Long Island Botanical Society

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Gone With the Wind?

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Figure 1. Mature seed head of *Tragopogon dubius* (goatsbeard or wild salsify). This seed head is very similar to but far larger than any dandelion (*Taraxacum*). The large spherical head is comprised of seeds each with a long beak ending in a feathery, parachute-like structure called a pappus; this type of seed is highly adapted to wind dispersal. Photo by Jerry Friedman.

Introduction

In the summer of 1979 I participated in a graduate course, "Advanced Field Ecology," at the University of Minnesota's Lake Itasca Forestry and Biological Station. Lake Itasca also has the interest of being the official source of the Mississippi River. There were fifteen students and several instructors, including Stephen Hubbell (tropical ecology), Michael Singer (butterflies) and Bernd Heinrich (insect physiology; now retired, he has a column in each issue of "Natural History").

We did various group projects; the one I was responsible for writing up considered phenotypic variation of wing pattern in three species of butterfly. It was an outbreak year for Painted Lady butterflies so we had a large supply of individuals of this species—road kill, picked up the hundreds at roadside.

Tragopogon and Study Site

For completion of the course, the curriculum required every student to do an individual project. Considering what one to take on, I was primed when on one of our field trips, not far from the Station, I'd seen something that resonated from my youth, a mystery then, but not now. The childhood memory was of seeing a kind of giant dandelion with a striking seed head, far larger than any dandelion (Fig. 1). Today, I know it was goatsbeard or wild salsify, *Tragopogon* sp., not only a striking plant when fully in seed, but one of the uncommon plants that is a biennial (Hart 1977). There were many individuals of the genus along the edge of this rough track within a few walking minutes of the Station, and the individuals were in various states: from buds to flowers (Fig. 2, page 27) to seed heads. So these became my project and the paper I produced was titled "Some aspects of reproductive strategies in *Tragopogon major* Jacq. (Compositae)" [Compositae then, Asteraceae now]. The species I was studying is now more properly called *Tragopogon dubius*.

The convenience of the location, the ease of taking field measurements, and of returning specimens to the lab, made for a satisfactory study organism and a useful project. I began to collect data, both on plant size and on seed heads. This article deals only with something I noted about the achenes in the seed head and thoughts on its significance.

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Society News

Native *Magnolia* collection at Queens Botanical Garden, by Morgan Potter. The idea of a Queens Botanical Garden native *Magnolia* collection came out of one of our Horticulture Committee meetings in the fall of 2017. Andrew Greller, a long time committee member and Professor Emeritus of Botany at Queens College offered to fund the project. We started with 8 species listed on the USDA Natural Resources Conservation Service website. *Magnolia acuminata* (cucumber tree), *Magnolia ashei* (Ashe's magnolia), *Magnolia fraseri* (mountain magnolia), *Magnolia grandiflora* (southern magnolia), *Magnolia macrophylla* (bigleaf magnolia), *Magnolia pyramidata* (pyramid magnolia), *Magnolia tripetala* (umbrella-tree) and *Magnolia virginia* (sweetbay). Three of these species, *M. ashei, fraserii* and *pyramidata* are found in southern states but we decided to give them all a shot, who knows with climate change?

Next, we considered the location. Magnolias prefer acidic soil, quite a few are understory trees, and as mentioned above, three are outside our hardiness zone of 7. We chose a site on a sheltered slope bordering the Woodland Garden already populated with several non-native species and cultivars. Just up the hill are two mature tulip trees (*Liriodendron tulipifera*), which coincidentally is the closest living relative to the magnolia. The location also has the closest to "native soil" on the property. Queens Botanical Garden is situated on top of an old ash dump from the early 1900s and probably contributes to most of the garden having alkaline soil indicated by our pink hydrangeas and difficultly growing ericaceous plants.

With a bit of research and a few specially grown specimens, we were able to plant two of each species in the 2018 growing season. A full year later, all but the three southern species remain. We have one *Magnolia fraserii* holding on; this species is found as far north as the Appalachian Mountains in West Virginia and Pennsylvania so fingers crossed it makes it through to the next season. For the future, we've toyed with the idea of expanding the collection to include sister species from China, Korea and Japan which could be a really interesting story about divergent evolution in similar climates.

Rich Kelly
6 Dec. 1950 – 6 Sept. 2019

(Gone With the Wind, continued from cover)

Technically each seed in the head is an achene with a pappus, but for purposes here, I treat the achene without its pappus as the seed, and the pappus as a separate unit (Fig. 3). I note here that some of the following two paragraphs is taken, heavily edited, from the text of the paper I wrote then.

Tragopogon in General

Upon maturation the seed head reopens rapidly, often on a sunny day, and often within an hour or so. The pappi (plural of pappus) spread open and the achenes take their final orientations, producing a large, spherical head, often 10 cm or more in diameter. The achenes are quickly dispersed by wind, a common reproductive strategy in many Asteraceae.

A typical achene is an elongate beaked affair, the beak being the thin part of the achene that attaches to the pappus, the whole being the reproductive unit. The main body of the achene is compressed side to side and sometimes provided with blunt spines on its surface. The pappus consists of thirty or more separate hair-like fibers arranged radially at the end of the beak of the achene, the fibers interconnected with fine plumose hairs between them, and I'll sometimes call this the "parachute" in later discussion. If you've seen a dandelion seedhead and its achenes, you've seen all of the above in miniature.

I felt the seed heads merited some closer looks, and one of the matters I investigated was a question: Do the individual fruits (achene and pappus) show any phenotypic traits that might relate to variation in their relation to wind-mediated seed distribution?

Of the characteristics I looked at and considered, far more thorough work has been done (Greene & Casada, 2010; McGinley, 1989; McGinley & Brigham, 1989; Maxwell, Zobel & Woodfine, 1994) but it's somewhat pleasing to me that some of what I found pre-dates some points in these papers. But my study can only ever be called "preliminary" and it was never carried any further. I only considered it the beginning of a formal paper—never taken on. So…

Methods:

I weighed the individual seeds from nine intact flowers for a total of 579 weights, the number of seeds from each flower ranged from 21 to 120 and the mean weight of seeds on each individual flower ranged from 5.0 mg to 10.0 mg, but always with a considerable range in weight on any particular flower.

Histograms for seed weights for each flower did not appear to show a normal distribution. The seeds from the outer whorl were nearly always the heaviest on each flower, and several histograms were clearly bimodal, showing me that there were basically two distinct seed populations in each flower: light seeds in the inner whorl, heavy seeds in the outermost whorl, and this outer whorl included the achenes from the larger, showy ligulate flowers, an obvious correlation between floret size and achene size. Visually, the achenes of the two sub-populations had clearly different phenotypes. Inner whorl achenes were slender, relatively smooth, and pale straw color. Outer whorl achenes were no longer than the inner, but stouter, dark brown, and with some beak-like surface spines giving the achene a rough appearance

Figure 2. A flower head of *Tragopogon dubius* (goatsbeard or wild salsify). Each flower head may have the appearance of being a single flower but the head in this photo is comprised of 13 yellow "ray flowers" subtended by a row of long green narrow bracts. Photo from Google Images, author not given.

It was clear to me that the difference in phenotypes I saw is to a degree related to the two kinds of florets in the inflorescence. Since the florets in the outermost whorl are clearly the most substantial, and so would seem to require more of the plant resources to form and bring to maturity, it was not surprising that the achenes from this sub-population are clearly the heaviest as well as having a phenotype different from the more central, smaller florets. But there were more heavy achenes than showy florets. This makes my conclusions only partial.

The spininess of the outermost achenes might be an adaptation for animal transport. I noted in the field that the outermost achenes were the last to break free from the receptacle and often remained on the plant until they became rain-draggled and near useless for wind transport. Perhaps, then, this state increased the chance of animal transport, but even with spines, the seeds did not easily stick to at least my clothing. I never had to pick them off. But I have no observations with any relevance to animal transportation of the achenes.

Since *Tragopogon*, like *Taraxacum*, is clearly evolved for the seeds to be transported by wind, and like dandelions, the pappus of *Tragopogon* is the "parachute" that keeps the seed

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(Gone With the Wind, continued from page 27)

for some time in the air when it is blown from the plant. And so the question came to me to wonder if there was any difference in the relation of pappus size to the weight of the associated achene.

From the unnumbered plants I collected nine fully mature complete seed heads of various sizes. The criterion for selection was that the heads range from what seemed to be the largest in the population down to smaller ones, "small" being relative. They were still substantial. In addition to size I selected only those heads that had a full complement of seeds, with no more than one or two aborted ones. I carefully(!) carried the entire heads, one at a time, back to the lab, dried them in a small drying oven, and then, one by one, I dissected each, seed by seed, from the innermost whorl, this being the seeds at the top of the dome-shaped receptacle, to the outermost, this being those seeds at the bottom of the receptacle. Orientation of the seeds reflects the orientation of the florets, inner to outer.

However, from six of these nine heads, I reserved for later use two or more (n=11) intact units (achene with attached pappus) from the innermost whorl and from the outermost, selected by eye as appearing typical of their position class. I saw little variation within each class of the many in it, so I was willing to assume I had little bias in my selection. These eleven intact units from each class from six heads were carefully stored for later experiments, described next.

Dropping the Achenes

I then dropped each reserved intact achene-pappus unit in a quiet, draft-free environment, from a height of two meters off a stepladder, and the fall timed with a stopwatch. I did this ten times for each achene-pappus unit and averaged. Then I carefully separated the pappus from the achene and traced the outline of each pappus then found its area in mm^2 with a compensating polar planimeter. Planimeter? Mettler? Stepladder? Well this *was* a research station. A few of the naked achenes were dropped, but they fell so fast, whether they were "heavy" or "light," I found it impossible with my technique to see a difference in rate. But the fall rate overall of naked achenes was *about* 2.2 meters/sec.

Data Table: Comparison of Inner Achenes vs. Outer Achenes

n=11 for both, values are means

weight area in mg	pappus (mm^2)	fall rate (m/sec)
Inner 4.6 mg	129 mm^2	0.28 m/sec
Outer 7.1 mg	121 mm^2	0.37 m/sec

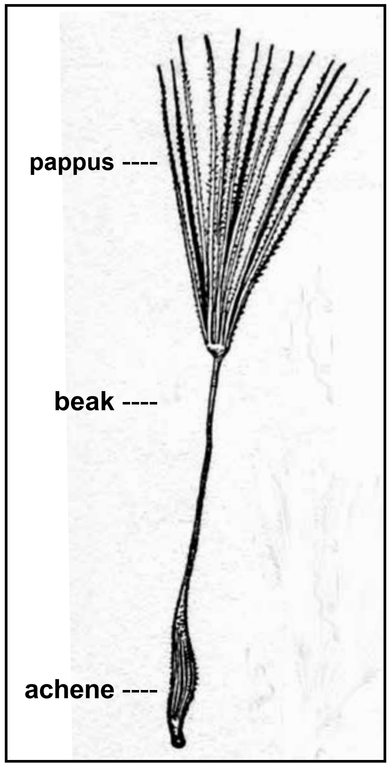

Figure 3. Achenes are the fruit-type encountered in the Aster Family. In *Tragopogon* the achene is attenuated into a beak which is terminated by a whorl of plumes (pappus). Illustration from George H.M. Lawrence (1955), *An Introduction to Plant Taxonomy.*

It is the comparison of the rate of fall of the intact achene-pappus unit, to the weight of the achene-pappus, and the size (surface area) of the pappus that is the basis of the following results and analysis—and some speculative conclusions.

The results from the dropping of intact achenes produced no real surprise. The heavier achenes fell fastest. What was of more interest was the area of the respective pappuses. There was *no* clear positive correlation between the rate of fall of the intact achene and its pappus area. Pappus size was relatively the same for *both* the lighter inner achenes and the significantly heavier outer achenes. Since the outer achenes are the heaviest, relatively speaking the outer pappus seems a *worse* structure for wind transport, as these "parachutes" of *relatively* the *same* size, if not slightly *smaller* than those on the lighter inner achenes, were clearly less effective at retarding the fall of a heavier load. So, these results gave me pause to think about a few aspects that might related to selection in the achenes of this plant. These are all speculation on my part, I emphasize.

Some Speculative Conclusions

One would think that if there were heavier seeds there would be a pressure to produce a larger, more robust pappus for them to compensate, and maintain similar flight characteristics. But what might work against a more substantial pappus? I put forward the idea of a problem of spacing. The seed head of *Tragopogon* is clearly "spherical," with a surface area, divvied up between all of the achenes, and there is only so much area to "distribute" between the pappuses of the achenes. Any selection for a larger pappus for the heavier achenes

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lessens the overall area to be distributed to the pappuses of other achenes, and there must be some upper limit to the size of the seed head. To evolve a larger pappus for a fixed number of achenes would require either a larger area of the sphere of the seed head, and this means more investment in lengthening the beak connecting achene to pappus; or there could be more effective, more substantial outer whorl pappuses with a necessary reduction in numbers of achenes per flower and so have more space to divide up between the jostling pappus of each of the fewer achenes. The *optimum strategy*, which certainly is not contraindicated by my data, seems to be a kind of share and share alike in constructing a pappus. On the other hand it might be that pappuses of significant unequal size are difficult to evolve because this might somehow--and I *emphasize* the uncertainty of the speculation—lead to less successful overall reproductive success, and in the Darwinian sense, lowered fitness.

As I saw, the data give no evidence of any strong difference between the pappus of an outer or an inner achene. They were of similar size (area) but of varied effectiveness, considering the weight of the associated achene. I'd think, then, there are developmental constraints on formation of a pappus such that most of them on the flower are about the same, despite the seed weight variation.

Admitting all of this, it appears that most plants, even with obvious dispersal mechanisms, often do not get their seeds too far from the parent (Harper, 1970). My observation of an event in the field illustrated this. While collecting seed heads, as I was approaching an individual to harvest the head, a gust of wind came up and nearly the entire set of achenes blew off in an instant. Many of the achenes traveled in a clump, an associated unit with other achenes, their pappuses clinging to each other. Even so, those achenes that were single units and attained an unencumbered flight were all on the ground and entangled in low vegetation and debris within four or five meters of the parent plant with the likelihood of further travel seemingly slight. It must be the rare single achene with its pappus that encounters enough turbulence and an unobstructed flyway to ensure a long distance flight. The observation that heavy achenes have worse "parachutes" could be possibly an adaptation that puts some seeds closer to the parent where conditions have favored its success, the lighter ones with nearly equivalent parachutes able to drift farther to hope for patches of suitable habitat: the farther you go, the greater chance of finding one if they are widespread, but scattered. This seems very speculative.

Yet another observation led to another thought. I noted that on many mostly empty receptacles the remaining achenes were the outermost, heaviest ones with their so-so pappuses. That they cling more tightly to the receptacle could mean that it takes a brisker wind to dislodge them and so give them a greater potential flight distance, compensating for the apparent disparity in pappus effectiveness. A selected trait?

Much of all this seems only in the realm of the "possible," but might also be a "just so" story. Still one might conclude that there is little significant difference between achieved wind transport distances of heavy vs. light. Instead, what I saw reflects the selection for the large, conspicuous outer *flowers* here, and the evolution of showy flowers is about pollination, not wind transport. Devoting more resources to these outer florets means there are more resources that could also go to the developing achene, "better fed," but other forces, evolutionary and developmental, lead to a "standard" pappus.

Perhaps the production of varied phenotypes able to effect different transport distances is not to be seen here as a significant selective force producing the variation I saw in the achenes of *Tragopogon*, but is a contingent side effect of other, more powerful selective forces (Gadgil and Bossert, 1970).

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Restoring the Natural Water Flow at West Brook, Oakdale, Suffolk County

John L. Turner
Co-Chair, LIBS Conservation Committee

Figure 1. West Brook flowing free and wild for the first time in more than 100 years. The mucky soils of the drained artificial pond now support a high diversity of native plants including dozens of species of sedges (*Cyperus* spp., *Eleocharis* spp.) and wildflowers (*Gratiola aurea, Persicaria* spp.). The formerly flooded site is revegetating naturally into high quality riverside marsh habitat which provides habitat and food for many wildlife species and is rare on Long Island and perhaps in New York. Photo by John Potente, 30 August 2019.

At the turn of the last century a dam was constructed on West Brook, a tributary of the Connetquot River, in Oakdale just north of Montauk Highway and in one fell swoop, a fifteen-foot wide dam shut off miles of stream spawning habitat, creating in its place a shallow impoundment/pond. This dam permanently blocked access for fish spawning north of the dam in the West Brook system for more than a century. The dam also had adverse impacts to plants as it flooded and drowned countless species of native plants that grew adjacent to the stream including a colony of rare Atlantic white cedar (*Chamaecyparis thyoides*) that had called the stream banks home for millennia.

Fast forward to earlier this year when the dam failed and the pond drained. Suddenly we were presented with a rare opportunity: 1) fix the dam and recreate the artificial impoundment or 2) proceed on a path of restoring the site's original ecological setting. For differing but overlapping reasons the Long Island Botanical Society and the Seatuck Environmental Association support restoring West Brook's natural free-flowing conditions.

For Seatuck it represents a chance to reconnect the stream as one contiguous living system, from its headwaters where it drains from the aquifer to its mouth where it merges with the Connetquot River. A living system in which migratory fish like American eel and several species of river herring can reclaim what was once their birthright of an intact habitat providing all the conditions necessary to create and sustain life.

Retaining the free-flowing conditions provides these diadromous fish a chance to increase their numbers. If this happens not only will the fish species directly benefit but a web of other predatory species is sustained

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too, ranging from river otters, and predatory eagles and ospreys thriving in coastal habitats, to striped bass and tuna patrolling ocean waters.

Retention of the free-flowing conditions also provides the opportunity for plant life, which could not survive in the previous flooded conditions, to prosper. Remarkably, already dozens of native species are rebounding in the muddy, exposed impoundment/pond bottom, as discovered by a recent visit (30 August 2019) by LIBS members Eric Lamont and John Potente and key staff from Seatuck including Enrico Nardone, John Turner, Maureen Dunn, and Emily Hall. Many species of sedges, rushes, and numerous wildflowers already are becoming established (Fig. 1), creating a spreading green blanket over most of the exposed bottom. A small patch of golden hedge hyssop (*Gratiola aurea*), one of my favorite wetland plants that grows along the shores of streams, ponds and lakes and is common in some places in the Pine Barrens, has established itself on the west side of the stream.

Bird species which would not have used the impoundment also are responding to the newly restored habitat; during the visit we saw several species of shorebirds, including semipalmated plovers, least sandpipers, killdeer and a lone spotted sandpiper, feeding in the sand and mudflats. Wading birds like great blue herons and American egrets also stalked the flats.

If left alone the stream will find its own course through the former impoundment/pond bottom setting the community's hydrological elevations and dimensions. Through time a freshwater streamside marsh, filled with dozens of wetland species will emerge, a natural community which is exceedingly rare on Long Island and which has great ecological value. Excitedly, this new habitat could also provide the opportunity to restore some rare native plants species like Atlantic white cedar, which persists in a small stand adjacent to the site.

The dam breaking gives us a rarely given opportunity to restore nature. The Long Island Botanical and Seatuck Environmental Association hope that state decision-makers seize this moment and select river herring, golden hedge-hyssop, and semipalmated plovers over yet another commonplace artificial impoundment and let West Brook flow freely again.

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"In many respects the botanist looks at the world from a point of view precisely the reverse of that of other people. Rich fields of corn are to him waste lands; cities are his abhorrence, and great open areas under high cultivation he calls 'poor country'; while on the other hand the impenetrable forest delights his gaze, the rocky cliffs charm him, thin-soiled barrens, boggy fens, and unreclaimable swamps and morasses are for him the finest land in a state. He takes no delight in the 'march of civilization'; the ax and the plow are to him symbols of barbarism, and the reclaiming of waste lands and opening up of his favorite haunts to cultivation he instinctively denounces as acts of vandalism."

L. Frank Ward, 1881.
In: Flora of Washington, D.C. and Vicinity
US National Museum, Washington, DC.

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Upcoming Programs

October 8, 2019* **Tuesday, 7:30 PM**

Andrew Greller: "Wildflowers of the Island of Crete, Greece." This talk will cover the mountains and seashore habitats of Crete, with many orchid species highlighted from this Bob Gibbons led trip. Coverage will include the Sclerophyll Woodlands of Mediterranean evergreens and the Garrigue shrublands or chaparral type habitats. Andy is Vice President of LIBS and Professor Emeritus of Biology, Queens College. In 2017 he was honored with the Torrey Botanical Society's Distinguished Service Award.

November 12, 2019* **Tuesday, 7:30PM**

Daniel Atha: "New York's Worst Invasives No One Has Ever Heard Of." Eleven non-native plant species have recently been discovered in New York City. Some are highly invasive and pose a serious threat to gardens and natural areas. Hear how they were discovered and learn the key characters for identification. Daniel Atha (The New York Botanical Garden) co-manages the New York City EcoFlora, a community science project to document the wild flora of New York City.

No meeting December 2019!

* All programs held at Bill Paterson Nature Center, Muttontown Preserve, East Norwich
Refreshments and informal talk begin at 7:30 p.m. Formal meeting starts at 8:00 p.m.
Directions to Muttontown: 516-354-6506