The Saga Saga

On September 7, 1970 Ralph Pratt – a Springport, Michigan High School student - ran his lawn mower over a large, spiny insect. He picked up the pieces and jogged to Eleanor Irons' house near Tompkins, a small village in Jackson County. At that time, Eleanor was the Entomology Leader in the local 4H club. Young Mr. Pratt may never have taken a second look at the creature, if it hadn't been for the existence and influence of the "4H-ers" in this farming community. An intimate knowledge of beneficial organisms and pests in this area can be a matter of success or failure of the local economy.

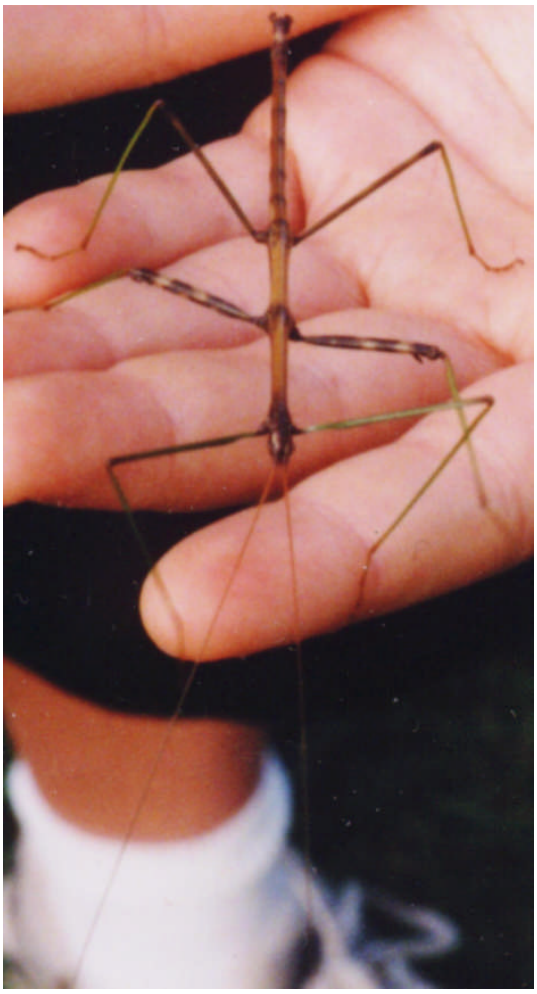
{Saga pedo, cleaning her hind left foot parts.}

Eleanor knew she was looking at a unique and new organism, and so passed it on to several nearby university level professionals for evaluation. A brief reading of Dr. Irving Cantral's 1972 article about this event, and the proper classification of the insect – *Saga pedo* led this author on a two-year chase that spans the US Midwest to wheat fields on an island in the Mediterranean, and includes French insect specialists. Cantral obviously had a strong emotional reaction to the discovery, as he introduced *Saga pedo* as "…a katydid new to Michigan and the New World." He posed the 93 mm specimen "on Clematis, shortly after she died. Arranging a vicious predator on brightly colored blossoms after she died? The only way to make sense of this attitude in a scientist is to spend time with one of these obligate parthenogenic arthropods, oneself. This intrepid bearer of her own clones brings out the best in her fans.

{Eleanor Irons}

An important fact in this story is that the central characters are not slogging, wealthy explorers in pith helmets, slashing their ways through the jungle. They are nurturing adults, and students like the ones in our classrooms. Other interesting twists in the tale are that *Saga pedo* – an imported organism – eats grasshoppers, and is a matriarchal species reproducing asexually. No males have been seen overseas since its classification by Pallas in 1771.

Move the clock forward nearly three decades from that first sighting of *Saga pedo* in Michigan, to the Greek island of Euboea in 1999. On a sunny May afternoon in the short grass across the bay from Almiropotamos, one of her close relatives, *Saga hellenica* looked to me like a cross between a grasshopper, a praying mantis and a stick bug (remember those?), begging to be picked up and examined.



A phasmatid (stick insect) in my son's palm, the Catskills, July, 2001}

When my first *Saga* bit me on the Greek Island of Euboea, I was in a state of curious risk, and was appropriately rewarded: Seeing what looked like a bubble of blood where the mandibles had painfully pinched my finger, I cussed and threw this green five-inch pugilist into the weeds at the base of an old olive tree. He landed like a parachutist, with his spiny arms splayed, crawled through the dry grass & back up onto the porch, and charged me again! Not to be out-done, I poked him gently in the long face with an available broom handle and ran for the camera.

I kept up the taunt, got him (*S. hellenica* are male & female) onto a folding chair, and zoomed in on that face – the long, horse-like mug with two tentative "feelers" tickling the air between the camera lens and the back of the chair. He did a kind of "cha-cha" on four of his six legs, raising the other two expectantly in some primal dance ready for rough, unsure, strategic terrain – a grass specialist, for sure.

I ran out of tape too soon. Picking him up on a piece of paper, I tossed him into the weeds and finished closing up a cottage that I helped build with a friend and fellow traveler Misia Leonard back in the 80's, near Agios Dimitrios:

Cottage notwithstanding, the road between Agios Dimitrios and the bridge at Chalcis is mountainous and gets tortuous and positively slippery with salt spray. To describe the way the roads twist and turn, there's the occasional triangular yellow sign by the rocky side of the road, reading "**συνέχεια**" with an icon of a snake waiting at each turn. Why would a *Saga hellenica* cross such a road? Many meet their end that way, in this era of pedal and metal. It's good to rent a stick shift if you can; you'll wear out the breaks on an automatic and frustrate everyone in your unwilling caravan.

The plane back home was to leave in less than 10 hours. I still had to find an old friend, Aris's new flat in Athens; I'd played with him on his parent's carpet when he was four, and now he'd keep my specimens in his grown-up fridge overnight, in Exarcheia. I drove down the new Olympic freeway to the airport by sunrise the next day, at 4 AM, and made the plane on time.

Since that day, a number of Greeks with whom I shared the experience admitted to the same encounter - curiosity, then a quick pinch and a drop of what looks like blood, but turns out to be a blob of reddish-brown saliva. One acquaintance was relieved and partially amazed that someone else had also had the "fake blood on my finger" experience with a surprised *Saga hellenica* remembered from childhood.

S. hellenica is one of many species in the *Saginae*. These flightless, predatory katydids evolved with their prey, and now patrol the southern European grasslands all the way from Spain to the Ukraine. There is little research available that adequately documents the approximate dates of its spread over the European landscape, as it surely followed its jumping prey into human agriculture. Fortunately, mitochondrial DNA is increasingly being used to reveal migration patterns in plants and animals. The members of a species who have accumulated the most differences in "mtDNA" nucleotide sequences are thought to have been in their location the longest. In a few cases, Saga breeding populations overlap, so species partially exclude each other. This may be the case with *Saga hellenica*, in some parts of the lower Balkans. It's partly true between populations with males (*Saga rammei*) and those without them (*Saga pedo)* in southern France.

One group of researchers – GEEM (Groupement d'Études Entomologiques Méditerranée) - have taken several different Saga "species" and placed them in the same

cages, to find that they are capable of mating. They found that all cross matings with other *Saga* species (*S. natoliae* & *S. rhodiensis* excepted) were possible. The birth & mating of hybrids has already taken place, but due to an average three year hatching time, the jury's still out on whether or not most of these independently varying matings can produce dependently varying fertile offspring. Science? Well, whaddya know!

Former karyotype information exists about these unusual creatures, eclipsed now by recent chromosome work (GEEM again) showing that the matriarchal *S. pedo* is polyploid. The GEEM web page is easy to find, and has many great photos. Here the link to the paper in French (Note again, this often involves groups of students doing the research.):
http://geem06.free.fr//etudesaga/Lemonnier_2007_ASEF_43_2_249_252_compact.pdf

{The controlled environments at the GEEM research centers, in France}

Several years ago, on a return trip to the Greek island of Euboea I caught a male and a female, both located in grain fields, like the ones in Michigan. It took five full days of searching, as *Saga hellenica* is wizard at camouflage. In a green field *S. hellenica* is green. In a field of dried grass, it's brown.

Zaharoula Totos, an old friend from a village near the cottage, took an afternoon to walk me through the fields nearby Lake Dystos where she'd seen them. As long as I would drive her and her girlfriend Eleni to nearby mountain-top churches so they could light candles, they were willing to bounce, laugh and jiggle over the rocky roads of Euboea with me. They waited in the rental car or gathered herbs by the roadside as I walked in the shoulder-high grass of fallow fields, listening for the whispering whistle of the males, often confusing it with similar katydids with wings. (Imagine using meows to locate calico cats in the dark, only to come across tiger tabbies when parting the weeds.) I had only a brief spring break in Greece, and after five or six days of turning my miserable human echo-location talents on among the grain fields, the mood grew urgent.

No matter how concerned or distraught I'd become, Zaharoula and her old girls farming network would always have a classic hearth-cooked pita or delicious fresh fish soup waiting at the end of the day.

{S hellenica male in a jar on Zaharoula's porch, 5/2007}

Saga hangs upside-down, looking like a bloated grain itself, blowing in the breeze. When it walks, it does the cha-cha, gently swaying with the same frequency as a stalk of grass, moving with millions of other stalks, in waves. The back and forth motion is easy to see in walking sticks; it's a kind of behavioral camouflage. Praying mantises sway from side to side before they jump from one spot to another, presumably to judge distance. I noticed these behaviors when, as children, my sister Irene & I would hunt and catch insects in the fields around our 1950's home on Long Island. The *Saginae*, grasshoppers, praying mantises, stick insects and even cockroaches are all *Orthopterans*.

{A praying Mantis found on the gate to the Greek property}

On another trip to Euboea this past July, Zaharoula mentioned that she'd seen *Saga* furtively scuttling across roads shortly after dusk, when a car's headlights would startle them.

{Zaharoula & Eleni, my favorite Greek persons ever…}

I actually tried the idea, and it worked! Several stopped to look into my high beams, but quickly lost themselves in the brush by Almiropotamos bay.

Back in Michigan, next year: Where did this insect come from? Folks in Springport saw the offspring climbing walls – even pants legs – as early as the Fall of 1970.

{Mr. & Mrs. Pratt on their Townley Road farm}

The Pratts (Earl & Floy, Ralph's parents) in nearby Tompkins village also remember an American Classical era when their children entered international plowing contests. The local farmer was king of the land, and southern Michigan was a dreamland of Norman Rockwellian proportions.

Almost mystically, upon entering the town of Springport, a sign presents itself:

It's the advertisement of the **S**pringport **A**rea **G**rowth **A**ssociation. The entire southern tier of the state of Michigan is seen as somehow "depressed" economically. The letters "S.A.G.A." shine out from that blue sign proudly announcing the local township's desire to rise out of someone's definition of poverty. Meanwhile, the entire area is a Brigadoon, the Shangri-La of the Midwest states, blasted as they are by progress, sung about by songs like "My City was Gone" (The Pretenders…"back to Ohio"). The fall of the great Detroit automobile and Music empires has left most folks wondering where they should go when they grow up, unless they take this little piece of heaven for what it is, and continue the tradition of family farming, until the subdivision blues of exurban Chicago arrive, some decades hence.

Considering the fact that it's far cheaper to drive from NYC to Michigan and strike a tent in Jackson County than it is to fly to Europe and shell out for hotels and car rentals, I spent *weeks* two summers ago gently parting the tall grass that borders the fields near Springport, looking for specimens. Frustratingly, I recovered no samples, but what I did find was far more interesting: People came from farmhouses, passing cars and tractors to "shoot the breeze" about science, high school education, their families and ancestors. Children took to helping out, inviting me to meet their parents and grandparents. Before long, this teacher from Brooklyn became a local fixture, attracting reports, sightings and tales from farms nearby.

One resident, Mrs. Keeler, took pity on me and walked over from her son Ben's place to hand me a partially crushed specimen she'd been keeping in her freezer for years. Invited to a prep meeting of the local 4H entomology chapter, I met this amazing group of unsung heroes:

{In the Hawkins' garage, last year}

That's Leona in the lower right hand corner of the photo, me with the NYBTA tee shirt, Eleanor Irons herself (lower center), Mrs. Hawkins, Haley Keeler and Kelsey Hawkins (upper row), dedicated 4H-ers preparing for an insect presentation. They were delighted to learn that someone had taken an interest in this precious organism in their fields again. They showed me where they'd kept a specimen found years before, and even gave me several un-hatched eggs it had injected into the sandy soil of its tank.

{*S. pedo* Eggs, flattened by dryness, Michigan)}

The University personnel who had collected specimens from Eleanor and the local children back in the1970's never returned any information regarding them, and academic interest dwindled when fewer and fewer *S. pedo* were seen.

A recent scientific article declared the North American Saginae to be effectively extinct – but not according to the 4H-ers in Jackson County! On June 20th of this past year (2008) Leona called to proudly announce that she had recovered a juvenile specimen while jogging down the road near her son's house. This was from visual contact only; like the other katydids, it's only the male that sings. Female Saginae have the equipment (a stridulum) but never use it. Leona brought the creature to her grand children, and they began a regimen of catching grasshoppers for it:

"The growth rate is tremendous. She's always bigger than her prey, and even when the hoppers are nearly half her size, this presents no problem to her. She holds her prey with all four front legs, studies it a moment, and then starts with the head." I sent her

a camcorder in the mail, to record as much of the creature's behavior as possible, before I would have the time and money to make that year's trip to Michigan.

In one month, the captured specimen grew from a little more than 2 inches long to nearly 5 and 1/2 inches. During that month, I submitted several grant proposals for mitochondrial DNA amplification and got to work on measuring and photographing the *S. hellenica* and *S. pedo* specimens I had stored in the refrigerator of Brooklyn Tech's Environmental lab. If all goes well, the students in our Environmental major will be scraping tiny bits of muscle from the hind legs of these specimens and running them through the Thermal Cycler we bought with Brooklyn Tech Alumni Association money.

During the last week of August 2008, I made the trip, NYC to Tompkins again. Arriving late, I called the Keelers to set up a bug meeting for noon the next day, and set up a tent in Rockey's Campground, Albion. The next morning, before sunrise, I slowly drove along every road in Tompkins to try the Euboea headlights-trick, but with no sightings. Saga pedo's crepuscular habits here are probably out of synch with its cousin in Greece, as their luck and speed have yielded dead specimens instead of quick ones.

{A road in Tompkins}

Danielle Townsend

It was still early, so I hit a Burger King near the blacktop to Albion for breakfast and it was back to the campground for a shower and a nap before the bug pow-wow. At the Hawkin's place (Dad's a taxidermist) Eleanor, Leona, Danielle the Hawkins & Keeler kids, and *Saga pedo* were already cooking up plans for the next entomology presentation at the big 4-H Club meeting. One student, Danielle – who'd also spent many an hour catching grasshoppers - couldn't make it for the group shot, but mailed a wallet likeness. Eleanor had just had a shoulder replacement, but was as excited as I was to pass the katydid flame on that beautiful late summer day.

{Chase, Isaac, Leona, Kelsey, Haley, Eleanor & pooch}

We photographed the specimen they'd been feeding & recording since mid June. Steve Keeler and Danielle had alternately gathered incredible footage of Saga pedo's feeding & preening displays. We watched it eat preferred grasshoppers and even test the sandy soil in the terrarium with its ovipositor. We all took a little walk together, during which Eleanor bemoaned the fact that she no longer sees blue snakes anymore, since somebody filled in some of the swamps nearby. Leona also expressed interest in the fact that even with all the nut trees lining Brown Road, there are no visible walnut moths these days.

They called ahead to the Pratts for me, and Earl and Floy said "Come on over!" Earl was at the shop having his truck fixed after hitting a deer. Floy and I talked until he came back and I had the pleasure of eating the best peaches I had all summer. Ralph, their son had found the first adult on my 20th birthday back in '70, and is now a 28-year man in the Marines, closing down a camp in Fallujia to give it over to the locals there. David Frick, who found the first whole one, now runs a booming roofing industry in Wisconsin. Merlin Pratt (their son), also mentioned in Dr. Cantrell's article, is presently preaching in Cantor (a suburb of Detroit) with his wife.

When Earl came home, we spoke of the reasons for the appearance of *Saga pedo* in Jackson County. He was of two minds on the issue: One – the local tradition – is that the Losey family, who used to run a big plow-making business accidentally brought back an egg or two in the treads or other crevices on a plow they used for a contest in Italy. The Loseys always denied this as they took great care in cleaning their equipment after international trips, during which their contestants always won…

Another finger points at the 1835 Nicholas Townley family, after whom the road on which the first *S pedo* was encountered, is named: Mr. Townley's descendants were known for importing potted plants. The soil thereof is yet another candidate for being the

horse on which *Saga pedo* rode into town. In any event the question still waits to be answered. Fortunately, *Saga pedo* is here, and carries no diseases for humans or domesticated animals. She is beneficial in the extreme, eating as she does, grasshoppers – pests! Better yet, she is flightless and so is only at the beginning of a long, slow and precarious walk to local success as a species that marginally competes with birds, amphibians, reptiles, praying mantises and mammals for her prey: locusts.

After comparing notes on Iris gardening and commenting on the disturbing presence of bumblebees, I took my leave of the Pratts and shot over to the Reule property on Clement, where I was welcomed by Paula and her husband John, tending a garden best described as a cornucopia. Leona had asked me to meet her there and was several minutes late, so I was given the run of their back yard to search for *Saga* and any grasshoppers I could find to feed the specimen I'd received earlier in the day.

There were hoppers by the dozen, everywhere I looked. All but seven or eight had seen me first by the time Mrs. Keeler arrived with two jars and a butterfly net. We parted the weeds awhile, discussing the survival of this "invader," as the sun finally made its way west. About halfway across the rear border of the property we heard squeaks and hollers from the direction of the house, and saw a crowd gathering by the back door, waving to us. Janet Webb and her grand daughter, Jenna Brewer had just recovered a *Saga pedo* of their own! They had no idea that we'd been at the Reule residence, and had come by to show their neighbors an unusual insect that had just bitten Jim, Jenna's Grandpa. She had it in a plastic peanut butter jar.

{Jenna Brewer}

Leona & I looked at each other in amazement. Both of us had been searching for years for the one she had finally captured last June, and here a neighbor casually walks up with another in hand? The level of coincidence was simply too great. Janet and her grand daughter were incredulous at the idea of releasing it in the back by the neighboring

farmer's soybean crop. But soon the laughter of three adventurous children announced it across the wide open fresh-cut fields.

Coincidence is always the best signpost on a less traveled path, so we all let Jenna's katydid go. The insect cha-cha'd her way into the high grass border slowly, deliberately, and full of eggs. After everybody went back to the house, I stood by, finding Saga and losing her in the weeds, while Leona took shots with the camera and expressed second thoughts about the release.

"Do you want to switch the smaller, less gravid one I fed all summer with this one?" We weighed the value of discovery versus species survival and grew more and more used to the idea that the truly wild one had a better chance of hatching her eggs and surviving in this field than the more domesticated one kept in a terrarium these past two months. "Besides, you and your students will learn an awful lot from the one I had anyway, and you can always come back for another, if you need one."

Leona Keeler, releasing an insect she'd been searching for, for years}

After bidding an anxious but affectionate farewell to the folks at the Reule's place, I shared a picnic-table party with the owners of Rockey's Campground, and wouldn't you know it: *Saga pedo* declaratively injected the sandy soil of her tank with several eggs, right before our eyes! A whoop went up at the campground table and

several cell-phone cameras popped, as the rarest insect in North America strutted her stuff. We named her “Rocky One”

Sadly the specimen became egg bound. Hanging from the screen covering the tank, she actually performed surgery on herself, biting the connection between her abdomen and the ovipositor open, to release an egg onto the surface of the sandy soil of her tank. Not long after that however, another egg lodged itself in the opening and blocked all of the other developing embryos from being injected in the soil. From that point on, she simply grew larger and larger, eating voraciously until early September, the usual end of life’s cycle for this species.

Upon arrival in Brooklyn, I contacted the GEEM folks in France (Michele Lemonnier-Darcemont & Christian Darcemont) to announce the capture and nurture this creature. They were delighted, and we traded of several eggs for their karyotype work there, for French & Italian *Saga pedo* parts for my students to expand their mitochondrial DNA studies. The significance of this geographic spread of samples isn’t lost on any Living Environment student who knows the value of mtDNA in understanding migration and population differences within the same species.

Perhaps it was because I spent many hours hunting for grasshoppers out on Long Island during the time that remained to her, that I became emotionally involved with the tenacity of this determined creature. When she became too weak to chase the prey I’d caught, she climbed up to the lip of the terrarium and permitted me to slake her thirst with a medicine dropper. Not only her eggs, but the very muscles in her legs will carry secrets my Brooklyn Tech students can use.

What information can this give us? Picking out a gene from the mt DNA “plasmid” in any Orthopteran – say the one for generating an enzyme for the Krebs Cycle – should give a good nucleotide sequence. The PCR kits available on the market for Secondary-Ed use already allow students with freshman Biology under their belt to determine which of two ALU haplotypes they are, using a few hair or cheek cells.

Worried that you might not know how to fold this stuff in with your AP or elective course curriculum? Buy a kit! Let go of your class “control” and your students will proudly do the rest. The proteinase, the polymerase, the free nucleotides and other ingredients come neatly packaged for completion of the study in several laboratory periods. Deciding what the primers should look like is a matter of key-wording recent scientific papers done on any other Orthopteran and submitting the sequence of a typical insect enzyme to manufacturers for primer design. Primer pairs are cheap.

Why the interest in this creature? By all rights, it should be classified as an invasive species, but due to the fact that it doesn’t fly, its march over the Michigan landscape has been slow: None have been seen any further than a mile or two from the original sightings back in the early seventies.

The fact that it eats pests makes it attractive in its own right. There is also plenty of room for interstate student collaboration on the collection and processing of data – geographic spread rates from historical and future sightings, reproductive behavior, ways to document the its competition with other consumers in its position on the food chain.

The opportunity for getting secondary students involved with real molecular biology data gathering is immense. In this case, it's a rare insect. In other cases, any arthropod will do. There are many biology teachers in NYC who have wondered what their students are doing with worms, grasshoppers and frogs - when millipedes, moths, cockroaches and mice are far more available and familiar to city dwellers. All of life's forms are the result of the same four nucleotides. What are we doing about it?

How many educators have hobbies like this one? I'll bet that every life science teacher has something to share with our children that can enrich their understanding of how science is done. Our fascinations make science real for our students, and the deeper we get into these objects of curiosity, the closer we and our students get to actually doing research, instead of reading about it and spitting out the proverbial "steps in the scientific method" for a pop quiz.

In the present condition of secondary education, Saga represents virgin territory. All biology teachers who have recently graduated from college (or availed themselves of developmental opportunities like Cold Spring Harbor workshops) know how to pursue this: PCR! A quick trip to the NCBI web page brings our students access to any species-specific sequence they can teach themselves to find. Second-hand thermal cyclers are available at below $1K – and the necessary chemicals are already sold in affordable kits, in coordination with the DNA Learning Center in Cold Spring Harbor.

Doing a little anecdotal research by way of conversations held with children and adults in the area revealed that sightings of *Saga pedo* over the past four decades took place in a generally northwesterly pattern. When plotting them on a map of the area using a GPS device, the trend was an increase in elevation as well.

Returning to the literature easily available about *S. pedo* in Europe, I learned that some are encountered more at one thousand feet above sea level. The land in the Springport area rises in general from about 900 to 1,000 feet, in a northeasterly trend. Has this intrepid invader been walking its way out of the lowlands for forty years? The cheapest and most effective way to test this idea is to involve children – students who play out in the fields all summer and who spend more time where the human and insect paths cross than we adults – even professional researching adults!

I could be wrong about its altitude constraints. Anything could be going on in her advance across the Michigan landscape, and any data coordinating position and time of occurrence is valuable. I copied several hundred fliers last month and mailed them off to the 4-H 'ers to share with local Middle and High School teachers around Springport. The fliers show photos of *S. pedo* and ask for locations and dates that friends & relatives can remember from local sightings.

Back in France, *Saga pedo* is known as "*Le Magicien dentellee*." It took me years of occasionally searching the taxonomic literature and web sites to determine the classification of this creature. Based on the work of the GEEM students, its status may come into question, once the "inter-species" mating shows results. What if they're like horses and mules? Will their babies be as unable to reproduce as a donkey? A recent paper by the Lemonnier-Darcemont couple indicate a wide variety of chromosomal changes in the Saginae: tetraploidy, pericentric inversions, and heterochromatin additions, linking it with *S rammei, S. campbelli, S. hellenica and S. natoliae* on a phylogenetic branch with *S. ornate and S. cappadocica* at its base. Both the people I've met in Greece & Michigan, and the katydid family tree are revealing themselves in a delightfully Dickensian fashion.

Saga pedo eventually left this life one day that September. Not wasting any time on decomposition, I dissected her with the simple tools in an old frog dissection kit, and "delivered" over thirty precious eggs. Several were mailed back to the 4-H 'ers in Springport, and a parcel of ten found its way to Michele Lemonnier-Darcemont in France, where the GEEM students will carefully incubate them over the coming years, to incorporate them into their own research.

There is no doubt in my mind that teachers who have the desire to pursue hunches for their students' enrichment are instantly rewarded by natural and human circumstance. We stand at the leading edge of childhood creativity and blind luck. The only obstacle is our sense of fun and adventure, and the willingness of those around us to participate. <u>We have the summers off.</u> We can accumulate tax deductions by traveling and exploring. And we can gain confidence from those who have come before, like the writers of NYBTA's past research journals (The Teaching Biologist, etc) and manuals for hands-on learning in the classroom.

{The “Extinct” Jackson County Saga pedo with 30 of her offspring.}

This summer, the Keelers called again to announce that Jeff Candill, a member of the local Board of Ed had located two specimens in his back yard. As usual, one was freed and the other, gravid already, was collected. “Rocky Two” died after successfully injecting her eggs into the soil of a terrarium. Her predatory habits mimicked those of the mammalian high-predators in two ways: The dispatch of her prey begins with a quick snip of the (ventral) nerve chord at the neck, and she gorges herself, resting for a day. Convergent evolution? A lion will first leap on a gazelle’s back to tear out one of the (dorsal) neck vertebrae for a relaxing meal, and when full-bellied will find a bough on which to sleep for a long time after eating.

My students and I will be practicing ARC-GIS mapping, and we’ve just received the funds to continue some of the mtDNA lines of inquiry. Those 4H Club members in Jackson county are gathering stories, dates and locations where *Saga pedo* has been and might be seen. The Brooklyn Tech Alumni Association came through with the funds needed to purchase the necessary DNA purification and PCR reagents. I have to order all the chemicals we’ll need to get the mtDNA work going. It’s almost time for the Fall semester again.

And it ain’t over ‘till these valiant, spiny little ladies sing.

John Cunningham,
Editor, ADAPTATION – NYBTA
September 7th , 2009

{Author and Friend}

The Predatory Bush Cricket:

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Orthoptera

Family: Tettigoniidae

Genus: Saga

Species: pedo