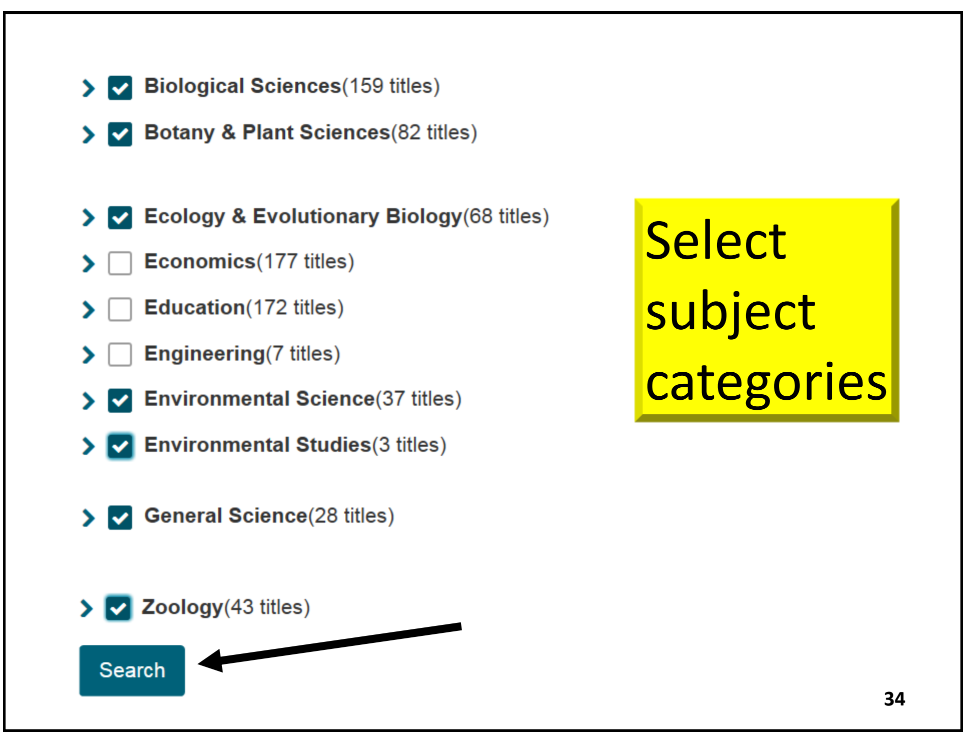
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By TIM WALKER

Picture a bird searching for a mid-afternoon snack – perhaps a butterfly. After all, butterflies fluttering from flower to flower make easy targets for a swooping bird.

Suddenly, the bird spies a bright orange butterfly. But instead of attacking, the bird ignores it. Why? Because the bird remembers what happened the last time it ate a bright orange butterfly: It vomited.

So the butterfly survives and continues on its way, courtesy of the bright orange warning that nature painted on its wings.

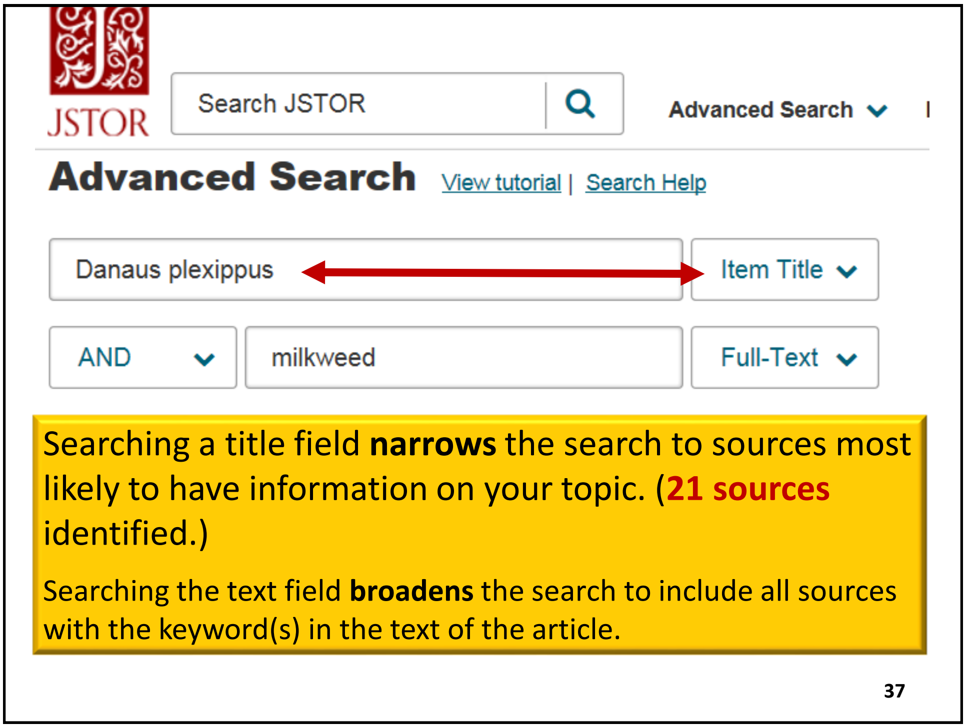
But was this a false warning? Did the butterfly's color trick the bird into passing up what would have actually made a tasty hors d'oeuvre? If the orange butterfly was a viceroy, *Limenitis archippus*, most biologists would have answered yes. For more than a century, the conventional wisdom has held that this winged insect cloaks a very appetizing body behind the colors of a toxic monarch butterfly, *Danaus plexippus*.

of the University of Florida in Gainesville have conducted an avian taste test, serv-

timore vicero admir held palata Dur a few

The only major visual feature distinguishing a monarch (left) from a viceroy (right) is the black semicircular line bisecting each of the viceroy's lower wings.

vicero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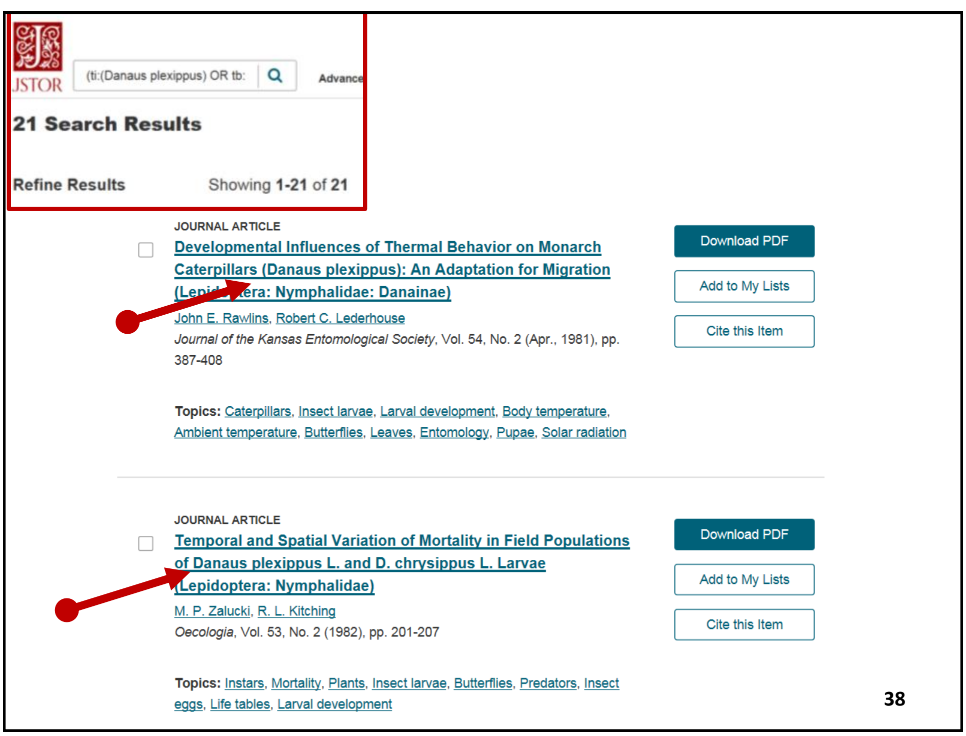
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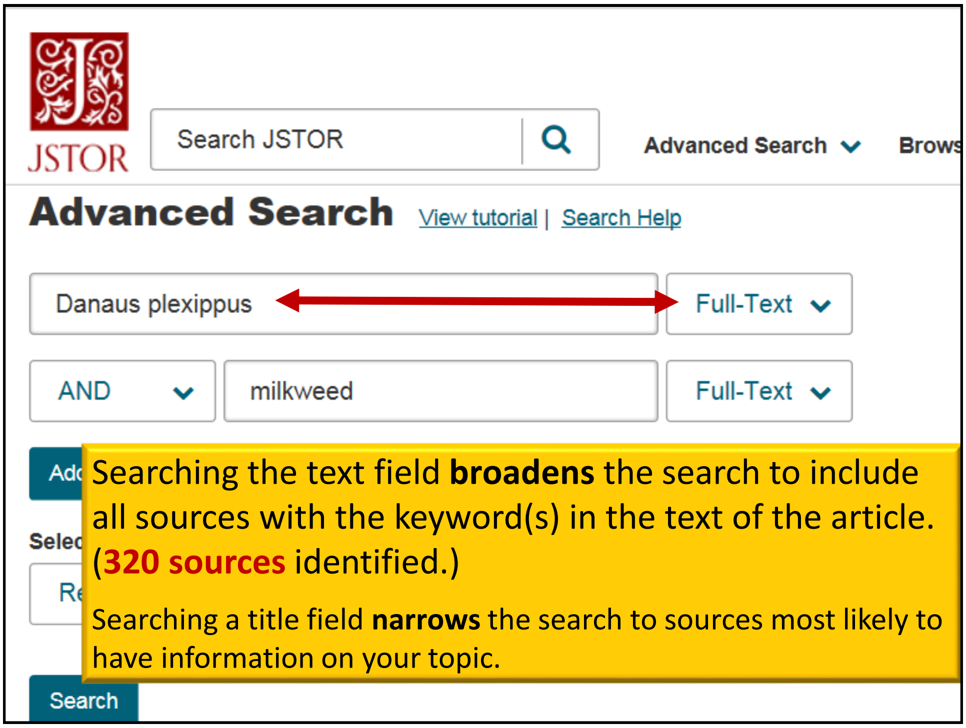
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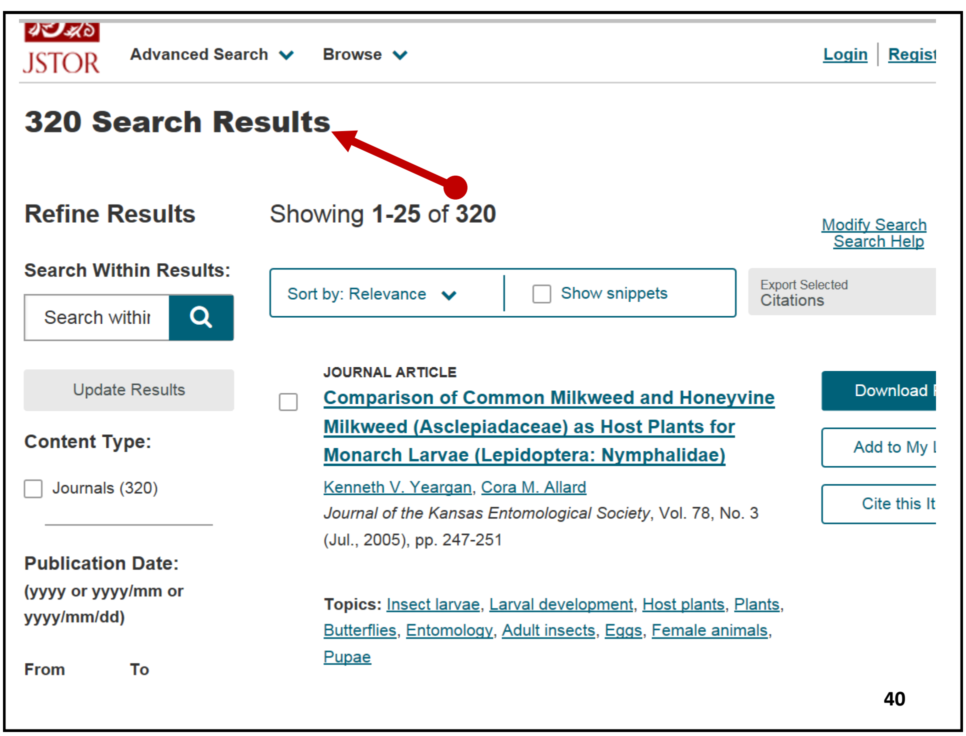
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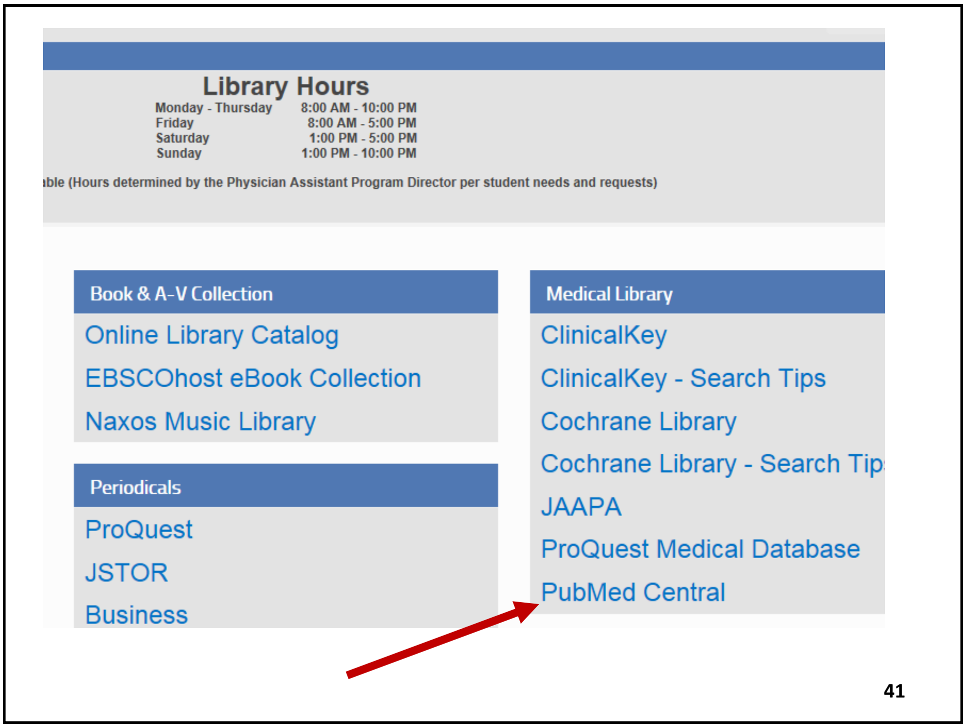
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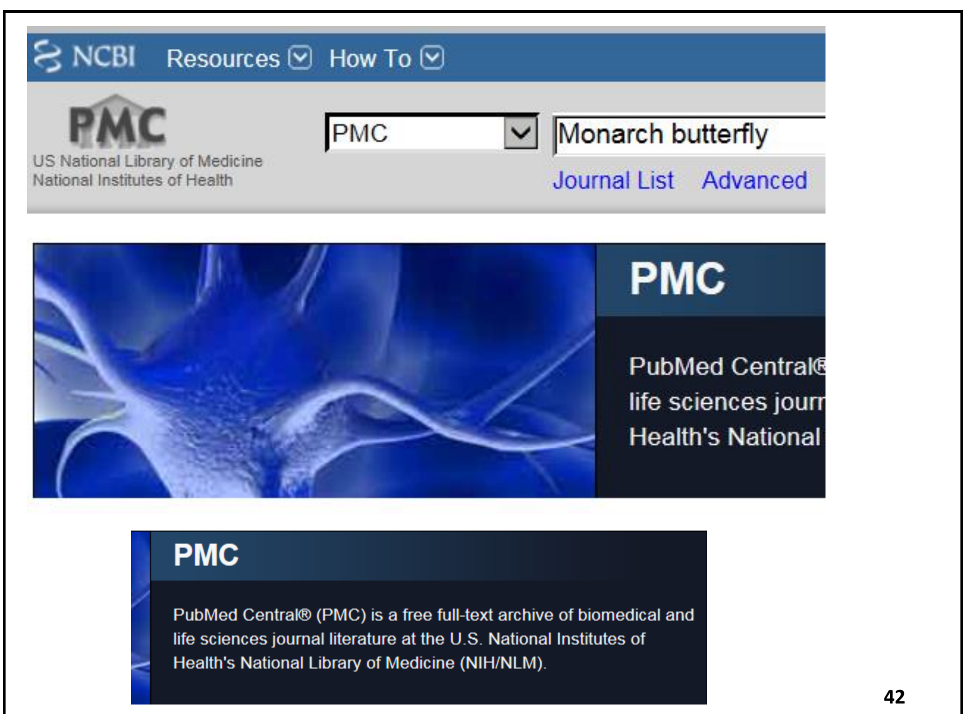
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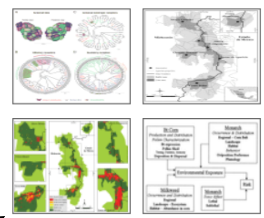

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Trends in Deforestation and Forest Degradation after a Decade of Monitoring in the Monarch Butterfly Biosphere Reserve in Mexico

OMAR VIDAL,* JOSÉ LÓPEZ-GARCÍA,† and EDUARDO RENDÓN-SALINAS‡

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Abstract

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We used aerial photographs, satellite images, and field surveys to monitor forest cover in the core zones of the Monarch Butterfly Biosphere Reserve in Mexico from 2001 to 2012. We used our data to assess the effectiveness of conservation actions that involved local, state, and federal authorities and community members (e.g., local landowners and private and civil organizations) in one of the world's most iconic protected areas. From

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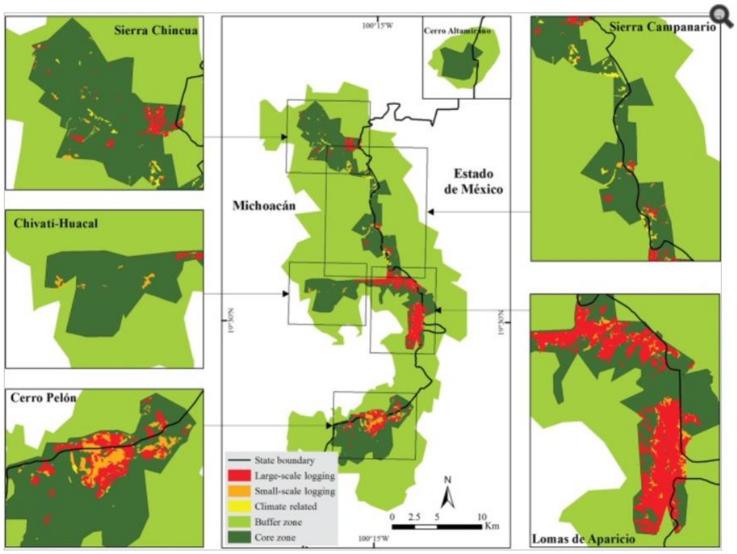

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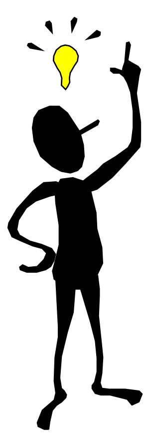

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