

Unlikely Pairing of Two Alien Species in Oregon Produces Unwanted Offspring

Alfonso Susanna

Institut Botànic de Barcelona (IBB-CSIC-ICUB), Pg. del Migdia s/n 08038 Barcelona, Spain

Cindy Roché

P.O. Box 808 Talent, OR 97540

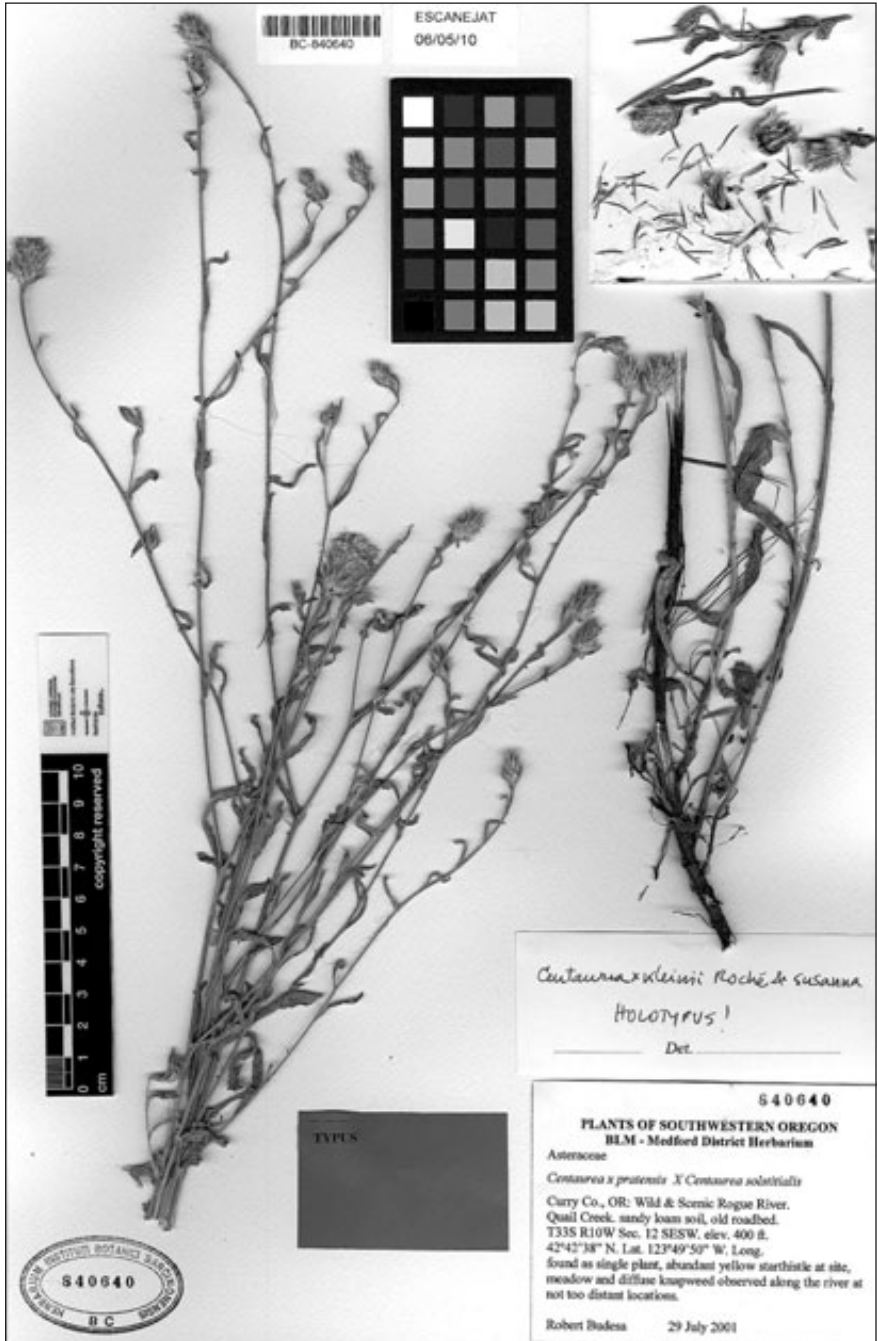
“Great Migrations” are commonly associated with animals. But plants migrate too, and they often use humans, who travel, farm, and graze domestic livestock, to expedite long-distance dispersal. These hitch-hikers are usually considered weeds in their new environments. One of the oldest examples, since Neolithic times (Rösch 1998), is cornflower (*Centaurea cyanus*), so named for its association with cultivated cereal grains. Although the development of herbicides reduced the impact of cornflower on crop yields, other species of *Centaurea* rank among the worst noncropland weeds in Oregon: yellow starthistle (*C. solstitialis*), diffuse knapweed (*C. diffusa*), spotted knapweed (*C. stoebe* = *C. maculosa*), squarrose knapweed (*C. virgata* ssp. *squarrosa*) and meadow knapweed (*C. moncktonii* = *C. pratensis*¹) (Roché and Roché 1991).

Invasion of new regions brings species together that formerly were seldom (if ever) in close proximity. Sometimes this creates opportunities for hybridization. For example, meadow knapweed, a cross between brown and black knapweed (*C. jacea* x *C. nigra*), was widely known in Europe before it was introduced in North America as a hybrid swarm (a mix of plants that included both parents and hybrids, and hybrid derivatives including F1s, F2s and backcrosses).

An Oregon *Centaurea* Goes to Barcelona

In 1998, Jeanne Klein (now Standley) collected a “robust and attractive” knapweed with yellow and lavender flowers along the Cow Creek Road while working for the Roseburg District Bureau of Land Management (BLM). The plant that originally caught her eye was a pale and silvery version of meadow knapweed, a weed that was abundant in the area. Besides the difference in flower color, she noted that

¹ *Centaurea pratensis* Thuill. and *C. debeauxii* Gren. & Godr. are among previous names widely used for the hybrid between *C. nigra* and *C. jacea*, but according to Wagenitz (1987), the correct name for this species is *C. moncktonii* C. E. Britton. This is also the accepted name in the Flora of North America (Keil and Ochsmann 2006).



Holotype of *Centaurea x kleinii*, collected by Robert Badesa in Curry County, Oregon, housed at the herbarium of the Institut Botànic de Barcelona (BC).

“the bracts were different than meadow knapweed,” and she wondered what species she had stumbled upon. “Most likely another noxious weed,” she thought, “but a really pretty one!” Some plants had lavender flowers, and some had pale yellow

flowers. She couldn't wait to key it out. When keying didn't produce results, the mystery deepened. She had noted the adjacent meadow knapweeds and yellow starthistle and began to wonder if the two had hybridized. That's when she enlisted the aid of other botanists. Ken Chambers at the OSU herbarium was stumped. Then, a chance meeting with a BLM manager from the Medford District (Robert Korfhage) provided a connection with his fiancée who had worked with knapweeds at Washington State University. As luck would have it, Cindy Roché was headed back to Spain to complete her post-doctoral research on *Crupina*. She offered to take pressed specimens to the group in Barcelona that was working on *Centaurea* systematics. Another BLM weed specialist, Bob Budesá, collected a similar plant on the Rogue River at Quail Creek (Curry County) and Jeanne found more plants at new locations in Douglas County. Last year we published an article describing it as a hybrid, honoring Jeanne as the discoverer and using Bob Budesá's collection as the type specimen (Roché and Susanna 2010). Since then, Barbara Mumblo, botanist with the Forest Service, reported a collection she made of the hybrid in 2006.

Against the Odds

The specimens looked like a hybrid between yellow starthistle and meadow knapweed. This combination is entirely unexpected for two reasons: these two taxa have incompatible chromosome numbers and are very distantly related, even though both putative parents belong to the large *Centaurea Jacea* clade (group of close relatives) that stands as the core group of the genus *Centaurea* (Garcia-Jacas *et al.* 2006). Under a geographic classification system, they segregate into two different clades. Brown and black knapweed (therefore, meadow) belong to section *Jacea*, which is in the clade of widely distributed species. *Centaurea solstitialis* belongs to section *Mesocentron* among the Western Mediterranean group of species (Garcia-Jacas *et al.* 2006). Thus, meadow knapweed and yellow starthistle are very distant relatives, even though the important characters that define the *Centaurea Jacea* clade (pollen type "Jacea" and achenes with a double pappus and lateral hilum).

The other reason that these two taxa should not cross is the difference in chromosome numbers. Based on multiple counts (Watanabe 2010), meadow knapweed is a tetraploid with $2n = 4x = 44$, while yellow starthistle is diploid with $2n = 16$. Probability of viable offspring from this incompatible combination should be extremely low. Yet, the apparent hybrid has been found in five separate locations; the distance and lack of seed production indicate that the hybrids arose from independent crossings.

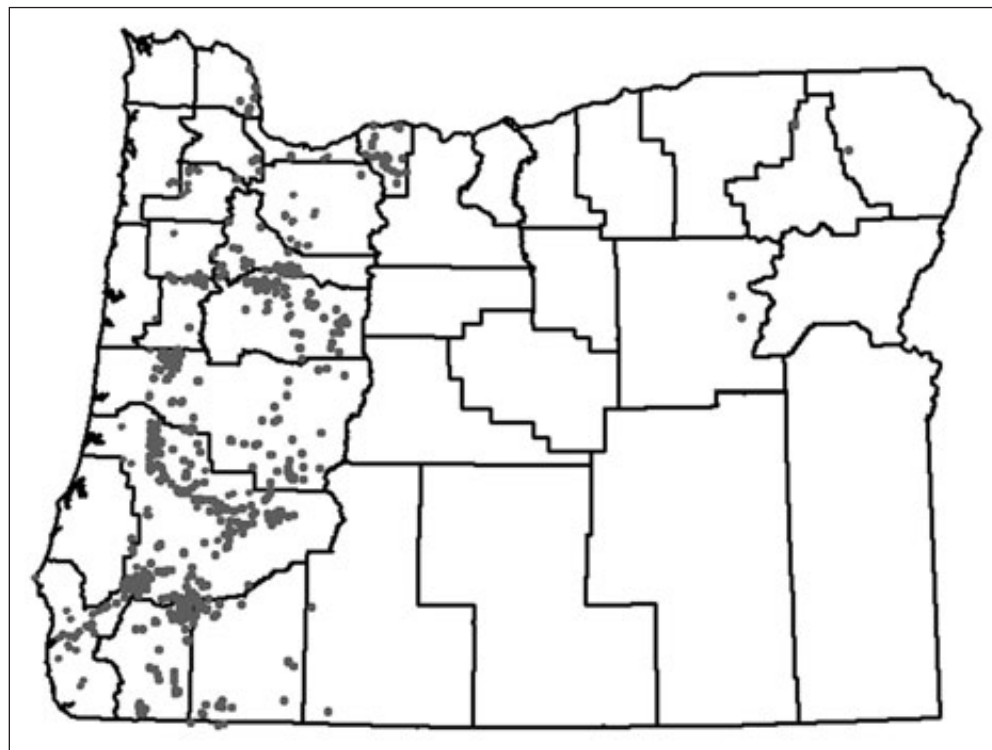
Morphologically, the hybrid is similar to meadow knapweed, but with obvious traces of its yellow starthistle ancestry in floret color, shape of the bracts surrounding the flower head, and hairiness of leaves and stems.

Geographic Origins and Expansion

Yellow starthistle is widely distributed along the Mediterranean region in its broadest sense, from Iran and Turkey to the Iberian Peninsula and North Africa. It originated in the Eastern Mediterranean, but has expanded to the entire Mediterranean region, usually associated with human disturbance. As an alien invader, it has colonized extensive areas in the western US, South America and Australia. Yellow starthistle became established in California in the mid-1800s and by 2000 infested more than four million hectares (Thomsen *et al.* 1996). It was first reported in Oregon in Douglas County in 1914 (Roché and Talbott 1986).

Meadow knapweed is a frequent and fully fertile hybrid between black knapweed and brown knapweed. Black knapweed is native to the British Isles, with hybrids being common when brown knapweed was introduced from the European continent (Marsden-Jones and Turrill 1954). Ockendon (1975) described the reverse situation in France, suggesting that brown knapweed was native and black knapweed introduced, which is highly questionable following Dostál (1976). Either way, because the F1 hybrid can back-cross with either parent and with other F1 individuals, hybrid swarms normally completely replace the pure forms. Both the parent species and the hybrid are common in Eurasia, becoming rare to the East.

The earliest reports of meadow knapweed in Oregon date to 1911 and 1918 in the Willamette Valley from Portland to Eugene (Roché and Talbott 1986). Howell (1959) reported



Distribution of meadow knapweed in Oregon. Map courtesy of Weed Mapper, Oregon Dept. of Agriculture (<http://www.oregon.gov/ODA/PLANT/WEEDS/weedmapper.shtml>).

that meadow knapweed was cultivated for winter forage near Roseburg (where it remains abundant today). It is leafier and more palatable to livestock than other knapweeds, but as plants mature, both palatability and nutritional value decline (Roché and Roché 1991).

Ecological Distribution

In its native range, yellow starthistle seldom grows in the mountains, being restricted to the Mediterranean climate of its origin. In western North America, its distribution is also correlated to Mediterranean climates, with the most aggressive invasion in California. In the more northern latitudes (e.g., Washington State, ca. 46° to 49° North), it is restricted to sunny, warm habitats such as south slopes at lower elevations, and despite repeated introductions, does not persist in British Columbia, Canada (Roché and Thill 2001). In Oregon, it is most competitive in the Mediterranean climate of the inland valleys between the Cascade and Coast Range mountains (a small, northern extension of the Central Valley of California), the warm basalt slopes in the Columbia Gorge, and south slopes in the foothills of the Blue Mountains.

As its common name suggests, meadow knapweed is a meadow plant, and according to most monographers (e.g., Marsden-Jones and Turrill 1954, Wagenitz 1987), in the Mediterranean region it grows only in the moistest places in the mountains. In western North America, meadow knapweed extends from coastal northern California through Oregon and Washington into British Columbia, primarily in moist forested regions and in meadows, irrigated pastures, and riparian zones (Roché and Johnson 2003). The largest populations of meadow knapweed in Oregon are in

the interior valley lowlands (Umpqua and Willamette Valleys) including both the east slopes of the Coast Range and the west slopes of the Cascade Range. In Douglas County the Klamath Range forms a mountain bridge between the Coast and Cascade Ranges; annual precipitation ranges from about 33 inches in the lowland valleys to over 51 inches in the foothills. Substantial populations also grow on the mesic eastern slopes and valleys of the Cascade Range near Hood River in the Columbia River Gorge in northern Oregon.

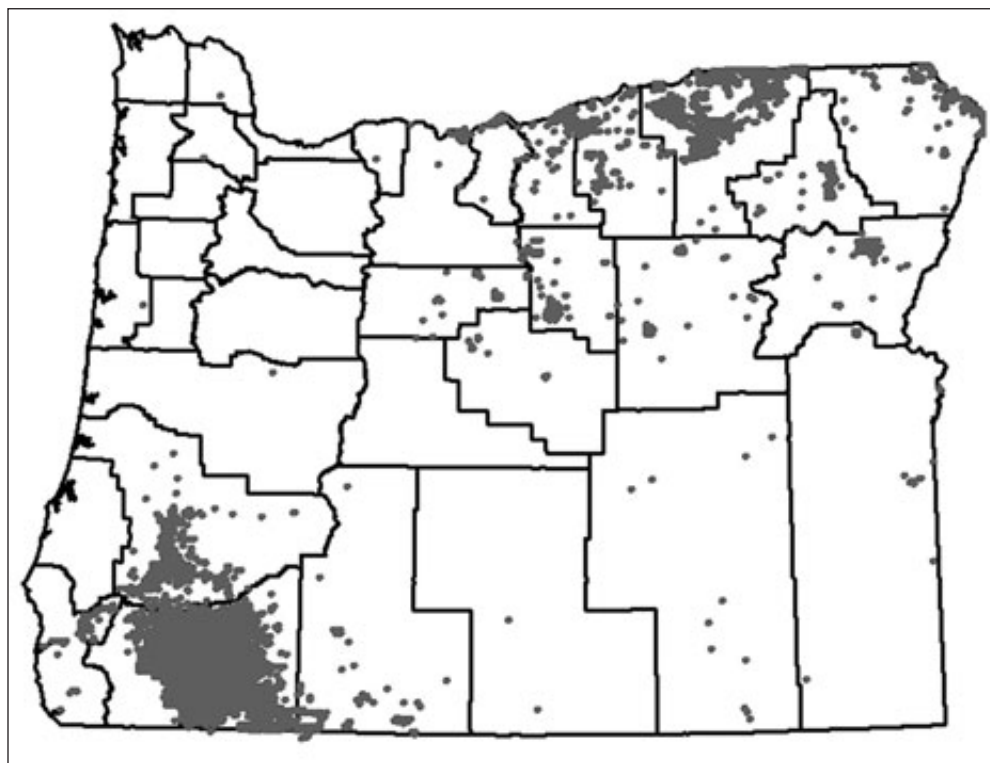
With a Little Help From Some Bees?

Centaurea species in general are entomophilous (insect pollinated) and are visited by a wide range of species for pollen and/or nectar (Marsden-Jones and Turrill 1954). Each disc floret contains both male and female flower parts, offering both pollen and nectar. To collect these rewards, an insect pushes its proboscis into each open floret separately. By moving successively across the head, it can pollinate many florets by crawling a very short distance, or by simply turning. Each floret has one ovule requiring only one viable and compatible pollen grain to bring about fertilization (Marsden-Jones and Turrill 1954).

Contact between meadow knapweed and yellow starthistle within the range of their native distribution is infrequent because their ecological requirements differ so greatly. What differs in southern Oregon is not the biology of the plants, but that appropriate habitats occur within flight range of the pollinators. Both species share disturbed sites on roadsides that are adjacent to mesic meadows and riparian zones that support meadow knapweed and warm south-facing slopes that are dominated by yellow starthistle.

Is This a New Weed?

The new hybrid is morphologically much closer to meadow knapweed. It is sterile, producing neither seeds nor viable pollen (Carol Mallory-Smith, pers. comm.). In its current form it could show weedy behavior as a perennial herb only through clonal reproduction. Yellow starthistle spreads exclusively by seed, but root and crown fragments of meadow knapweed regrow when disturbed by heavy equipment or cultivation (Roché and Johnson 2003). Alternatively, this sterile hybrid could be one mutation away from becoming a “super weed.” *Crupina intermedia* is a robust weedy invader that arose when *C. crupinastrum* ($2n = 28$) hybridized with *C. vulgaris* ($2n = 30$) and subsequently became tetraploid ($2n = 4x = 58$) (Couderc 1975). A parallel scenario for *Centaurea x kleinii* could yield a



Distribution of yellow starthistle in Oregon. Map courtesy of Weed Mapper, Oregon Dept. of Agriculture (<http://www.oregon.gov/ODA/PLANT/WEEDS/weedmapper.shtml>).

fertile hybrid with exceptional vigor ($2n = 4x = 60$). Fortunately, recent surveys indicate that control work by the BLM has been effective in eradicating the hybrid populations. No plants were found in 2010 at any of the BLM locations that formerly supported these hybrids. We don't know why it took over 100 years of

co-existence in Oregon for hybrids to appear, but it's clear that predicting weed behavior in new environments is a dangerous game. New introductions often experience a lag period before becoming invasive, so erring on the side of prevention is always recommended.

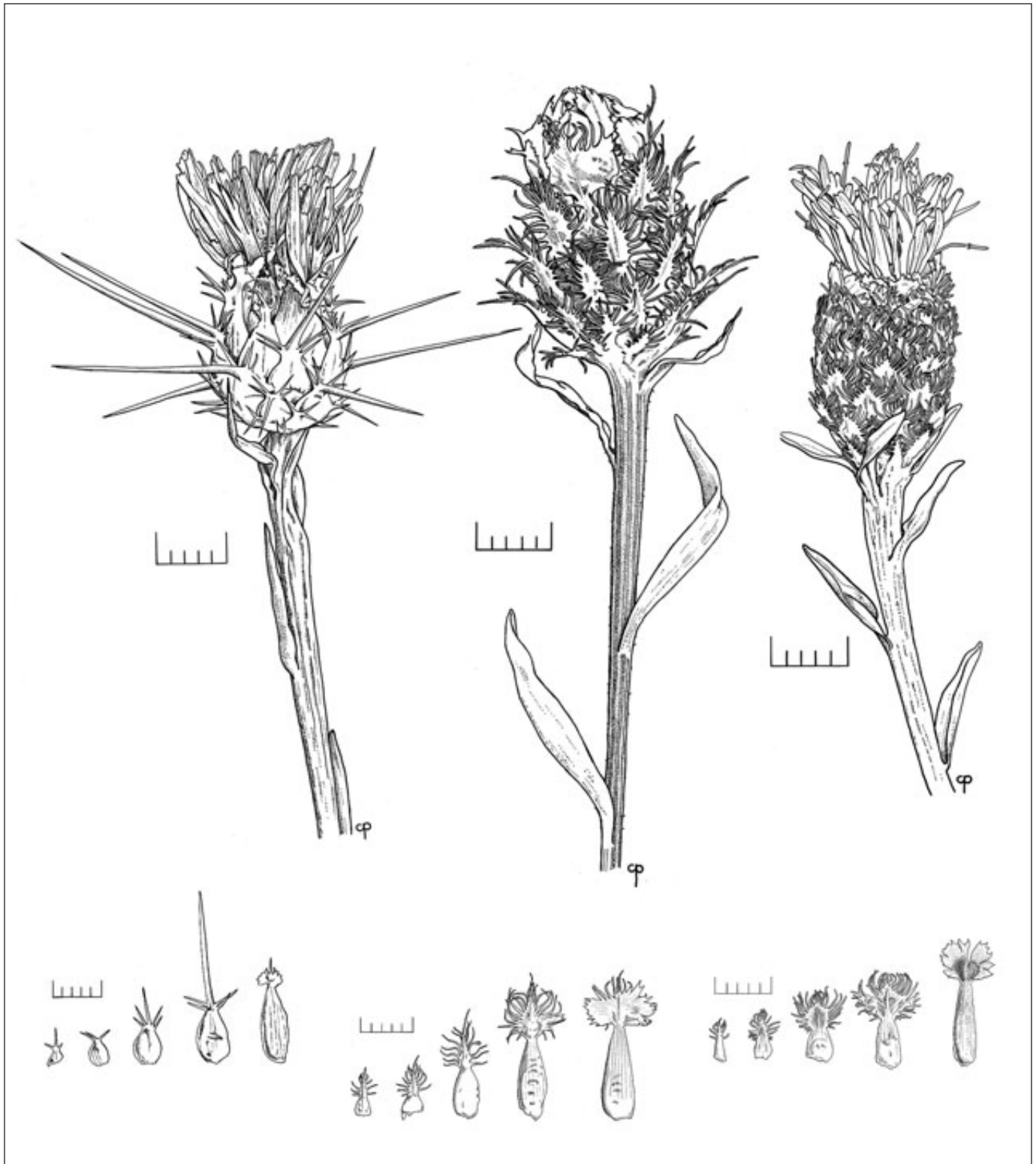


Illustration of capitula and phyllary bracts of yellow starthistle, meadow knapweed, and the hybrid between them. Scale: 5 mm in each. Drawings by Carles Puche.

Collection Sites

Curry County: Wild & Scenic Rogue River. Quail Creek. sandy loam soil, old roadbed. T33S R10W Section 12 SE¼ SW¼. Elevation 400 ft. 42°42'38" N. Lat. 123°49'50" W. Long. Found as single plant, abundant yellow starthistle at site, meadow and diffuse knapweed observed along the river at not too distant locations. Robert Budesa 29 July 2001.

Douglas County: Cow Creek Road, approximately 20 miles southwest of city of Riddle. Growing along roadside between road and Cow Creek. Elev. 290 m. 42° 50.303' N. Lat. 123° 37.204' W. Long. Associated species: *Pseudotsuga menziesii*, *Rubus discolor*, *Cytisus scoparius*, *Centaurea pratensis*, *Centaurea solstitialis*, *Daucus carota*, *Eschscholzia californica*, *Avena barbata*. Jeanne M. Klein; 07 September 2000.

Douglas County: Myrtle Island, near Tyee. 43° 28.426' N Lat. 123° 32.373' W Long. [T24S R7W Sec. 20] On leading edge of the island in cobbles and sandy soil. Elev. 70 m. Associated species: *Centaurea pratensis*, *Centaurea solstitialis*, *Rubus discolor*, *Chondrilla juncea*. Jeanne Klein & Pete Figura; 20 July 1998.

Douglas County: Island Creek BLM Day Use Area, along Cow Creek Road. Elev. 230 m. 42° 54.772' N. Lat. 123° 28.938' W. Long. Growing along roadside with *Vulpia myuros*, *Aira caryophylllea*, *Cynosurus echinatus*, *Madia* sp., *Pinus ponderosa*, *Rubus discolor*, *Centaurea solstitialis*, *Centaurea pratensis*. Cindy Roché & Jeanne Standley; 28 July 2003.

Curry County: along Rogue River at west end of Road 250, northern edge of gravel bar on north bank of river. T35S R13W Section 33 SWSW 42°29'59"N. Lat. 124°15'33"W. Long. 100 ft. elev. (From Gold Beach take Road 33 toward Agness, cross over the Rogue River at Lobster Bar and go to Road 3533; continue east ca. 2.5 miles to small road #250). One plant collected. Both *Centaurea moncktonii* and *C. solstitialis* in vicinity. Barbara Mumblo #7180601BAM 18 July 2006.

Acknowledgements

Jeanne Standley (BLM Coos Bay District), Bob Budesa (retired, BLM Medford District) and Barbara Mumblo (Rogue River-Siskiyou National Forest) provided information for known sites of the hybrid. Carol Mallory-Smith, Oregon State University, has maintained a small population in cultivation for six years and provided information on infertility. The Oregon Department of Agriculture (Weed Mapper; <http://www.oregon.gov/ODA/PLANT/WEEDS/weedmapper.shtml>) provided maps of yellow starthistle and meadow knapweed in Oregon. Carles Puche of the Botanic Institute of Barcelona created the wonderful line drawings.

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Location of the five collections of *Centaurea x kleinii* in Douglas and Curry counties, Oregon. Map prepared by Stephen Meyers, Oregon Flora Project.

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Alfonso Susanna in a watermelon pause during his 2009 summer campaign in Turkey.



Cindy Roché on Upper Rogue River Trail, Jackson County, Oregon. Photo by Robert Korfhage.

Alfonso Susanna is Director of the Botanic Institute of Barcelona, Spain. He and Dr. Núria Garcia-Jacas specialize in molecular systematics in Asteraceae. As visiting scientists at Washington State University, Pullman, Washington, 1994-1995, they investigated *Centaurea* species. Dr. Susanna is also editor of the journal, *Collectanea Botanica*, published annually (like *Kalmiopsis*).

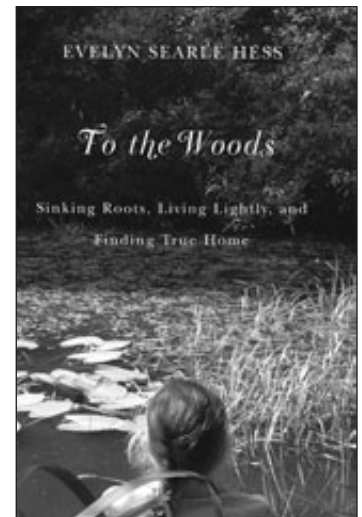
Cindy Roché, editor of *Kalmiopsis*, has a background in weed science, with an MS from Washington State University on the ecology of *Centaurea* species and a PhD from the University of Idaho on the developmental biology of two invasive species from the Mediterranean region, *Centaurea solstitialis* and *Crupina vulgaris*. Her post-doctoral research at the Botanic Institute in Barcelona focused on the origins of several introductions of *Crupina vulgaris*.

Book Reviews

To the Woods: Sinking Roots, Living Lightly, and Finding True Home

Hess, E.S. 2010. Corvallis (OR): Oregon State University Press. 175 pp. ISBN 978-087071-581-5. \$18.95 Paperback.

In 1992, Native Plant Society of Oregon member Evelyn Hess and her architect husband David, both in their mid-fifties and both formerly employed by the University of Oregon, "... left the toys and noise of urban society for the company of jumping mice, winter wrens, and dark nights full of stars and cricket song ..." to live on 21 logged-off acres in the Coast Range foothills south of Eugene. They would have "... no house, no electricity, (and) no indoor plumbing ..." in this new habitat where they developed a fledgling native plant nursery. *To the Woods* is Evelyn's personal account of their fifteen rewarding and challenging years in their new chosen habitat.



On a special shelf in my bedroom, Evelyn's book joins two others of the same genre: *We Took to the Woods* (1942), by Louise Dickinson Rich, and *Driftwood Valley* (1946) by Theodora Stanwell Fletcher (reissued by Oregon State University Press in 1999). All three books were written by women who, with their husbands, forsook the comforts of modern life to dwell close to nature and to write accounts of the joys and challenges of their relationship to the land. I strongly recommend all three to anyone who, like me, has ever dreamed of doing the same.

Evelyn divides her book into five parts. The first, "The Setting," describes the couple's work on their twenty-one acres of cut-over Coast Range hillside seventeen miles south of Eugene while still living in their home near the University of Oregon. Following that introduction, like *Driftwood Valley*, the book is arranged by seasons: Spring, Summer, Autumn, Winter. As Evelyn states in her Preface, "... each section records events and musings occurring in the specified season from any of the fifteen years 1992 to 2007."

The reader of Evelyn's account of their lives in the woods will marvel at the tenacity of the couple as they developed a plant nursery in the raw clear-cut environment. Living in a travel trailer with two dogs and a cat but no electricity or indoor plumbing proved a challenge even in summer, yet Evelyn clearly remained enthusiastic and enchanted with their simple life. As the reader will note, she even used an outdoor garbage can as a bathtub.

As Evelyn writes, she and her husband "... said good-bye to telephones, television, and electrical appliances ... We would make do." Early on they dug a pond for irrigation. The book's