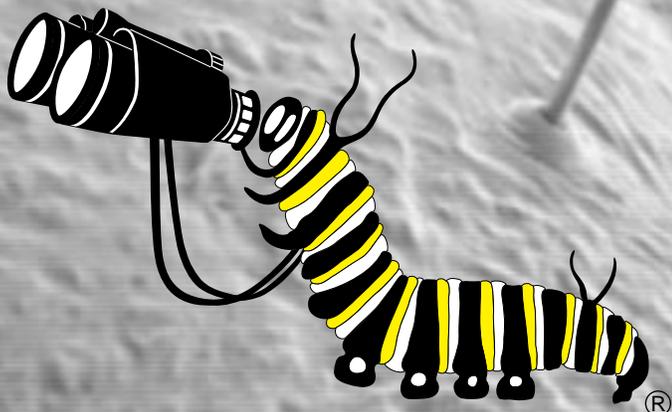


MONARCH WATCH

DEDICATED TO EDUCATION, CONSERVATION, AND RESEARCH

SUMMER 2000 • Vol. 8



1999 SEASON SUMMARY

1999 SEASON SUMMARY

TABLE OF CONTENTS

INTRODUCTION.	3
SEASONAL MONARCH POPULATIONS	5
WHY SO FEW MONARCHS IN 1999?	7
TRANSGENICS AND MONARCHS.	8
MONARCH POPULATION SIZE.	11
MONARCH BREEDING HABITAT	14
LETTERS TO MONARCH WATCH.	17
MONARCH FAIR & TEACHER TRAINING.	18
FEATURED MILKWEEDS.	19
FEATURED TEACHERS.	20
CHALLENGES TO STUDENTS.	22
THE BEST OF DPLEX	24
ADOPT-A-CLASSROOM UPDATE.	26
1999 MONARCH RECOVERY MAPS.	28
1999 SEASON TAG RECOVERIES.	29
OTHER RECOVERIES AND REPORTS	42
ECOTOURISM: BLESSING OR CURSE?	43
40 YEARS OF TAGGING.	44
PROMOTIONAL AND EDUCATIONAL ITEMS	46
NEW PROJECT FOR SPRING 2001.	49
ORANGE MONARCH PUPAE	50
MORELIA MEETING UPDATE	53
MONARCH RECORDS	54
FREQUENTLY ASKED QUESTIONS	56
TECH NOTES	58
MONARCH SPEAKERS.	59
THE MONARCH PROGRAM	60
PAPER MODEL BUTTERFLIES	62
MONARCH BIBLIOGRAPHY UPDATE.	66
REGIONAL COORDINATORS	67
HOW TO REACH MONARCH WATCH.	BACK COVER

Monarch Watch is a cooperative network of students, teachers, volunteers and researchers dedicated to the study of the biology of the Monarch butterfly, *Danaus plexippus*.

Our goals are: to further science education, particularly in primary and secondary school systems; to promote the conservation of Monarch butterflies; and to involve thousands of students and adults in a cooperative study of the Monarchs' spectacular fall migration.

The project is directed by Dr. Orley R. "Chip" Taylor (Department of Entomology, University of Kansas) in collaboration with Brad Williamson (Olathe East High School) and Dr. Karen Oberhauser (University of Minnesota).

Monarch Watch wishes to thank all members, taggers, participants and contributors. We appreciate your enthusiastic cooperation and assistance in furthering the goals of this program.

Thank you to the regional coordinators - without your assistance things would be even more hectic in our lab!

Thank you to all the staff and students at KU who so ably assist with the day-to-day activities of this program - Jim Lovett, Dana Wilfong, Cathy Walters, and the entire Critter Crew.

A big thank you to everyone who contributed to this year's Season Summary, including David Gibo and Janis Lentz for their writing; Cara Weeks for her wonderful illustrations; and Shannon Seider and Larry Gibbs for their excellent work as our resident t-shirt models.

A special thank you goes out to all of you who send us cards, letters, photographs, news clippings, and other neat stuff. It is really exciting for us to see Monarch Watchers in action, and it is very rewarding to learn of the positive experiences that people have with Monarchs and Monarch Watch.

On the cover: What on Earth?! No, this isn't the latest Hubble Space Telescope discovery...this is a Scanning Electron Micrograph (SEM) image of a Monarch larva's head capsule (170x). The three olive-shaped objects are ocelli (simple eyes) and are surrounded by numerous setae (sensory hairs). Even though Monarch caterpillars have six pairs of ocelli, they still have poor vision since these eyes are only capable of detecting differences in light intensity. Photo by Jim, Dana and Cathy.

This publication is funded by tagging memberships, tax-deductible contributions to Monarch Watch and a grant from the Kansas Department of Fish and Wildlife. This year's summary was authored and prepared by Orley R. Taylor (Department of Entomology, University of Kansas, Lawrence, KS 66045) and three exceptional, multi-talented individuals - Jim Lovett, Dana Wilfong and Cathy Walters. © 2000 Monarch Watch. All rights reserved.

INTRODUCTION

With each passing year we've tried to improve the Season Summary. Last year we featured a color photo on the cover for the first time. This year we've incorporated eight pages with color photos into the body of the report.

Without a doubt, the most personal and memorable event of the year for all of us at Monarch Watch was our trip to deliver Adopt-A-Classroom materials to schools in the Monarch Reserve in Mexico. We sent many of you a report describing our adventures on this trip. This summary can be found on the Web site. Our addendum to this report can be found on page 26.

Janis Lentz, the teacher who prepared the Math and Science curriculum distributed with our materials in Mexico, has also written a short description of her students' involvement in this program.

The big story this year was Bt corn and its potential impact on Monarchs. Pollen from these transgenic corn varieties may contain a toxic protein that can kill Lepidoptera larvae if they eat leaves covered with this pollen. The Bt story was a "triggering event" that set into motion an extensive discussion in the media, within environmental groups, and among scientists, about the safety of genetically modified organisms (GMOs). (See recent popular articles, p. 66.) This debate continues. The impact of the Bt corn pollen on Monarchs is an issue which is only partially resolved. Discussions of this topic can be found on pages 8-10.

In this issue, we have a guest contributor, Dr. David Gibo. A long time Monarch researcher and glider pilot, Dr. Gibo has lent his flying/gliding expertise to the development of a text which describes the principles of flight (p. 62). Students can test flight principles by simply photocopying and cutting out the models provided and then flying them according to the directions. The models are designed to have

different flight attributes and we hope the differences among the models will lead to some lively discussions in classrooms as to why Monarchs have certain design features.



Among the photos you will find pictures of orange Monarch pupae. This phenotype has never been described for Monarchs although similar forms are known for butterflies closely related to Monarchs. The story of the discovery and study of this unique color form is described on page 50.

The 1999 fall migration was unusual. Although the population was demonstrably larger than in 1998, taggers, especially those in the Midwest, were not as successful finding Monarchs as in previous years. Some of the reasons for these lower tagging rates are discussed on page 7.

One of the features in this volume is a review of an analysis of the patterns seen in the recovery data (p. 44). This was another record season for tag recoveries. There were 400 recoveries at the overwintering sites in 1998-1999 but over 650 during the 1999-2000 season. We anticipate that the final total for 1999 will be over 700 recovered tags once all the records from Mexico are received. Many new records were established this year (p. 54). Overall,

there was one recapture for every 130 butterflies tagged but the recovery rate was about 1/60 in the Midwest. This rate of recapture is truly remarkable and unparalleled in the annals of mark and recapture studies. Last year I used these data to estimate the size of the fall migration. A similar estimate can be found on page 11; however, the process of revisiting the assumptions used to make the estimate has led me to downsize my estimate for 1998.

If you connected with our office during the last year, you've probably been in touch with Cathy Walters. Cathy has taken over all the record keeping for accounts and tagging. She somehow manages to keep from going bonkers while trying to keep track of all the tagging data and it was an especially difficult job this year. Dana Wilfong is now in charge of special projects and fills in wherever she is needed. Jim Lovett continues to manage the Web site and provide the technical expertise needed in many phases of our operation.

We have instituted a few changes in how we manage Monarch Watch. Because of the large number of tags distributed each year and the difficulties associated with maintaining accurate records, we are no longer distributing tagging kits through regional coordinators. These coordinators were very helpful in recruiting taggers in their areas and we hope they will continue to do so. However, now that we have streamlined some of our record keeping operations, it is simply more efficient for us to distribute all the tagging supplies ourselves.

The tagging program is extraordinarily

EACH YEAR IT BECOMES MORE DIFFICULT TO CHOOSE AMONG THE POSSIBLE ITEMS TO INCLUDE IN THIS ANNUAL SUMMARY. WE APOLOGIZE IF YOUR FAVORITE TOPIC HAS NOT BEEN COVERED. WE WELCOME YOUR SUGGESTIONS FOR INCLUSION IN THE SUMMARY FOR 2000.

valuable. There is no other way to obtain the kind of information this program is providing on the dynamics of the migration and the size of the population. By participating in this program you help to fund this basic research on Monarchs. This is an expensive program and it costs more than \$55,000 per year to coordinate all aspects of the tagging and to publish the Season Summary. Your membership fees only cover part of these costs. More than half of the funds for the tagging program are derived from the sale of promotional items such as t-shirts, educational materials, and contributions.

To recover the costs of this program more effectively, we have restructured the memberships as you can see on the

order form. The changes are relatively minor and will not substantially increase our income or the costs to you. Therefore, we are actively seeking corporate support for the tagging program. If you have any ideas on how we can do this, please get in touch.

Because the tagging program has been more costly than we anticipated, we have established a "Tag Recovery Fund". Contributions to the fund are used to purchase recovered tags from the guides at the overwintering colonies. The guides make an effort to search for the tags among the dead butterflies on the forest floor and the live butterflies as they visit watering sites. The modest incentive (\$5) we offer for each tag has been responsible

for the increased recovery rate.

We wish to personally thank all of you who have participated in or contributed to Monarch Watch this past year. Your support is essential to the program and inspires us to keep trying to improve Monarch Watch.

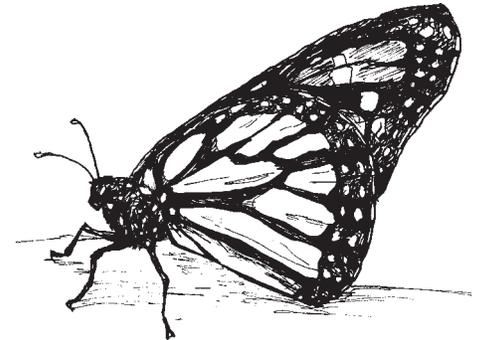


Illustration by Cara Weeks

TOURS TO MEXICO

Anyone can visit the Monarch overwintering sites near Angangueo, Michoacán. Transportation from Mexico City to Angangueo (approximately an 80-mile journey) is available. Many prefer to rent a car in Mexico City and spend the night in Angangueo to get an early morning start. From Angangueo, a local bus can be taken to the Monarch colonies at El Rosario or Sierra Chincua. Another possibility is to take a tour.

The following organizations will lead tours in 2001:

The Natural History Museum of Los Angeles County will host a Monarch Butterfly Safari tour 16-21 Feb 2001. The trip includes a visit to Mexico City to tour the National Museum of Anthropology and Templo Mayor (the Cathedral of Mexico), as well as two days with the Monarchs and two nights at the Don Bruno Hotel in Angangueo. Call 213-763-3350 for more information.

The Monarch Program • 450 Ocean View Avenue • Encinitas, CA 92024 • 760-944-7113 • Monarchprg@aol.com

Meta Butler Hunt Travel Inc. conducts tours to Mexico in cooperation with William Calvert.

Meta Butler Hunt Travel Inc. • 1509 Old West 38th St. • Austin, TX 78731 • 800-759-1509

If you decide to go on your own, there are two hotels in Angangueo that we recommend. The first is the Hotel Don Bruno. This hotel has a beautiful garden in the center as you enter. To contact the Don Bruno, call 011-52-715-600-26 (also a fax number) and ask for Sheela or Engracea. The second hotel in Angangueo is the Hotel Margarita. You can contact them by calling 011-52-715-601-49 and asking for Simon. If you would like to stay in a beautiful resort and don't mind a forty-minute drive to Angangueo, we recommend staying in the San Cayetano. This hotel is run by Pablo and Lisette Span. Their property is in a beautiful secluded area in Zitácuaro. You can contact Pablo or Lisette at 011-52-715-19-26.

Once you arrive at the sanctuary, expect to pay an entrance fee of about 15 pesos (about US\$1.50), to hike up a long mountain trail. At elevations above 10,000 feet, you might find yourself making frequent stops to catch your breath! At Sierra Chincua horses are available to ride up the mountain slopes, which makes it more accessible for those who are unable to make the hike. The trip is well worth the effort. The Monarchs roosting in the mountains and flying overhead will take your breath away.

Here are some traveling hints to help you prepare for the trip:

- Wear layers of clothing. The temperature in the early morning hours can dip into the 30's and daylight temperatures can reach into the 60's.
- Bring comfortable hiking shoes. The hike to the overwintering sites can be long and steep.
- Pack the appropriate film for low light conditions because the Monarchs will be under the forest canopy. Photographing them can be quite difficult and you will be asked not to use a flash, so be prepared.
- If you have a heart condition or a medical problem that interferes with your breathing (like asthma), make sure that you talk to your doctor before making the trip. You will be at elevations of 10,000 feet or more and breathing becomes difficult when you are not used to the lower level of oxygen at these heights.

SEASONAL MONARCH POPULATIONS

In each Season Summary and Premigration Newsletter, I provide a qualitative assessment of the condition of the Monarch population in eastern North America. These assessments are based on reports received from our email discussion list (Dplex-L, which has approximately 500 subscribers), emails, faxes, phone calls, letters, and my personal experience. I wish to emphasize that the assessments are qualitative. More quantitative information on population sizes and dynamics is needed to understand Monarch biology and to develop sound environmental policy if we wish to sustain Monarch populations.

1998 SEASON

The number of Monarch sightings reported to Journey North (www.learner.org/jnorth) in spring 1998 were surprisingly low considering the size of the overwintering population during the 1997-98 winter. The low number may have been the result of a prolonged El Niño related drought that reduced the survival of the overwintering Monarchs and the returning migrants. The number of spring sightings was only about 60% of those reported for 1997 and signaled a generally poor summer and fall for the Monarch population in 1998.

The weather conditions during the 1998 fall migration were extremely mild with few severe weather fronts. This may have aided the survival of the migrants particularly the stragglers since there were a number of recoveries of Monarchs that departed from northern areas as late as early October.

WINTER 1998/1999- SUMMER 1999

In spite of the many indications of a low Monarch population at the overwintering sites in Mexico during the 1998-99 season, the reports of Monarchs seen during the spring of 1999 and the number of eggs and larvae found in many areas early in the summer of 1999 suggested a return to

normal Monarch numbers last fall. There were no reports of weather related mortality during the winter in the colonies and the butterflies seemed to have access to water throughout the season. In March 1999, it was not as dry in northern Mexico and southern Texas as it had been the previous year and these conditions may have been more favorable for the returning reproductive Monarchs. In any case, even though the number of overwintering Monarchs was lower in 1998-99, the number of spring sightings in 1999 was similar to that of 1998.



This male Monarch spent quite some time "sunning" himself to increase his body temperature so that he could fly.

Photo by Jim Lovett, El Rosario, Jan 2000.

The difference between the two years may have been survival of the first generation Monarchs. The last of the first sweep Monarchs, i.e. the overwintering Monarchs, usually complete their migration and die by the first week of May in the Midwest. These few remaining stragglers from the previous fall are actually overlapped by first generation offspring from the southern states, especially Texas, which begin moving north in mid April. These butterflies begin moving into the northern states in the first week of May and in 1999 they arrived in unusual numbers all across the northern tier of states. Karen Oberhauser reported higher numbers of Monarchs than usual in Minnesota and Wisconsin from May through mid July. There are similar reports of good early season numbers of Monarchs in Michigan and Maine. In Kansas, the number of Monarchs appeared to be

average for mid July. On the other hand, Monarch numbers appeared to be down along the mid-Atlantic coast, which was in the throes of a significant dry spell through most of the summer.

FALL 1999

In the 1999 PreMigration Newsletter, I wrote the following:

What are the prospects for the fall migration? At this writing (19 July), they appear to be quite good. Large numbers of new adults are beginning to emerge in the northern states and the females will lay the eggs (mostly from 20 July -5 August) that give rise to the migratory generation. Overall, the migration in 1999 should be better than in 1998 but the migrants will probably be less abundant than in 1996 and 1997 both of which were extraordinary years for Monarchs.

Later, at meetings and in emails, I predicted the overwintering population would be approximately 100 million Monarchs. I boldly made this claim even though the tagging efforts of Midwestern taggers in September were generally less successful than they had been during the last several seasons, including 1998 when the population was clearly down. Possible reasons for the lower tagging success, e.g. favorable winds, are discussed on p. 7 and a discussion of the overall size of the overwintering population (90.5-108.6 million) can be found on p. 11. In making the estimate of 100 million, I was relying on the reports of Monarch reproduction rather than the accounts of the numbers of migrants observed in concentrations along the migratory route. Under favorable conditions the butterflies are not as concentrated and it is more difficult to get a sense of their numbers.

WINTER 1999/2000

Monarchs began to arrive at the overwintering sites in Mexico during the last few days of October - right on time for the 1 November Day of the Dead celebrations in Mexico. By all accounts the winter was mild in Mexico and

there were no reports of winter kill due to severe winter storms. It was a dry winter but not as dry as the 1997-98 El Niño winter. Although water sources dried up and dust levels increased as the season advanced, creating concerns about the impact of tourism on the Sanctuaries and the Monarchs (p. 43), the population seemed to get through the winter in relatively good condition. Curiously, there was a shift in the proportion of the Monarchs at the main colonies this past winter. Eligio García, who measures the size of the colonies, reported that the colony at El Rosario measured 3.78 hectares or 42% of the population of all colonies combined. This was an increase from 2.12 hectares (33%) in 1998. While El Rosario increased, the size of the colony at Chincua decreased to .92 hectares from 1.96, leading to speculation about the impact of tourism on the quality of this site. The two colonies are usually similar in size so the 4:1 ratio (3.78/.92) this year was unusual. Generally, the colonies at El Rosario and Chincua represent 60-70% of the total overwintering population but this year only 52% of the Monarchs overwintered at these two sites. How Monarchs select overwintering sites is not known. The importance of characteristics of the forest habitat and the influence of proximate factors, such as weather or disturbance, is unclear. Continued monitoring of the overwintering populations will be needed to establish the factors that determine yearly differences in the use of the overwintering locations.

SPRING 2000

Monarchs are off to the best start since the spring of 1997. Modest numbers of Monarchs were reported in Texas in late February. Despite the extremely dry conditions in much of the state and an abundance of fire ants in many locations, Monarchs appear to have reproduced with sufficient success to produce the wave of first generation adults which swept northward to colonize the northern part of the milkweed habitat. The recolonization is shown on the map from Journey North p. 42.

Will this fine start translate into a large fall population? It is too early to make a prediction. However, there is an ominous sign of drought in the Corn Belt, the heartland of Monarch reproduction. The drought, as of mid-May, covered most of the corn belt and this area, according to the isotope work of



These critters were among the first generation of Monarch caterpillars that we observed here in Lawrence, Kansas this spring. Young Monarch larvae seem to prefer to feed on the tender apical leaves of milkweed plants.

Photos by O.R. Taylor.

Wassenaar and Hobson (1998)*, accounts for 50% of the Monarchs that reach the overwintering sites in Mexico. Weekly updates on soil moisture conditions throughout the United States are available online at <http://enso.unl.edu/monitor>.

A few years ago it was easy to dismiss long-range weather predictions, they simply weren't very reliable. The present weather models are much more accurate, so these forecasts are of real concern. It will be an interesting season and we will have an update on the status of the Monarch population in the Premigration Newsletter.

*See the 1998 Season Summary for a report on this research. It is available for download as a PDF file on our Web site and hard copies are also available while supplies last - see the order form for details.



VIDEO BRIEFS

Last year Monarch Watch assisted Japanese and British film crews with the filming of Monarch related videos. The Japanese film crew from Field Life, Inc. out of Tokyo produced a 30 minute program "Spaceship Earth: The Amazing Monarch Migration" which aired on Japanese public television in the fall of 1999. The program focused on the mystery of the Monarch migration and featured Mexican researcher Eduardo Rendón as well as Dr. David Gibo from the University of Toronto. The video includes spectacular footage of Monarchs leaving Mexico in March, and stages of the life cycle (videotaped at Monarch Watch). The film emphasizes education and features the three country connection made through schools participating in Journey North. Unfortunately, this wonderful video did not air in the US.

The British Discovery Channel project "How Animals Tell Time" was also produced with the help of Monarch Watch. The British film crew came to Lawrence in September of 1999 and the special aired in January 2000 on Discovery's Animal Planet. Dr. Taylor contributed to two topics in the production. In the first portion of the special, Dr. Taylor reproduced a feeding experiment which demonstrates that honeybees can tell the time of day. In another segment Dr. Taylor and Dr. Gibo's altitude angle theory of the Monarch migration was discussed. In broad terms, the migration appears to follow the declining and increasing altitudes of the fall and spring sun in a predictable fashion. To date, all the data seem to be consistent with this theory and Drs. Taylor and Gibo are preparing a manuscript on this topic.

WHY SO FEW MONARCHS IN 1999?

Appearances can be deceiving and many of us were deceived by the fall migration. Last summer we heard of large numbers of Monarchs breeding throughout the northern states from the Dakotas to Maine with substantial numbers in Ontario and Quebec as well. We expected a larger migration than in 1998. I had predicted the wintering population would be approximately 100 million Monarchs; so, it was a surprise when fewer than usual Monarchs were reported and tagged in the Midwest during the migration. At the same time, record numbers of Monarchs were reported along the East Coast, particularly at Cape May. Each fall Dick Walton, in collaboration with Lincoln Brower and numerous volunteers, monitors the Monarch populations at Cape May for eight weeks beginning on 1 September. The number of Monarchs observed during the first two weeks was within the normal range but in the third week the number observed in the census was above normal (106). The fourth week produced an average of 181 Monarchs, the second highest number recorded per week during the previous seven years. Then, weeks five through eight produced a whopping 463, 475, 409, and 358 Monarchs respectively. These numbers are extraordinary for several reasons. First, the mean for all the census records for 1999 is 329, which is three times greater than the means recorded during any of the previous seven years. Second, the numbers recorded each week of October were exceptionally high indicating large numbers of Monarchs were migrating late in the season. For example, the mean number observed during the census in the eighth week is 60 for the previous seven years but in 1999 the number was six times greater (358). The highest number of Monarchs is usually recorded in the fourth and fifth weeks each season; however, in 1999 the peak weeks were the fifth and sixth.

FOR MORE INFORMATION ON THE ANNUAL MONARCH MONITORING PROJECT AT CAPE MAY, VISIT THE PROJECT'S WEBSITE AT: www.concord.org/~dick/mon.html

How can we account for the high number of Monarchs at Cape May and the lower number observed and tagged in the Midwest? Remember Hurricane Floyd (15-17 September) and the subsequent storms along the Atlantic coast last fall? These weather patterns were dominated by strong winds from the south. Monarchs tend to accumulate in sheltered places and on peninsulas such as Cape May if head winds from the SW, S, or SE exceed 15 miles per hour. It is under these conditions, which are often present during the migration in the Midwest, that the largest numbers of Monarchs are usually seen. At the time the storms from the south Atlantic were pounding the East Coast, the weather pattern in the midwest was dominated by low winds at ground level and upper level patterns that facilitated high altitude transport of Monarchs to the SSW. Monarchs use thermals to gain altitude under the

proper conditions and will migrate at 1000-5000 feet. When this occurs, relatively few Monarchs are seen at the usual clustering areas and we can easily get the impression that the population is low when, in fact, the Monarchs are moving through in large numbers but beyond our field of view. To stress this point, Dr. David Gibo related that when he was tracking Monarchs with Wayne Wolf in Texas using radar, Wayne estimated, based on radar images of Monarchs flying overhead, that 12,000 butterflies had passed through a 1 km window during the ten hours of migration on 22 October. During the same interval, David saw only seven Monarchs at ground level.

So, were the populations in the east the largest in the last eight years or were the Monarchs simply more concentrated because of the weather patterns? It's hard to say. Perhaps both. The numbers of Monarchs reported in Quebec, eastern Ontario, and New England were high. However, the curl of the counterclockwise rotation of the east coast storms may have directed a large number of Monarchs SE toward the coast concentrating them in a manner that gave the appearance of an extraordinarily high population.



Dr. David Gibo (right) and Wayne Wolf in front of the radar unit they used to track Monarchs flying overhead. Photo contributed by David Gibo.

TRANSGENICS AND MONARCHS

Recent advances in genetic technology make it possible to isolate a gene from one species and insert it into the genome (DNA) of another species. If the splice is successful, and many are not, the introduced gene is expressed in succeeding generations. Many crops have been modified to incorporate a crystalline endotoxin, a protein, from a bacterium known as *Bacillus thuringiensis* (Bt) into their tissues. Lepidoptera are susceptible to this toxin and once tissue containing this protein is consumed by a larva it binds to the epithelium of the gut, creating pores in cells which disrupt digestion and allow entry of pathogenic bacteria that multiply and kill the larva. The idea, of course, is to provide the plant with an internal defense against herbivores. This method is considered safe since the data thus far indicates the Bt protein is not toxic to vertebrates and breaks down rapidly in the environment.

The first Bt corn (Event 176 developed by Mycogen) was approved for commercial use in August 1995. Four other Bt corn hybrids BT11 (Novartis, August 1996), Mon810 (Monsanto, December 1996), CBH35 (AgrEvo, March 1997), and DBT48 (Dekalb, March 1997) were subsequently approved. Widescale planting of Bt corn began in the spring of 1997. Twenty-five million acres of Bt corn, 32% of the U.S. corn crop, were distributed throughout the corn growing regions by 1999. This is an amazingly high rate of adoption of a new product. Once concerns were raised about Monarchs, it was evident that the issue might not be trivial, based upon the extensive Bt corn acreage.

In the 1998 Season Summary I expressed concerns about the rapid adoption of genetically modified (GM) or transgenic crops in U.S. agriculture and their possible impact on Monarchs. The use of corn and soybeans genetically modified to resist applications of herbicides could lead to

significant reductions of milkweeds within and adjacent to these row crops thereby reducing the milkweed base upon which the Monarch population depends. The implicit assumption in this reasoning is that Monarchs are dependent on the milkweeds that "contaminate" cropland. The number of Monarchs produced in different



Common milkweed (Asclepias syriaca) in a Lawrence, KS corn field.

Photo by O.R. Taylor.

habitats, is not well understood. However, there are two reasons for concern about the potential loss of milkweed within cropland. First, the recent paper by Wassenaar and Hobson (1998) shows that 50% of the Monarchs at the overwintering sites in Mexico originate from the most intensely farmed region of the midwest. Secondly, our Geographic Information System (GIS) analysis (p. 14) indicates that there is too little non-agricultural habitat to support the number of Monarchs in the migratory population. Agricultural practices and land use patterns are certainly related, now and in the future, to the size of the Monarch population.

Last year when preparing the 1998 Season Summary, I was aware that John Losey et al. were about to publish their paper in *Nature* (20 May) showing that 44 % of second instar Monarch larvae died after 72 hours of feeding on milkweed leaves dusted with Bt corn pollen. Nevertheless, I was unprepared for the response of environmen-

tal groups, concerned citizens, and the media to this finding (see Popular Articles in Bibliography p. 66). Because I know something about Monarchs, the media and others, assumed I had something to say about Bt corn and Monarchs and later, on the kinds of research needed to determine if Bt corn pollen significantly affects the

Monarch population. Thus, I found myself drawn into the Bt controversy and the subsequent research efforts. The following account is a general summary of the research done on Bt corn and Monarchs in 1999 as well as some of the topics for future study.

SPECIFIC RESEARCH FUNDED IN 1999

The outcry over Bt corn, and the issues raised with respect to Monarch conservation, resulted in an immediate push to assess the magnitude of the potential impact of Bt corn pollen on Monarchs. To facilitate this assessment, the biotechnology companies agreed to support research during the 1999 season through BIO, the Biotechnology Industry Organization. Partly due to the short time frame, the studies were limited to the toxicity, the temporal and spatial distribution of the pollen, and the overlap of Monarch life stages with the timing of anthesis (shedding) of corn pollen across the corn growing regions. Preliminary surveys were conducted to establish the

distribution and abundance of milkweed adjacent to and within corn fields. Funds were not available to determine the mortality of Monarch larvae exposed to Bt pollen under field conditions.

The following is a brief synopsis of the questions addressed by researchers and the preliminary answers derived from research in 1999.

How toxic is the pollen from the Bt corn hybrids? The Bt events differ in their toxicity. Event 176 was engineered specifically to enhance the expression of the toxin in the pollen. Toxic pollen was seen as a way of killing second generation corn borer larvae that tend to consume pollen in the leaf axils before boring into the stalks. Ironically, Event 176 is not considered to be effective against second generation corn borers and its use is geographically restricted (www.oznet.ksu.edu/ex_swao/entomology/latest.htm). In 1999, only 3 million acres of Event 176 were planted throughout the United States. It is this Bt corn hybrid which is the greatest threat to Monarchs. Several laboratory tests have shown pollen from Event 176 to be highly toxic to first and second instar Monarchs, more so than Mon810 or the Bt11 used in the Losey et al. study. In high concentrations, pollen from Bt11 and Mon810 can kill Monarch larvae, and in moderate to low concentrations it noticeably delays larval development. The significance of this effect is not yet known. Pollen from CBH35 and DBT48 does not appear to be toxic to Monarch larvae due to low expression of the protein.

How extensively do Monarch immature stages overlap with the anthesis (shedding) of Bt corn pollen? Models of the periods of corn anthesis and the development of successive Monarch generations through the seasons suggest that the overlap is low at the southern extreme of the corn belt but becomes almost synchronous in late July and August in the northern half of the corn belt.

How long is the toxin active in the pollen? The toxicity of Bt corn pollen appears to decline under field condi-

tions after five days.

What is the shadow cast by corn pollen? Although corn pollen is wind dispersed, it is heavy. This results in a concentration of pollen, in terms of grains per square centimeter, that falls off rapidly with increasing distance. Combining this spatial distribution with data on the toxicity of the pollen suggests that Monarch larvae feeding on milkweed more than three meters from the edge of a corn field would not be exposed to lethal doses of pollen.

Is milkweed common within corn fields? Surveys conducted in 1999 substantiated that milkweed is relatively common in field margins. More importantly, one survey established milkweed to be relatively common within corn fields.

WHAT STILL NEEDS TO BE DONE?

The research in 1999 provides us with many answers concerning the Bt corn/Monarch relationships. Yet, many of the critical studies have not been done and, in many respects, the results should be considered preliminary. We list some of the research issues and questions that have been considered for further study below.

Are all Monarch larval instars susceptible to the toxins in Bt pollen? All the toxicity studies to date have utilized first and second instar larvae. These small larvae are susceptible to the Bt toxins but it is not known whether larger larvae exhibit a degree of resistance to Bt toxins, as observed in other Lepidoptera.

What is the significance of the delayed development of Monarch larvae exposed to Bt toxins? In a number of the laboratory tests, Monarch larvae fed sublethal doses of Bt pollen showed delayed development. The studies were terminated before it was established whether these larvae would have survived to the adult stage. There are a number of reasons why delayed development might be as significant as direct mortality, so this factor will be studied further.

What is the half-life of the Bt toxin in the corn pollen? The preliminary stud-

ies suggest that the pollen and toxin begins to degrade after five days but much more information is needed since field conditions differ greatly from region to region.

How can toxicity and susceptibility be quantitatively assessed in both the laboratory and the field? Toxicity and susceptibility are surprisingly complicated. There are three types of Bt corn hybrids in use with different expressions of Bt in the pollen and there can be differences in susceptibility of the Monarchs due to differences in larval stage, physical conditions and genetics. It will take several years to work out these relationships.

What is the post harvest persistence of the Bt toxin in the soil? There are a number of non-target, yet biologically important, soil organisms that might be affected by the presence of Bt toxins in the soil. A recent study indicates root exudates of Bt corn contain the Bt toxin which retains its insecticidal properties. The toxin adhered to the colloidal (clay-like) particles and humic acid in the soil and persisted through the eight month study. In light of this study, the persistence of Bt is likely to be re-examined.

Are other non-target species affected by Bt toxins? Over 100 potentially susceptible Lepidoptera are known to occur within and adjacent to corn fields and there are a number of soil organisms whose susceptibility to Bt toxins is uncertain. The exposure and susceptibility of these species to Bt toxins deserves further study.

Do Monarch larvae in the field die as a result of exposure to Bt toxins? The preliminary answer to this question is yes, based both on experimental evidence and theoretical grounds. However, due to the distribution of pollen immediately adjacent to corn fields, these results cannot be used to answer the impact question. The ultimate goal is to define the impact of Bt corn on Monarch populations. The three meter danger zone to Monarchs surrounding the fields constitutes an extremely small portion of the milkweed/Monarch habitat. If we want to answer the impact question, we must

establish the distribution and abundance of milkweed within the 25 million acres of Bt corn and the extent to which Monarchs use these milkweeds as hosts. Further, we need to know the relative survival of Monarch larvae within these fields. Because corn fields generally lack a high diversity of predators and parasites, it is possible that Monarch production is higher than in the field margins or other diverse habitats.

What loss of Monarchs due to add-on (human assisted) mortality constitutes a significant impact and how might a negative impact be mitigated? From the point of view of Monarch conservation, any negative impact is undesirable. However, from the point

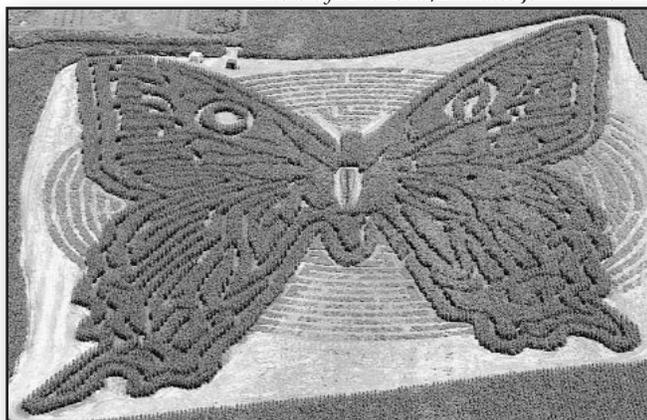
of view of the Monarch population, we need to know whether the negative effect will be additive, driving down the population, or whether the impact will be compensated for by some other population process or interaction. Mitigation is an issue that also requires study. Can the impact of add-on mortality be modified by changing land management practices and restoring milkweed habitat?

Lastly, we have to ask if we have missed anything. To answer this question we must review all of the

completed and proposed studies to be sure that all issues have been considered. These reviews often reveal interactions or properties of the system that have been overlooked.

There should be more to report on Bt corn and Monarchs after this growing season.

Photo by Mike Yoder/Lawrence Journal-World.



THE AMAZING MAIZE MAZE

As the Legend goes: If anyone desires a wish to come true, they must first capture a butterfly and whisper that wish to it. Since a butterfly can make no sound, the butterfly can not reveal the wish to anyone. In gratitude for giving the butterfly its freedom, the wish is granted.

This is the second year for a corn maze at Pendleton's Country Market (1446 E. 1850 Road, Lawrence, KS). Last year's turtle maze attracted about 5,000 visitors from forty different countries and all but three states. Stan Herd is known for using natural materials to create massive works of art that are best viewed from the air. This year's "Butterfly Wishes Maze" covers eight acres and is constructed of corn and soybeans.

If you would like to visit the Butterfly Wishes Maze, it will be open Monday through Saturday (8am to dusk) and Sunday (1pm to dusk) through Labor Day. The cost for touring the maze is \$7.00 for adults, \$4.00 for children ages 4 to 12, and free for children 3 and under. Monarch Watch will have a tent with Monarchs and milkweed set up along with other educational items and posters at the butterfly maze for those of you interested in visiting.

BT CORN AND MONARCHS AS A SYMBOL OF LARGER ISSUES

An avalanche of publicity and public debate, both in North America and Europe, about the costs and benefits of transgenic technology followed the release of the article by John Losey and his colleagues on the effect of Bt corn pollen on Monarch butterflies. It was clear from the outset that the response was out of proportion to the importance of Monarch butterflies in the minds of the public. The Monarch came to symbolize larger issues and deep-felt fears and suspicions of a new technology that is poorly understood by the public. Concern about the safety of this technology has been simmering for some time but the activists lacked the smoking gun needed to get the attention of the public. The Losey article seemed to provide the evidence needed to call the safety of genetically modified organisms (GMOs) into question and the publication of this article became what media analyst Eric Abbott* called a "triggering event" - an event which catalyzes activities and debate and polarizes opinion. Monarchs were denigrated as the panda bears of the insect world by some while they served as the basis and justification for law suits and fund raising efforts by others.

The public debate on the pros and cons of GMOs continues in news articles and on discussion lists to this day. In many similar cases, such news stories lose their punch with time, public interest wanes and even the media gets bored with repeated coverage of the same issue. Will this be the case with GMOs and Monarchs? Research to date has provided half an answer to the question - "what is the impact of Bt corn on Monarch butterfly populations?" The preliminary studies can be interpreted to suggest that the impact may be low but the REAL impact issue has not been dealt with. Research is needed to establish the extent to which milkweed occurs in corn fields, the degree to which Monarchs use these milkweeds as hostplants, and the extent to which Monarch larvae exposed to Bt pollen in corn fields die as a result of this exposure. If, once this research is completed, the impact on Monarchs is determined to be low the environmental concerns may fade. However, I would expect the food safety issue associated with GMOs to persist. If, on the other hand, Monarchs and/or other non-target species are shown to be negatively impacted by Bt corn pollen, the debate about the environmental impacts of GMOs will be renewed - with vigor.

*Iowa State University, presentation to the USDA conference on Monarch butterflies and Bt corn in Kansas City, February 2000.

MONARCH POPULATION SIZE

Using the tag recovery data, I was able to derive an estimate for the migratory population in the fall of 1998 (294-360 million). This was a first, only made possible because of the large number of recoveries (400) at El Rosario, the principal overwintering site in Mexico. The number of recoveries at El Rosario was even higher this year (597 as of 1 May). Using the same logic employed last year, I estimate that there were roughly 505 million Monarchs in the 1999 migratory population. The method and assumptions used to reach this estimate were outlined in the 1998 Season Summary and will not be repeated here. Rather, I will provide the background for making the estimate and then will explain a slightly different approach, which yields a lower estimate for the size of the fall migratory population for both years (182 million for 1998 and 252 million for 1999).

ESTIMATED POPULATION PARAMETERS

To derive the estimate for population size, it was necessary estimate the:

1. total area occupied by Monarchs at all overwintering sites (9.05 hectares).
2. number of Monarchs (density) per hectare (10-12 million).
3. proportion of the total area represented by the Monarchs at El Rosario ($3.78 / 9.05 \text{ hectares} = 42\%$).
4. total number of Monarchs tagged (73,519).
5. rate of mortality of overwintering Monarchs from the time of their arrival to the time when most tags were recovered (50%).

SIZE OF THE OVERWINTERING POPULATION

The total area occupied by Monarchs this past winter was estimated by Eligio García Serrano (Calderón et al. 2000) to be 9.05 hectares (1 hectare = 2.2 acres). If we use the Brower (10 million) or Calvert (12 million) estimates of Monarchs per hectare, the estimate

for the overwintering population is 90.5 - 108.6 million Monarchs. The population at El Rosario occupied 3.78 hectares (about 42% of the total) and therefore had approximately 38.0-45.6 million Monarchs early in November/December 1999. For the purpose of simplifying all the calculations in this report, I will use the higher estimate, 45.6 million (12 million Monarchs/hectare).

NUMBER OF MONARCHS TAGGED

During the fall of 1999, we issued approximately 248,000 tags but only a portion of these were used. There are three ways to estimate the number of Monarchs tagged. The most direct method is to use the returned datasheets. We can average the number of records per page (with several subsamples) and multiply this by the total number of pages of records. A less direct method is to look at tagging records from people who tagged large numbers of Monarchs and estimate the mean number of recoveries in Mexico per number tagged. A third method is simply to add the estimated number of unreturned data sheets to the estimated number of returned data sheets. The first method yields an estimate of 62,788 Monarchs tagged. The second method yields a rate of 1 recovery per 130 Monarchs tagged; therefore, 597 Monarchs recovered in Mexico leads to an estimate of 77,610 Monarchs tagged in 1999. The third estimate derived from the number of returned combined with unreturned data sheets is 73,519 Monarchs tagged. This is the most realistic estimate and the one I will use for these calculations.

SURVIVAL OF TAGGED MONARCHS

If we tagged 73,519 Monarchs, and these Monarchs arrived at random at all of the colonies, as suggested from the isotope study (Wassenaar and Hobson 1998), and El Rosario contained 42% of all the overwintering Monarchs, the maximum number of

tagged Monarchs at El Rosario would be 30,878. However, some unknown portion of the Monarchs does not survive the journey. Although we don't know the number that die on their way to Mexico, we can ask how many tags would be "at risk" (i.e. available for recovery) if certain percentages survived through the principal period (January-March) during which tags are recovered. Mortality increases steadily through the overwintering period and differs yearly and among roosts. As a simplification, I've assumed that 50% of the initial late November population was alive during the recovery period.

The maximum number of tags at risk of recovery at El Rosario if all tagged Monarchs survived (42% of 73,519) is 30,878. If we assume that 25-75% of the Monarchs that arrived at El Rosario are alive in late winter when most of the recoveries are made, we can bracket the ratios of tags at risk to the total number of Monarchs in the population. This gives us the number of butterflies alive per tag.

If 75% of all tagged ($23,159 = 30,878 \times .75$) and untagged Monarchs survive to the time of recovery, and 597 are recovered, the recovery rate is 2.6% of the tags at risk and there is one tag per 1477 butterflies in the population at El Rosario (34.2 million).

If 50% of all tagged (15,439) and untagged Monarchs survive to the time of recovery, the recovery rate is 3.9% of the tags at risk and there is one tag per 1477 butterflies in the population.

If 25% of all tagged (7,720) and untagged Monarchs survive to the time of recovery, the recovery rate is 7.7% and there is one tag per 1477 butterflies in the population.

Under these conditions the recovery rate increases but the ratio of tagged to untagged butterflies remains the same.

These estimates of the tags at risk bracket the possibilities, but we don't really know whether the number at risk was closer to 7,720 or 23,159.

We can interpret these recovery rates as the percentage of all butterflies alive that had to be viewed to recover 597 tags. If, for example, there were 15,439 tags at risk, to recover 597 tags (1477 butterflies viewed per recovery) would have required the local searchers to view 881,769 Monarchs or 3.9% of 22.8 million butterflies in the population at El Rosario.

SEARCH EFFORT

We don't know the amount of search effort (number of person hours) involved to find 597 tags. Searching is concentrated along the watercourses being visited by the butterflies. The butterflies are concentrated at these water sites 2-6 hours per day depending on the temperatures and cloud conditions. The question is what proportion of the total population of Monarchs at El Rosario were viewed by the searchers over the entire search period? Finding the tags isn't easy or quickly done. There are possibly 2160 guide days per season (approximately 18 guides/day for the 120 day season) or 3.6 guide days per recovered tag. This seems low but some guides don't actively search for the tags and on many days the butterflies don't fly or visit water making it difficult to search for tags. The rate of return (tag recovery) per unit effort and the number of butterflies surveyed per unit time are essential to our estimate. Given the number of tags recovered by the guides who actively search for the tags, the recovery rate is roughly one tag per 1-3 hours of searching but we don't know how many butterflies they scan to achieve this rate of recovery.

All the butterflies can not be viewed to see if they are tagged due to their positions in trees; therefore, we have to make some additional assumptions about the average number of butterflies viewed to recover a tag or the percentage of the population viewed by those seeking tags.

If we have an estimate of the percentage of the total population that was viewed, we can estimate the average number of butterflies that must have been viewed to obtain each tag.

If the search effort viewed 50% (11.4

million) of all Monarchs surviving at El Rosario, assuming half (22.8 million) are alive, to find 597 tagged butterflies, the searchers found 1 tag per 19,095 butterflies and there were 1194 (2 x 597) or 3.9% (1194/30,878) tags at risk at the time of recovery.

If they scanned 25% of all Monarchs and found 597 tags, the searchers found 1 tag per 9,548 butterflies and there were 2388 (7.7%) tags at risk at the time of recovery.

If 12.5% were viewed, there was 1 tag per 4,774 butterflies and about 4776 tags (15.5%) tags at risk at the time of recovery.

If 4% were viewed there was 1 tag per 1528 butterflies and about 14,925 tags (48.3%) at risk at the time of recovery.

There is an axiom of ecology known as "giving up time". This concept has been applied to predators that search for prey e.g., a Great Blue Heron searching for frogs and small fish. How long would, or should, the bird search unsuccessfully in one place before leaving to search at another location? This return per unit effort concept applies to the recovery of tags. How many butterflies would you scan without finding a tag before you gave up the search? Or, stated another way, how often would you have to find a tag to keep searching? The answer depends on the motivation of the individual searcher. Nevertheless, it seems unlikely that many tags would be recovered if tags were as few as 1/10,000 or less.

SIZE OF THE MIGRATORY POPULATION

We still have to make assumptions, so let's assume, as we did in 1998, that to make 597 recoveries the local people viewed 18% of the butterflies (4.1 million viewed, one tag per 6,868 butterflies and 3317 tags at risk in the total population). Again, we are assuming half the butterflies that arrived at El Rosario are alive through the search period. We have already assumed 50% mortality for the total population and if 3317 is 50% of the number of tagged butterflies that arrived at El Rosario, then the total number of tagged butter-

flies that arrived was 6634. If 73,519 were tagged, the percentage arriving at El Rosario (6634/30,878) is 21.5%. If this is a realistic estimate of survival, what does this say about the size of the entire migratory population? If the mortality rates are similar for tagged and untagged Monarchs, and the 45.6 million Monarchs that arrived at El Rosario are only 21.5% of those that attempted the journey, the total number that started the migration toward El Rosario is 212 million. Since El Rosario represents 42% of the butterflies and we assume the same relationships hold for the entire population, then the estimate for the fall migratory population becomes 505 million.

I'm not satisfied with this analysis, or the one for 1998. For both years, the estimated size of the migratory population seems too high. The projections are based primarily on the arbitrary assessment that the searchers viewed 18% of the population to recover the tags. This seems reasonable but it results in an estimate that 80% of the Monarchs do not survive the migration.

If we use 9% viewed as our estimate (2.05 million viewed, one tag per 3434 butterflies and 6633 tags at risk in the total population) the following scenario is created. We have already assumed 50% mortality for the total population and, if 6633 is 50% of the number of tagged butterflies that arrived at El Rosario, the total number of tagged butterflies was 13,266. It follows that, if 73,519 were tagged, the percentage of Monarchs surviving to reach El Rosario increases (13,266/30,878) to 43.0%. Again, selection of 9% is arbitrary but it seems more realistic in light of the probable search effort. In this scenario, the estimated number of migratory Monarchs headed for El Rosario for the fall of 1999 is 106 million and for the entire population is 252 million. Using the same approach retroactively to the 1998 data yields an estimate of 182 million. Both of these estimates are more in line with the production of Monarchs expected based on our analysis of available breeding habitat (see p. 14).

After struggling with this estimation procedure again, I can see that I've not only made it too complicated but I've confounded the analysis by trying to separate the mortality during the migration and at the overwintering site. Let's revisit the basic way of deriving a population estimate from mark and recapture to see if we can arrive at a better way of estimating total mortality from the time of tagging through the period of tag recovery. The basic formula for the Lincoln-Peterson Index to estimate the size of a population is:

$$\frac{\text{Number marked in sample}}{\text{Total caught (viewed) in sample}} = \frac{\text{Number marked in total population}}{\text{Total population size}}$$

Usually we know three terms in this equation and we solve for total population size. In this case, we only know the number marked (recaptured) in the sample (597) and the total population size (45.6 million). We don't really know the total caught, in this case viewed, or the number marked in the total population since some unknown proportion of these died during the migration and are not at risk of being recovered. However, we can bracket the possible survivorship by showing the outcomes over a range of numbers

of butterflies viewed per tag recovered (Table 1).

The first thing you might notice as you look at this table is that the range of estimates (147-800 million) for the fall population is very similar for 1998 and 1999. However, this does not mean the populations were the same size. Indeed, we already know that the total number of hectares of butterflies at the overwintering sites was smaller in 1998 than in 1999 (5.55 vs. 9.05 = 1/1.63). Let's look at the maximum number of butterflies per tag for the two years at El Rosario. In 1998, there was 26,400 tags/21.98 million or 1 tag per 833 butterflies but in 1999 there was 30,878 tags/45.6 million or 1 tag per 1477 butterflies. This gives a ratio of 1/1.77. In other words, for each tag recovered in 1999 we would expect that the collectors viewed 1.77 times more butterflies than in 1998 due to the larger size of the population. This assumes equal rates of mortality for the two years. How would this work out? Suppose that in 1998 an average of 3000 butterflies were scanned or viewed for each tag recovered. This means 5.5% of the population was viewed, the percentage surviving was 27.8% and the total population was 240.0 million. The comparable figures in 1999 would be 5312 butterflies per tag, 7.0% viewed, 27.8% survival and a

total population of 390.5 million. These are just examples not population estimates.

After all of this, what can we say about the size of the fall migratory population? It seems likely that the fall populations for the last two years were greater than 147 million and less than 400 million. The tag recovery rates are simply too high, and the implied survival rates too low, for the populations to have been as large as 700-800 million. How can we narrow the estimate with the information available? My intuition and logic tell me that the recovery rate or reward rate for most of the searchers is in the range of 2000-3500 butterflies viewed per tag recovered and that survival ranges from 25-45%. Until more information becomes available, the estimates above for 1998 (182 million, 4500 butterflies viewed/recovery, 33% survival) and 1999 (252 million, 3434 butterflies viewed/recovery, 43% survival) will have to suffice.

As a footnote to survivorship, I should mention that the procedure I've outlined in Table 1 underestimates mortality. I've assumed all tags are recovered from live butterflies even though some unknown proportion of the tags are recovered from dead butterflies found at watering sites or on the forest floor. In effect, the procedure only provides us with a measure of the tags at risk of recovery on live and dead butterflies combined.

*The Monarch Watch 1998 Season Summary is available (while supplies last) for \$4 - see the order form for details. It is also available online as a PDF file at www.MonarchWatch.org.

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Table 1. Monarch Population size estimates for 1998 and 1999.

1999*						
Number of observations per recovery	Ratio of recoveries to total observed	% of population viewed	Number of tags at risk	Proportion of tags at risk (survival)	Millions headed to El Rosario	Millions in total population
2,000	.000500	2.6	22,800	0.738	61.8	147.0
3,000	.000333	3.9	15,200	0.492	92.6	220.6
4,000	.000250	5.2	11,400	0.369	123.5	294.1
5,000	.000200	6.5	9,120	0.295	154.4	367.6
10,000	.000100	13.1	4,560	0.148	308.8	735.2
1998**						
Number of observations per recovery	Ratio of recoveries to total observed	% of population viewed	Number of tags at risk	Proportion of tags at risk (survival)	Millions headed to El Rosario	Millions in total population
2,000	.000500	3.6	10,990	0.416	52.8	160.0
3,000	.000333	5.5	7,327	0.278	79.2	240.0
4,000	.000250	7.3	5,495	0.208	105.6	320.0
5,000	.000200	9.1	4,396	0.167	132.0	400.0
10,000	.000100	18.2	2,198	0.083	264.0	800.0

*Total population 108.6 million. Population at El Rosario 45.6 million (42% of total). Assumes 73,519 Monarchs tagged, 30,878 expected at El Rosario.

**Total population 66.6 million. Population at El Rosario 21.98 million (33% of total). Assumes 80,000 Monarchs tagged, 26,400 expected at El Rosario.

MONARCH BREEDING HABITAT

What constitutes Monarch summer breeding habitat and how much of this habitat occurs east of the Rockies?

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PROLOGUE

When I fly, I ask for a window seat. The view from the window gives me a different perspective of land-use patterns and habitat types than I might gain from driving or looking at maps. In recent years, with my mind so focused on Monarchs, I've speculated on where the Monarchs are breeding down below. Much of the landscape in the midwest is so intensely farmed that it doesn't seem possible that there are enough acres with milkweeds to support the Monarch populations we see each fall. And, if I fly to the east coast, I'm impressed with the extent of forests and urban areas, habitats which are not known to support large numbers of breeding Monarchs. So, where do all the Monarchs come from? How much milkweed is out there and where is it distributed? These questions assumed greater importance with the publication of the study by Losey et al. (1999) in May of 1999. This study showed that 44% of 2nd instar Monarch larvae which fed on milkweed leaves dusted with pollen from Bt corn died within 96 hours. Although this was a laboratory study, it immediately raised questions about the impact that pollen from 25 million acres of Bt corn might have on Monarchs. In these paragraphs I will summarize a study of the summer breeding habitats I recently conducted with Jason Shields, a graduate student in the Department of Geography at the University of Kansas.

INTRODUCTION AND METHODS

The goal of our study was to define the geographic area of the summer breeding range for the Monarch in eastern North America and to identify the effective breeding habitat within this geographic area. In addition, we

attempted to determine if corn constitutes a significant portion of the effective breeding habitat for the Monarch.

Landcover for the Monarch summer breeding range was identified through the use of geographic information system (GIS) data sets. Many of the 159 landcover classifications used in this analysis are similar and were therefore grouped into 20 larger categories. These categories were subsequently grouped into unsuitable (non-breeding) and suitable (breeding) habitats (Table 1) based on the possibility that the habitat could contain significant populations of milkweeds.

Non-Breeding Habitats	Breeding Habitats
Urban	Corn
Water	Dryland Crop
Barren	Grass/Crop
Mixed Forest	Grassland
Deciduous Forest	Herbaceous Wetlands
Alpine Tundra	Irrigated Crop
Coniferous Forests	Mixed Dry/Irrigated
Desert Shrub	Mixed Shrub/Grass
Unknown	Savanna
	Wood/Crop
	Woodlands

Table 1. Unsuitable (non-breeding) and Suitable Breeding Habitats for Monarch butterflies.

The summer breeding range for an estimated 95% of the Monarch population includes all of the breeding habitat east of the Rocky Mountains including the high plains of Colorado, Wyoming

and Montana as well as the Rio Grande valley of New Mexico. Excluded is the area of Ontario and Quebec which may account for 5% of the fall migratory population. Because the high plains involve a large area with few milkweeds and Monarchs and they probably contribute no more than 5% of the fall population, landcover was also summarized for the 90% Monarch production area shown in Figure 1-A. Because the highest Monarch production occurs within the cornbelt (Wassenaar and Hobson 1998, Hobson, Wassenaar and Taylor 1999), landcover was summarized for this region as defined in Figure 1-B. We assumed for the purpose of this analysis that Monarchs only breed north of 37° during the summer. This southern limit is strongly supported by the lack of observations of Monarchs south of 37° from mid-June to mid-August. Since road margins often contain numerous patches of milkweed plants and are therefore assumed to be high-quality habitat for Monarchs, we attempted to establish the amount of this habitat in each state.

RESULTS AND DISCUSSION

The landcover for each of the summer breeding ranges and its breakdown into unsuitable and suitable habitats for Monarchs are summarized in Table 2.

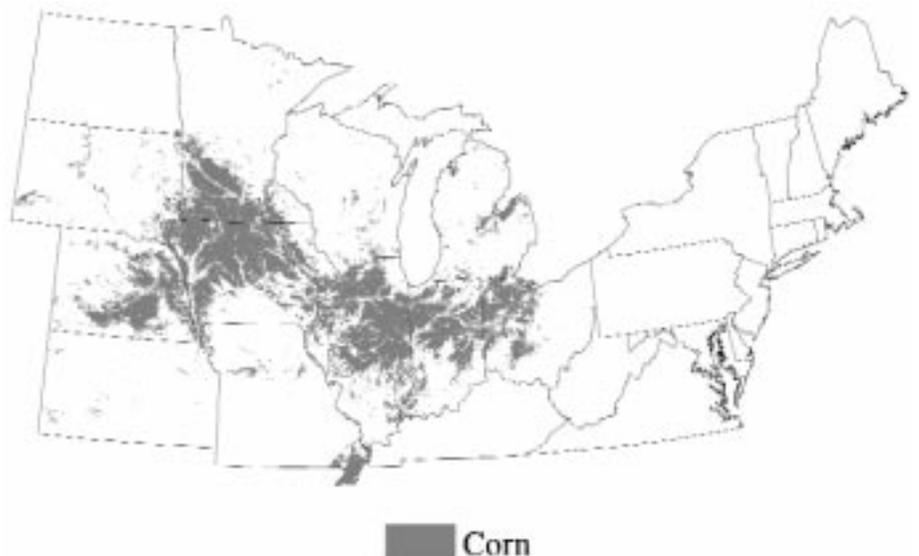


Figure 1-A. Corn distribution within the 90% Monarch production area.



Figure 1-B. Monarch production area in eastern North America; includes cornbelt region illustrated in Figure 1-A.

This study provides a geographic information system (GIS) based assessment of the effective breeding habitat for the summer generations. We estimate that for the 95% breeding area 65.1% or 2.25 million km² constitute milkweed/Monarch habitat. If Canada were included in our figures, the total effective breeding area would be 2.50 million km² of Monarch butterflies in eastern North America. Previously, Brower (1999), using a broader summer breeding range, estimated that the total breeding area was 2.60 million km² inclusive of the breeding areas in Canada. Evidently Brower excluded non-breeding areas from the total breeding area shown on his map but does not indicate how this was done. Nevertheless, the concurrence of these estimates helps us define the habitat limits for the Monarchs and will aid in assessing the potential impact on the Monarch population of habitat destruction, add-on mortality due to the use of pesticides, and the planting of Bt corn.

The designation of unsuitable and suitable breeding habitats for Monarchs is based in part on the distribution and abundance of milkweeds and what is known about Monarch behavior. There

are 108 species of milkweeds in North America (Woodson 1954) and most of these species occur as persistent perennials in open (non-forested) habitats. Although some milkweeds occur within forests, these species are uncommon to rare. Monarchs, being open area species, generally do not use milkweeds within forests as host-plants. Deciduous and mixed forests were therefore designated as unsuitable habitats. Urban areas were also excluded. Although there is some production of Monarchs within urban areas, particularly in the midwest, this production is considered to be low due to the absence of milkweeds from most urban environments. Suitable Monarch habitats were considered to be any open habitats which appeared to have the potential to sustain milkweed populations. In fact, much of the "suitable habitat" contains little or no milkweed. The landcover classification shows that many of the suitable habitats are intensely managed (e.g., alfalfa) and probably lack milkweed. At this point, because there are no surveys for milkweed abundance across all of the landcover types, we can only speculate how much of the "suitable

habitat" is actually populated with milkweed plants. We estimate that 60% of this suitable or effective breeding habitat contains milkweed. If this is true and we use 2.5 million km² as the effective breeding habitat for eastern North America, then 1.5 million km² (370.6 million acres) account for the Monarch productivity each season.

This leads to the question of the number of Monarchs produced per unit area. The size of the fall Monarch population is not known but certainly varies from year to year based on climatic and biotic factors. The only estimate we have of the total number of migrating Monarchs in the fall was derived from the Monarch Watch mark and recapture effort of 1998. Based on 400 recaptures of 80,000 tagged butterflies, Taylor (1999) estimated that the 1998 fall population ranged from 294-360 million Monarchs. The population in 1998 was relatively low but if there were 360 million Monarchs in the fall 1999 population it means that approximately .97 Monarchs were produced per acre during the last generation (360 million/370.6 million acres). This is a high number per acre for the entire milkweed habitat. For each Monarch that reaches the adult stage there are likely to be twenty or more that fail to do so due to predation and other causes of mortality. Twenty or more Monarch larvae per acre in the last generation should result in substantial defoliation of milkweed. In general, defoliation is not particularly evident in various Monarch/milkweed habitats. This raises a number of questions. Are we just not seeing the defoliation or finding the larvae? Are the Monarchs being produced in large

habitat" is actually populated with milkweed plants. We estimate that 60% of this suitable or effective breeding habitat contains milkweed. If this is true and we use 2.5 million km² as the effective breeding habitat for eastern North America, then 1.5 million km² (370.6 million acres) account for the Monarch productivity each season.

Landcover	95%	90%	Cornbelt
Total Area (sq. km)	3,452,548	2,568,545	1,865,740
Corn	6.80%	9.00%	12.30%
Non-breeding habitat	34.90%	40.10%	25.00%
Breeding habitat	65.10%	59.90%	75.00%

Composition of Breeding Habitat

Corn	10.5%* (12.7%)	15.1% (18.3%)	16.4% (18.9%)
Other Crops	57.20%	74.20%	71.90%
Other Habitats	32.30%	10.70%	11.70%

Table 2. Proportions of corn in subareas of the summer Monarch breeding range
*Based on Kansas Applied Remote Sensing corn mask. Percentage in brackets is adjusted for corn acreage reported by the USDA for 1999.

numbers in habitats we are unaware of? Or, have we substantially overestimated the number of Monarchs in the fall population? Given the limits of our present knowledge, any combination of these scenarios is possible.

Landcover attributed to corn varies from 13-19% depending on the breeding area classifications (Table 2). Within the cornbelt, which is probably the most important area for Monarch production (Wassenaar and Hobson 1998), corn constitutes 19% of the potential suitable habitat. Thus, it is likely that at some level, cornfields and the associated milkweed (Hartzler and Buhler 1999) account for a portion of Monarch production. If no Monarchs were produced in this habitat, it becomes even more difficult to explain Monarch production.

Milkweeds are common along roadsides; in fact, it is along roadsides where these plants are most often encountered. The presumption is that significant numbers of Monarchs are produced in these areas and this may be the case. The productivity of this habitat has not been assessed. However, our analysis shows that these habitats are not extensive and only constitute 1-3% of the total land area in each state. Road margins do not

appear to be sufficient to account for more than 5% of the total Monarch production and perhaps less.

CONCLUSIONS

1. Monarch breeding habitat is restricted to open areas - most of which are in agricultural production.
2. Corn fields constitute a significant portion (19% in the cornbelt) of the effective breeding habitat for the Monarch.
3. The number of Monarchs estimated for the fall migratory populations are difficult to account for based on the apparent breeding habitat.
4. If we assume that Monarchs are not using corn fields as a habitat, it becomes even more difficult to account for the numbers of Monarchs in the fall population.
5. Production of Monarchs in each of the suitable sub-habitats, including corn, is unknown.
6. Road margins only constitute 1-3% of the area in each state and even though these areas often contain milkweed, this habitat is not sufficient in area to account for a large portion of the Monarch population.
7. The distribution and abundance of milkweed is too poorly known to predict Monarch production based on sub-habitats among the suitable habi-

tat categories.

ACKNOWLEDGEMENT

This analysis was funded by a small grant from Biotechnology Industry Organization (BIO).

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WHY DO MONARCHS GO TO FLORIDA?

Okay, if these butterflies are so smart why do so many of them end up in Florida in the winter?

An assumption implicit in this question is that the butterflies "know" where they are going. Do they? Probably not, at least not in a cognitive sense. If not, what are the Monarchs responding to that gives guidance to, or determines, the directions taken? Monarchs probably have a number of orientation mechanisms and even though much of the evidence suggests orientation to the earth's magnetic field is the primary guidance system, (Schmidt-Koenig 1993*) it would not be surprising if this mechanism is overridden in some areas by major physiographic features such as mountains and coastlines. The arrival of Monarchs in Florida each fall could be the consequence of being blown off course or of just doing what Monarchs do everywhere as they migrate in the fall. In other words, even though they use the same information for guidance they use elsewhere, they end up in what appears to us to be an unusual place. But, is it? Maybe not.

As Monarchs head down the east coast, some of them move inland. A small number of the Monarchs that move inland are recaptured enroute (to the SW) and some are recovered in Mexico. Other Monarchs appear to hug the coast or use the coastal plain eventually arriving in Florida. Large numbers of Monarchs arrive in St. Marks (the NW corner of the Florida peninsula) each fall and some apparently fly to the west and reach Mexico while others move into the peninsula to the SE. Farther south in Florida, Monarchs arrive in large numbers in October but appear to be unable to sustain a non-reproductive condition. These butterflies become reproductive and 3-4 generations of Monarchs have been observed throughout the winter in Florida. What we don't know is whether the offspring of the fall migrants migrate north in the spring. Monarchs disappear from most of Florida in late spring and throughout the summer. This seems to suggest they move north in the spring but this has not been established. Therefore, at this time, we are uncertain whether Florida is a dead end or a trap for the fall migrants or whether the fall repopulation and spring depopulation, with migration northward, constitutes a unique part of the overall migration picture.

*Reference appears on page 45.

LETTERS TO MONARCH WATCH

I just had to write and tell you about my trip to the El Rosario Monarch Butterfly Sanctuary.

My husband hired a tour guide he knows from Mexico City and the three of us drove about four hours to Anganguero. From there we hired a local gentleman with a four wheel drive to drive us to Rosario. Little did we know it would be a forty five minute trip on up the mountain on an extremely rough "road". After paying our \$1.50 each at Rosario we started our hike up the trail. It didn't take long to realize it wasn't going to be easy. The elevation is over 10,500 feet, the incline was a bit steep, and the dust from the trail was in every breath we took. We made frequent stops to rest and a couple of times I almost gave up. I'm so glad I didn't! I can't find the words to describe the spectacle. It's truly an awesome sight to see. And we could hear the fluttering of their wings! Amazing!

From now on I will look at every monarch with a deeper respect, admiration, and love and continue to do my part in helping preserve this magnificent little creature.

Thank you for teaching me through your website. I look forward to learning more.

**Jo Wilson
Lebanon, OH**

This is a great program and I try to involve my students as much as possible. We sometimes take it for granted that everyone is familiar with butterflies and that monarchs are special because of their migration. Some of them have never seen a butterfly up close, much less touched one.

Hopefully we can participate again next year. It will be my last year as a public school teacher, but my husband and I plan to continue to be a part of Monarch Watch.

**Anita Brisco
Kilpatrick Elementary School
Texarkana, AR**

Words can never describe the joy of tagging our beloved monarchs. Thank you for this remarkable opportunity to study more about this beautiful friend.

Our major work was done on labor day

weekend at our beach. It was a beautiful sunny day with little wind, few clouds, very warm temperatures for Michigan at that time in September...This was our 27th summer for raising monarchs. We will be tagging them from now on.

**Millie and Ralph Janka
Boyne Falls, MI**

My name is Kaitlyn Molina, I did a science fair project on "How Does the Concentration or sweetness of Nectar Effect the Preference of the Monarch for the Nectar." I just thought you might be interested in the fact that this web site was very helpful. (THANKS a lot!!!) At my school (Forest Lakes Elem.) I won an exemplary ribbon and one of six best of shows and am going to compete at district today.

**Kaitlyn Molina
Palm Harbor, FL**

I am writing this for my son Lucas. He is an avid monarch person and has recruited the whole family for the project. He has raised monarchs since he was about five. He is now twelve. This is the first year he has tagged them.

Lucas starts looking for eggs when he sights the first monarch. We "hunt" eggs on milkweed plants by looking at the underside of the leaves. He also checks for the larvae. We use cardboard boxes with doors and windows cut into them to make a house for the larvae and eggs. While the larvae are small he uses glass jars to be able to watch their progress.

Lucas has spoken at several community groups about his projects with the monarchs. He has also used it as a school project.

The major problem we have is feeding over fifty larvae at a time. We have found that if you pick several milkweed leaves at a time and store them in a plastic bag in the refrigerator they stay fresh for several days.

Lucas has learned a lot of tips about raising monarchs through experience. He is very interested in continuing to learn more.

**Ruth Ryder
Neoga, IL**

Your program has inspired my third grade class to establish a butterfly garden on our school campus during the spring of 2000. As a lead teacher at Moyock, I involve our entire student body in the tagging program. It is a big hit with both children and adults!

**Mrs. Sue Powers
Moyock, NC**

Every year, prior to the 100th day of school celebration, our kindergarten classes do a "service project". This year, the children collected pennies for your Adopt-A-Classroom program. The children collected and counted pennies for two weeks. Our kindergarten children and teachers are very passionate when it comes to Monarch butterflies. We have a butterfly Kindergarten that we love and care for and have been involved in a variety of other Monarch projects....

**Kindergarten Classes
Knowlton Township Elementary
Delaware, NJ**

At our school, David Lipscomb Elementary, each child committed to doing something to help someone else during the school year. Since we enjoy our butterfly study so much, our class decided that we would like to share our blessings with the children of Mexico.

Each child worked at home to earn the money to buy these supplies. They cleaned their rooms, made their beds, set the table, helped fold laundry, fed their pets, and picked up sticks in the yard. Then each one went to the store to pick out supplies and proudly brought them to school to fill the box.

Thank you for all that you do with the Monarch Watch programs. It is a wonderful teaching tool. My 4-year-olds are amazed by this special creature and eagerly tell everyone they see about monarch butterflies.

**Becky Collins
David Lipscomb Elementary School
Nashville, TN**

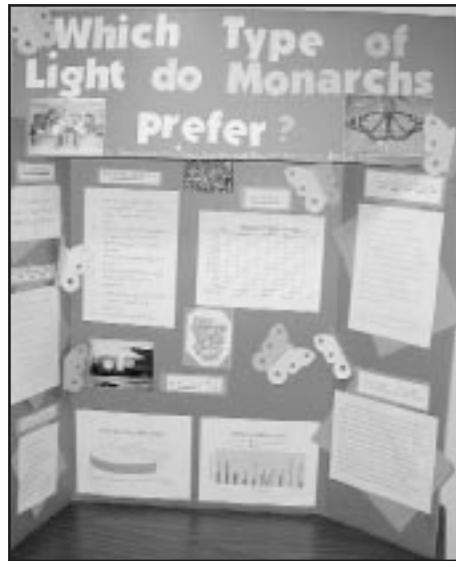
MONARCH FAIR & TEACHER TRAINING

The third annual Monarchs in the Classroom Monarch Fair was held on 4 December 1999 at the Bell Museum of Natural History on the University of Minnesota campus. The Monarch Fair is coordinated by Karen Oberhauser and her students at the University of Minnesota. These science fairs are an indicator of the success of teacher training that takes place in the preceding weeks.

Each summer Karen, with the assistance of her students and veteran teachers, offers a two-week course on Monarchs for Minnesota elementary and middle school teachers. During the first week of the course, teachers learn about Monarch biology and obtain hands-on experience with living Monarchs in the field and laboratory. In the second week, teachers use their first-hand knowledge of Monarchs to develop classroom projects. They practice teaching Monarch-centered activities using age-appropriate observational techniques and inquiry methods. The goal is to provide teachers with the confidence and skills necessary to mentor their students through independent research projects which can then be brought to the Monarch Fair at the end of the fall

season. The projects at each fair are admirable and they reflect Karen's dedication and skill at mentoring students and teachers.

Karen and Monarchs in the Classroom also host a Monarch Monitoring/Field Research Program which is funded by the National Science Foundation. The course provides an opportunity for middle and high school teachers from Minnesota, Wisconsin, Iowa, and Texas to immerse themselves and two students in an exciting Monarch butterfly research project. The participants



One of several poster presentations displayed at the Monarch Fair in Minnesota in the fall of 1999. Photo by O.R. Taylor.

take part in two week-long institutes, one in Texas and one in Minnesota. They learn about the scientific process by conducting research at a local field site during the summer and the school year.

Mary Kennedy, a teacher at the Texas Military Institute in San Antonio, TX, participated in the Monarch Monitoring/Field Research Program with her students. As a result, some of her students entered research projects into science fairs. Four of Mary's students presented their research at four different science fairs accumulating a total of eight awards. One student was even invited to present his research at a science fair in San Francisco and at the XXI International Congress of Entomology in Brazil. The students' project topics included: "Are Monarch Butterflies Reproductive During the Fall Migration through Texas", "The Effects of Temperature on Monarch Larvae", and "A Comparison of the Concentration of *Ophryocystis elektroscirrha* in Monarch Butterfly Populations".

To learn more about Monarchs in the Classroom, student projects, and courses that are offered for teachers, visit their website at:

www.MonarchLab.umn.edu

MINNESOTA BUTTERFLY BILL

On the 31st of March, Minnesota became the seventh state to designate the Monarch as the state butterfly or insect. Governor Jesse Ventura signed a bill making the Monarch the state butterfly while surrounded by fourth grade students from Anderson Elementary School of Mahtomedhi, MN. The students promoted passage of the bill on three visits to the state legislature. The Governor commented on the students' efforts by saying "That's indicative of how much effort it takes to pass a bill." Other states with Monarchs as the state butterfly or insect include, Alabama, Idaho, Illinois, Texas, Vermont, and West Virginia.



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FEATURED MILKWEEDS

Milkweeds belong to the plant family Asclepiadaceae which derives its name from Asklepios, the Greek god of medicine and healing. Though most members of the genus *Asclepias* are tropical, there are over 100 species in North America known for their milky sap or latex contained in the leaves. Most species are toxic to vertebrate herbivores if ingested due to the presence of cardenolide alkaloids in the leaves, stems, and fruits. The milkweed fruit is a follicle, commonly referred to as a pod, which splits at one suture to release many seeds, sometimes hundreds, depending on the species.

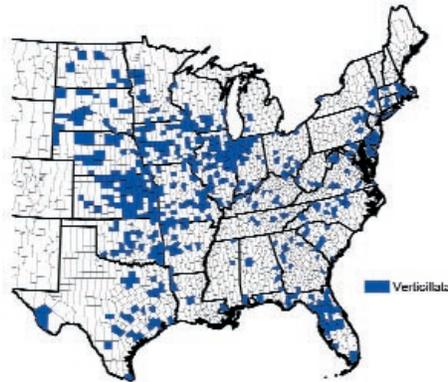
Like other milkweeds, our featured species, *A. verticillata* and *A. viridis*, are perennial forbs with a unique and fascinating pollination mechanism in which the plant relies on Lepidoptera

(butterflies and moths) and Hymenoptera (bees and wasps) for pollination. Hundreds of pollen grains are packaged into two connected sacs called pollinia, which are collectively referred to as the pollinarium (see photo on page 57). When a foraging insect lands on a flower, the pollinarium

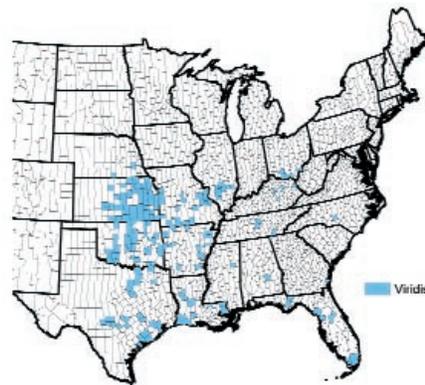
species is a significant mid-summer host plant for Monarch larvae in much of the eastern United States.

Asclepias viridis Walt., Spider milkweed
Asclepias verticillata L., Whorled milkweed

With ovate or broadly oblong leaves, *A. viridis* is easily distinguished from *A. verticillata*. This plant produces umbels of large, showy yellowish flowers from April to August. The gynostegium (the combined stamen, style and stigma of the flower) is pale purple-rose in color. *A. viridis* grows rapidly in the spring and is one of the first milkweed species to bloom each season. After fruiting, the plant senesces rapidly and energy is stored in a taproot. Generally, *A. viridis* is only used by first generation Monarchs from March to early June. Occasionally this species produces new shoots following summer rains in Texas where it can serve as a host for Monarchs in September.



The shaded areas of these maps represent counties where *A. verticillata* (above) and *A. viridis* (below) have been reported.



Asclepias verticillata - Whorled milkweed



um can easily attach itself to the insect's body. Once removed from the flower, the pollinia actually re-orient as the translator arms bend while drying. Upon landing on another flower, the properly oriented pollinarium is deposited into a receptive stigmatic groove where the pollinia breaks down and the pollen germinates, growing pollen tubes through the stigma to the ovules in the ovary.

Because its narrow leaves make *A. verticillata* appear grass-like to the uninformed observer, this common milkweed is often overlooked when not in bloom. From June to September, this milkweed produces greenish white to purple-tinged flowers in umbels (pedicels arise from one point). This



Asclepias viridis
 Spider milkweed



FEATURED TEACHERS

We would like to thank Cyrene Slegona, Mary Alice Aguilar, De Cansler, and all other teachers like them who work so hard to make science interesting and exciting for their students while teaching them important scientific principles.

CYRENE SLEGONA



Photo contributed by
Cyrene Slegona.

Cyrene Slegona brings a unique and creative teaching philosophy to her classroom. She has been interested in insects since she first watched a Monarch emerge from its chrysalis at age 10 and she now incorporates imaginative and exploratory learning in her classroom. Cyrene is a model teacher who learns with her students. She does this by taking advantage of the children's powers of observation and the questions they generate to explore novel aspects of insect biology.

Cyrene relies on the use of insects to get the students excited about science and asking questions. She takes their newfound enthusiasm and harnesses it to teach the children basic principles of physics, math, visual arts and creative writing. Cyrene summarizes her reasons for using insects in the classroom as follows:

Insects offer the observer an opportunity to see life from a different perspective. While it can be difficult to imagine yourself as a foreigner unless you have experience on which to draw, you can understand the behavior of a mantis or caterpillar because you can hold the creatures in your hand and really see what the insect reacts to. You can appreciate that there are other life concerns and priorities beyond those of humans. This opportunity to empathize is rewarding for children. As students/children learn about the life cycles of insects, their adaptations and rather nonhuman

behavior, they learn not to be uneasy around these creatures. That children can learn a never-ending amount of information, make countless connections, and ask questions becomes exciting. The learning boundaries expand farther and farther into the distance.

As an example of her teaching style, Cyrene developed a sixth grade classroom project which allows her students to create a mechanical insect model. The project requires her students to "design and construct a model of a Maine insect with three mechanisms that mimic life-like movements of the insect". In addition to the design and construction of a scale model of their insect of choice, the students keep a journal, design a brochure, and compose a poem about their experiences. For her efforts, Cyrene recently received the 1999 President's award from the Entomological Society of America for Outstanding Achievement in Primary Teaching Using Insects as Educational Material.

Cyrene's work with insects as a learning tool in the classroom not only inspires children to learn but also encourages them to protect those things they value.

The development of environmental stewards is not educationally mandated, but as children learn to value these creatures, the

foundation for future custodianship is being formed. What is valued is protected and perhaps one or more of the children who pass through my classroom will find it important to dedicate some time to this end. Wouldn't that be great?

--Cyrene Slegona

MARY ALICE AGUILAR

Mary Alice Aguilar has always been interested in Mexican culture and "all things Hispanic". This interest stems from her Bolivian descent and her Mexican husband. Since she first became aware of the Monarch migration eight years ago, she has been interested in these travelers to Mexico. But it wasn't until she was in Belize five years ago and heard about a snow storm that killed millions of Monarchs that Mary Alice's interest in Monarchs peaked. From that point on she has worked to incorporate Monarchs into her classroom at Louis L. Redding Intermediate School in Middletown, Delaware.

Mary Alice was a sixth grade math teacher at the time and had just taken an all-day Saturday course on Monarchs. Her school gave her the opportunity to teach a subject of her choice one period a day and this was all the incentive Mary Alice needed. Her students made origami butterflies, entered environmental posters into



Cyrene's students presenting their finished insect models to the rest of the class.

Photo contributed by Cyrene Slegona.



Mary Alice and her students working in their butterfly garden.

Photo contributed by Mary Alice Aguilar.

contests, wrote poetry, learned Spanish phonics, took a field trip to Ashland Nature Center for a day of Monarchs in the meadow, and wrote a play about the problems facing the Monarch. Performing their play from classroom to classroom her students raised \$400 (in change) for the Monarchs in Mexico. Mary Alice put in a phone call to the Nature Conservancy in Washington D.C. and was put in contact with Dr. Flavio Chazaro from Mexico. Dr. Chazaro knew an agricultural extension agent (Cristobal Urbino) working with ejidos (communities in Mexico) that had Monarchs in their mountains. Dr. Chazaro got the money to Cristobal Urbino and so began the relationship of Mary Alice and her students with the Mexican community of Lomas De Aparicio. Mary Alice visited Lomas De Aparicio on two occasions and each year, she shares her slides with the students who then raise money to send to the community.

Taking Mary Alice's lead, a boy scout and a girl scout troop visited Lomas De Aparicio and took gifts for the community. The mother of a scout in this group helped get 30,000 jars donated to this community to package honey for them to sell. She also learned that Cristobal Urbino now works for a businessman who is helping these communities develop natural exports to boost their economy. Things are looking brighter in Lomas De Aparicio and Mary Alice played an important role in getting things started for them.

Since her initial interest, Mary Alice

(now a fifth-grade teacher) and her students have worked on many projects using Monarchs. One such project was a math project which involved students mapping out the area of an overwintering site and realizing this site could easily fit in the land occupied by Redding and their new high school. Another lesson uses the flags of Delaware and Mexico to compare cultures. She and her students also complete a geography lesson called "Mexico in a Pizza Box" where students make their own maps of Mexico and the US inside a pizza box using beans as markers for physical features. All the while, the students are raising and tagging Monarchs, creating and maintaining their butterfly garden at school and mapping the spring re-migration using Journey North's Web site.

Mary Alice has received four different



Students in Mrs. Fitz's class participating in Mary Alice's "Mexico in a Pizza Box" lesson. Photo contributed by Mary Alice Aguilar.

grants that total nearly \$20,000 because of her enthusiasm to educate her students as well as other teachers.

Congratulations to Mary Alice for furthering cultural understanding and providing her students with an appreciation for Monarchs.

DE CANSLER

When we decided to feature De Cansler in this article, we didn't expect that she would have the time to respond to our request for information. She is probably one of the busiest middle school science teachers around and not one likely to "toot her own horn" according to Dr. Karen Oberhauser in MN. De is very busy with school, family and graduate work these days. She teaches seventh-ninth grade science at Willow Creek Middle



De Cansler (right) instructing fellow teacher Jackie Baker at the 1998 Monarchs in the Classroom workshop.

Photo contributed by Karen Oberhauser.

school in Rochester, MN. De was a Minnesota State Finalist for the Presidential Award for Excellence in Math and Science teaching in 1997 and 1998, the Featured Teacher for the Minnesota Science Teachers' Association in the fall of 1995, and recently received her Masters of Education in Secondary Curriculum and Instruction from the University of Minnesota. We heard many terrific things about De so we were very pleased that she made time to send photos and a letter explaining her work with Monarchs.

De wrote in the recent letter to Monarch Watch:

("TEACHERS" CONTINUED ON PAGE 52)

CHALLENGES TO STUDENTS

Each year we pose questions and challenges for students. We try to ask questions that students can answer with relatively simple experiments. Our goal is to promote independent research by students, and the ideas we've suggested could be adopted for research fairs. Teachers have told us they use these challenges as the basis for "active learning" in their classes. We hope this continues. We are interested in the results of these projects and students are encouraged to send their completed projects to us so that they may be shared with others via the Monarch Watch Web site.

PETER, PETER, PUMPKIN EATER?

Each year we receive a number of urgent inquiries from New Zealand and Australia about alternative host-plants for Monarchs. Monarchs become abundant at the end of the season and they eat all of the milkweed (usually *Asclepias fruiticosa/physocarpa*) in the gardens. Starvation is imminent by the time the message arrives and all I can suggest is that they experiment with pumpkin as a possible source of Monarch food. There is an extensive lore about pumpkins and Monarchs, but no data. One person claimed that 50% of the Monarchs survived to pupate after eating microwaved pumpkin pulp. Despite my pleas for reports from correspondents about their successes and failures getting Monarchs to feed on pumpkins, no one has ever reported back. Do Monarchs eat pumpkins or not? Design an experiment to find out. There are many varieties of pumpkins and squashes to choose from. You could feed the larvae seedlings (young plants), the rind of young fruits, or the pulp inside the pumpkin or squash (microwaved or not). You could start with young larvae that just hatched from eggs or transfer older (4th or 5th instar) larvae that started on milkweed. There are advantages and disadvantages of using either class of lar-

vae. Which group does better? The challenge is to design a test, with appropriate controls, to determine if pumpkin or squash is a suitable host for Monarchs. If you accept this challenge, please let us know your results.

CAN YOU MAKE A BETTER MODEL?

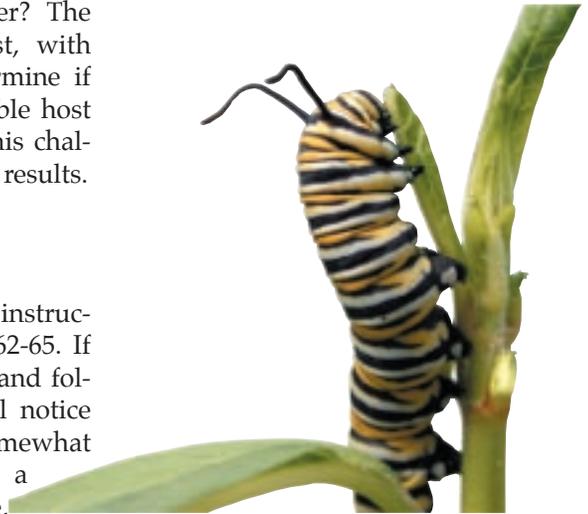
Model butterflies and flight instructions are provided on pages 62-65. If you work with these models, and follow the instructions, you will notice that some of the models fly somewhat better than others. By using a stop watch and a tape measure, or even a video camera, you can systematically quantify the differences among the models. The challenge is to make a better model or a model that performs in a specific way. Suppose you would like your model to glide farther, what would you do to increase the glide ratio? To answer this question you need to know the factors that determine glide ratio and use this information to design a model with a predetermined ratio. Test your new model. In effect, your model is a test of your hypothesis concerning glide ratios and a measure of your skill at building a model to your own specifications.

Here's an even tougher challenge. Obtain the mass of each of the models



Instructions for this Monarch jack-o'-lantern are available on our Web site.

Photo contributed by Mark Wloch.



and compare these masses with those of a live Monarch (.4 - .7 grams). Can you make a model that's as light as a Monarch and/or one which has the same flight performance?

WHY DO MONARCHS FLY TOWARD A LIGHT SOURCE?

Have you ever noticed that when Monarchs get loose in your classroom they go to the windows or the lights? This response makes sense - the butterfly is trying to escape and, being an open area species, it should be positively phototactic (attracted to the light). If you tipped over a container of cockroaches in your classroom, they would seek out dark places, under your desks and up pant legs (yikes!) because they are negatively phototactic. But light and dark are relative. The visible light spectrum has several components and these can be filtered. Have you ever been in a photographic darkroom? In photolabs, red lights are used because the unexposed film is not as sensitive as our eyes to red light. In effect, we can see the light but the film can't. Honeybees and many other insects are like the film; they can't see in red light. If we covered the windows and lights of your classroom with red filters, and then opened a hive of bees (hey, this really sounds exciting!), the bees would crawl but they wouldn't fly. If we removed a filter from one of the lights, some of the bees would head for that light source.

What about Monarchs? Butterflies are known to have a broad visual sensitivity and they can see from ultra violet (UV), which is invisible to us, to red. How could we test the response of Monarchs to light? Here's an idea: we know from experiments in our laboratory that Monarchs will climb up a Plexiglas tube (6 cm in diameter and 30 cm long) lined with gray fiberglass screen to a bright but diffuse light source from above. It would be relatively easy to design an apparatus so you could introduce Monarchs at the bottom and record the time taken for them to crawl to the top of the tube. You could design the system so that either the light source or the top of the tube is covered with photographic filters that filter out different wavelengths of light. You could record the responses of Monarchs to a variety of light conditions. If you conduct this test be sure to record the responses of males and females separately because there may be differences between the sexes. Use at least 5 individuals in each test to account for variability among individuals in response to these conditions. Also, be sure the test butterflies are well fed, at least 3 days old, and that the temperatures in the test environment are at least 75°F (24°C).

DOES YOUR MONARCH HAVE MAGNETIC MATERIAL?

Monarchs may contain magnetite, a magnetic material that is thought to be associated with magnetic orientation in a number of organisms. How could we find out if your Monarchs contain magnetite? This question is difficult to answer with living Monarchs but, if you have some dead specimens, there is a simple way to determine if they contain magnetite. Remove the wings of the dead Monarchs, after first drying them for several days under a lamp. Place the thoroughly dry bodies, 2-3 will do, in a mortar and pestle and grind them into a very fine powder. Place the powder in a 150 mL beaker and add 50 mL of acetone. It's best to do this in a well ventilated area or under a laboratory hood. Stir the powder into the acetone several times with a glass rod. Next, stir the mix with the end of a narrow test tube and then

examine the end of the tube to see if any particles adhere to the tube. Wipe the tube dry and then insert a magnet into the bottom of the test tube. Stir again and examine the end of the tube. If particles adhere to the tube, it is due to magnetic attraction. (To be sure magnetic attraction is involved, place a non-magnetic piece of metal in the test tube and test again.) If you find particles attracted to the test tube when it contains a magnet, does this mean that these magnetic materials were synthesized by the Monarch? Could these materials simply be contaminants? How would you find out?

WHY DO MONARCHS EAT THEIR SKIN?

Sounds yuckie, but one of the strange things Monarch larvae do, as well as most Lepidoptera, is eat the cuticle of the previous stage. It starts with the egg stage. Shortly after the Monarch larva emerges from the egg it turns around and eats the shell. It is only after eating most of the egg shell that it searches for a place to start feeding on the leaf. With each molt (transition to the next instar) the larva turns around and proceeds to eat the old skin before resuming feeding on the leaves. It seems like a silly thing to do but it may have a purpose. In any case, it would be interesting to ask some questions about this behavior. Systematic observations, with some questions in mind, might give us some insights as to why they eat these shed skins. Okay, what should we do? First we could record and time the behavior (at a specific temperature) to determine the normal pattern of skin eating. Then, we could play some tricks on them. What do



A Monarch larva eating its newly-molted skin. Photo by Anita Bibeau, appears in My Monarch Journal (ordering information on page 46).

they do if we remove their skin from the substrate? Do they search for it? If so, how long do they search? If we move the skin a few millimeters away from where they left it, can they find it? If so, how do they find it? Does it make a difference if we drag the skin across the leaf, leaving a trail or can they find it if we pick it up and move it? Do they need to eat their skins? Do you think they would survive if we removed the skin after each molt and didn't allow them to eat it? If they do survive, what is the advantage of eating their skin? Do the Monarchs, especially the larger instars, always molt on the plant? Maybe this is just a meal away from home.

BUG FEST 2000: INSECT APPRECIATION FAIR

Hosted by the Martin Park Nature Center in Oklahoma City, OK, this year's Bug Fest featured a tour of the OSU Insect Zoo, edible bug snacks, bug hikes and bug games for children of all ages. Paul Southerland, a professional photographer and fellow Monarch Watcher, set up the table shown below to display Monarch Watch goodies and his own wonderful photos.

Photo by Paul B. Southerland.



THE BEST OF DPLEX

Dplex-L (named for *Danaus plexippus*) is the email discussion list for Monarch Watch. We created this list to facilitate reports of sightings, observations of Monarch biology as well as discussions of Monarch biology and migratory behavior. All of the postings to Dplex-L since its inception in 1995 have been archived on our Web site at www.MonarchWatch.org/dplex. There are many useful records, observations, ideas and discussions among these messages. This year many of the "threads" or themes of the postings concerned Bt corn and GMO crops in general. Space limitations prohibit reprinting all but a few of the more informative communications in this publication.

20 May 1999 Bt Corn

Yes, it is true that doing a projection of the numbers [of Monarchs killed in] the Bt corn situation shows that any alarmist predictions regarding a significant impact on the population of Monarchs are wrong-headed at this point. What I see as significant about this study is a concrete illustration of the unintended side effects of our tinkering around with Nature. Bt works pretty well at killing lots of insects, not just European Corn Borers, corn rootworms and Monarchs. We are effectively setting out Bt factories in every corn field planted with Bt corn. How many other insect species are being impacted by this and to what degree? How about the effects on up the food chain on those insects who are predatory on the ones that are eating Bt? Is Bt accumulating in the soil and how does this affect the soil ecosystem?...Is anyone studying this?

Yes, it is true that herbivorous insects (including Monarchs) exposed to Bt corn, by virtue of their typical reproductive strategy (large numbers of young every generation) will in short order probably evolve effective resistance to Bt.* If they do, then what hap-

pens next in the corn fields?...What happens to the organic farmers who have only used Bt selectively and may be robbed of this alternative to the use of pesticides because all their problem insects are now Bt-resistant?

If farmers, in order to extend the effectiveness of the Bt corn strategy, need to be using other management techniques to control their pest problems in addition to just planting the Bt corn, how much commitment is Monsanto making to educate the farmers about this and assist them in implementing it? Or are they more concerned with short-term profits so they can pay back the cost of developing Bt corn?

How many other transgenic crops are out there creating biocides within themselves? Are we looking at a situation in the near future (or even presently) where our vast monocultures of row crops across the world are or will be so constituted? It is one thing to engineer resistance to Roundup into a plant so you can readily kill any competing plants within a field, but it is quite another when the crops themselves create toxins (however short-lived) that can spread on the wind.

And finally, yes it is true that researchers never quite seem to "get to the bottom of it". For those unaware of the workings of science; a hypothesis is proposed, an experiment is designed and conducted, analysis is made of the results, which usually leads to another hypothesis and/or attempts by other researchers to duplicate the experiment so it can be independently confirmed. Incrementally, progress is made toward "the truth", but grand advances seldom result from any one experimental setup. The reason for this goes back to an elementary principle of logic: It is much harder to prove something true than it is to disprove it.

**Jim Mason, Naturalist
Great Plains Nature Center
Wichita, KS**

*[*Actually, evolution of resistance to Bt in Monarchs is not likely to occur. See*

Frequently Asked Questions page 56 for an explanation.]

03 May 1999 Monarch Fecundity

I've studied monarch egg-laying behavior and fecundity for about 14 years....Lifetime fecundity varies with weather conditions, and individual females. In one very hot midwest summer (1988), average fecundities of captive females were about 500. In two more benign summers (1987 and 1994) they were 880 and 714. These numbers vary with mating history; [females] that are able to mate more than once tend to lay more eggs. The record in our lab was approximately 1200 (I think it was 1174, but I'd need to dig to find the exact number).

Daily fecundity changes over the course of a female's life. Young (4-6 days old), newly mated females lay about 40 eggs per day, on average. About three days after mating, these numbers tend to shoot up to about 80 eggs per day for 4-5 days (the highest I've seen in one day was 214). If held without milkweed, for a day or so, females lay more eggs. When females are about 10 days old, the number of eggs they lay per day decreases, until at the end of their lives they are only laying 10-20 [per day].

Of course, these numbers are just averages. There is an incredible amount of variation. I have studied the process of oogenesis (egg production) in the female, and it seems that female monarchs lay eggs as quickly as they make them, provided that milkweed is available and they have mated. Some female butterflies emerge from the pupa with all of their eggs "ready to go," but monarch females have no mature eggs until they are about 4 days old.

We'll have graphs and tables with these data (and lots more!) on our Web site at www.monarchlab.umn.edu

**Karen Oberhauser
University of Minnesota
St. Paul, MN**

01 Jun 1999

Milkweeds as Pests in Kitchner, ONT

We've heard for a number of years that Canadian govts from municipal level on up to provincial level have at times declared common milkweed a noxious pest. I do not know that this is the case in any US states.

We have worked for many years with a group of people who eventually formed The Wild Ones, now a national grass roots native landscapes advocacy and education group. They are headquartered in Milwaukee but have chapters throughout the Midwest and in other areas as well. Please visit their website at www.for-wild.org for specific contacts that might help you fight the ordinance. Perhaps the Canadian Nature Federation, the Canadian Wildflower Society, the Federation of Ontario Naturalists and the Canadian Wildlife Federation would be interested in examining this "weed" issue in Canada.

Lorrie Otto and Brett Rappaport are two Wild Ones leaders who have written and spoken for years about the wrongful labels many municipal weed ordinances place on plants and native landscapes. The Wild Ones handbook, which I believe is on-line, might give you some good reasons why you should go ahead and try "delisting" milkweed in your town/province.

I believe all of the official noxious pests on the Federal level in the US are invasive exotic species such as purple loosestrife, Johnson grass, yellow star thistle, musk and Canada thistle. On a more local level, plants may be placed on lists for less well-documented reasons than wetlands destruction or crop losses. If milkweed is a pest, it must be so due to its perceived impact on [agricultural] crops....

**Craig Tufts, Chief Naturalist
National Wildlife Federation
Vienna, VA**

19 February 2000

The Origin of the Scientific Name for the Monarch, *Danaus plexippus*

Danaus is the latinized form of *Danaos*. *Danaos* was the legendary

and apparently historic leader of the Danai who took and colonized Mycenae in Argos, Greece and may have been responsible for the "shaft-grave dynasty" (before 1500 BCE) The Danai reportedly came from Egypt via Crete and Rhodes. They have been linked to the Hyksos who were expelled from Egypt between 1600 and 1570 BCE), but are more likely to have been earlier colonists from Egypt. A nice name for something that disperses north and returns south.

Plexippus was the mythological brother of Althea who was killed by his nephew Meleager for trying to take the hide of the Calydonian Boar from Atlanta. As good a specific name as any I suppose.

**Chris Durden
Austin, Texas**

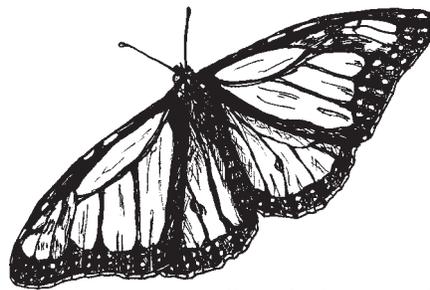


Illustration by Cara Weeks.

6 August 1999

Edible Plants Book

After posting my last message, about residents of southern Mexico eating milkweed seeds, I spotted a book on my shelf, as follows:

Sweet, Muriel. 1962. *Common Edible and Useful Plants of the West*. Naturegraph Co., Healdsburg, CA.... For milkweeds she wrote (in part):

"Poisonous to cattle and sheep, but rarely to horses. Indians dried and removed sheath from stalk after cutting. On outside of woody center was a fibre covering. This was removed and made into string, also fish nets. Milk was collected and rolled until firm enough to make chewing gum. Green plant was collected when very small and boiled in two waters to use as greens. Pods and stems were eaten; roots boiled and eaten with meat. Sometimes the plant was boiled and

added as thickening agent to manzanita cider. One variety was used for inflammatory rheumatism (probably *Asclepias cryptoceras*, which has very broad leaves with sudden, sharp points). The juice was used as healing application to cuts and wounds, also used for tattooing. Milk applied to warts, supposedly to entirely cure them."

One local natural history museum has [a] display of Indian culture and includes mention of the use of milkweed plants - though not to the extent given by Muriel Sweet.

**Adrian Wenner
Santa Barbara, California**

01 May 2000

A Chance Meeting and Perhaps Some Insights on the Spring Migration

Yesterday (Sunday 30 April 2000), while visiting the Baker Wetlands in south Lawrence with David Gibo, I stopped to chat with Lexie Powell, an avid birder, who has tagged with Monarch Watch. I asked Lexie if he had seen any Monarchs and he replied that he had seen 20-30 the previous day. We were astounded. I had only seen one Monarch this year (12 April) and had yet to find eggs even though Steve Case had found eggs on his milkweeds a few miles to the NW of Lawrence.

Naturally, we wanted to know where Lexie had seen these Monarchs and he directed us to a hilltop cemetery south of Lone Star Lake (SW of Lawrence). Lexie reported seeing Monarchs roosting in the tall pines and junipers at the cemetery. This sounded plausible so we obtained directions and reached the location in mid morning. Sure enough, the Monarchs were there. We managed to collect, [photograph, and release] 4, three males and one female while they visited dandelions for nectar. The Monarchs appeared to be moving through the area in mid day....

One question I have raised in the past concerns the sex ratio of the Monarchs that reach the limits of the northward migration for the overwintering generation. I knew that males reached KS but I had never seen enough of the worn and tattered migrants to get a

("DPLEX" CONTINUED ON PAGE 27)

ADOPT-A-CLASSROOM UPDATE

Mission accomplished. After two years of planning, fund raising, and collection of materials for the schools in Mexico near the Monarch overwintering sites, we finally made it. In January, we delivered school supplies and Math and Science kits to eighteen rural schools in the areas within and immediately adjacent to the Monarch sanctuaries. This trip was a huge success since it fulfilled our goal to assist the ejidos and communities in this region. I wish to thank all of you who contributed funds and classroom supplies or purchased Millennium Butterfly Garden Kits (a portion of the income from these kits

needs to be done. The communities and over 100 schools in the mountains surrounding the overwintering sites are in great need of assistance. With your help, we can continue to help these schools.

We are already planning the next trip. School supplies collected by students, teachers, and parents have been arriving over the last few weeks. These materials will be sorted into kits for the schools. Earlier in the spring, thanks to Jim Lee, manager of the Texas School Book

Depository we were able to obtain a donation of Spanish language Math and Science books for grades 1-5 valued at \$69,400. These materials are in storage in McAllen, Texas and we will pick them up on our way to Mexico this coming January. During our visits to the schools we asked the teachers what they would like us to bring next year. Most asked for additional science materials, particularly posters

and models that would facilitate the teaching of human health and physiology. If you know how to obtain donations of such materials, please let us know. We are also looking for used musical instruments, overhead projectors, simple microscopes, and other low-tech classroom equipment. Unfortunately, because of Mexican regulations and duties, we are unable to deliver used computers and other technical equipment to the schools.

Again, thank you for your interest in Adopt-A-Classroom. A copy of our Adopt-A-Classroom Annual Report



We were always greeted with many smiles!

Photo by Cathy Walters.

can be found on our Web site at www.MonarchWatch.org. If you would like a hard copy of this report, please let us know and we will mail one to you (while supplies last).

ADOPT-A-CLASSROOM A TEACHER'S PERSPECTIVE

**Janis Lentz, Jackson Elementary
McAllen, TX**

Collecting school supplies for Adopt-A-Classroom has become an important project for our class. We began two years ago by contacting other 5th grade classrooms in our school district, sending each class a letter and a hand-made poster urging them to collect dis-

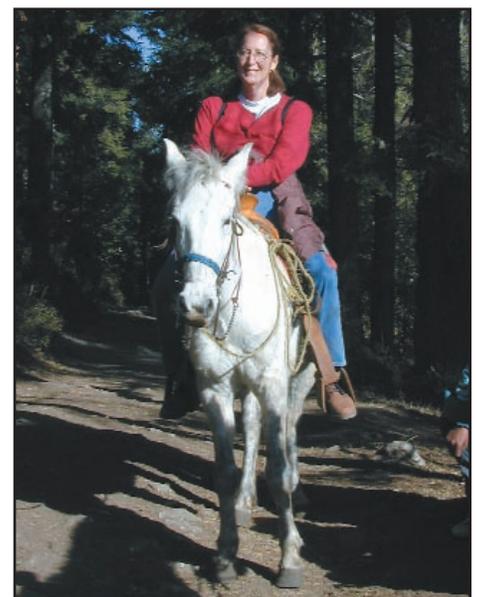
("ADOPT" CONTINUED ON PAGE 61)



The children at Escuela Guadalupe Victoria del Rosario clamoured to see themselves in the tiny display of our digital camera. After viewing each photo they all exclaimed: "¡Una más!" ("One more!"). Photo by Jim Lovett.

was used to finance the trip). We wish to thank, again, the many people mentioned in our Adopt-A-Classroom Annual Report who assisted in this endeavor both within the United States and Mexico. See page 4 for a complete list of contributors.

We achieved our goal and delivered a vanload of materials to the schools with a sense that we had helped in some way. However, despite our efforts in this major undertaking, I also had the feeling that we had accomplished very little relative to what



Janis and her mighty steed made the journey to see the Monarchs at Chincua.

Photo by Dana Wilfong.

("DPLEX" CONTINUED FROM PAGE 25)

sense of the proportion of males that reach this latitude (39°N). During two visits at the cemetery yesterday, we observed 15-20 Monarchs. Two of these were females but, judging by their flight behavior and coloration, the majority appeared to be males. Clearly, males are dispersing northward in significant numbers along with females....

The lesson in all of this might be the hill. The Monarchs appeared to be hilltopping and orienting to the tall pines and junipers in the cemetery. The trees formed an arc to the west in a manner that allowed the butterflies to sun themselves late in the day. In spite of being at the top of the hill, there were several areas that were relatively protected from the sweep of the wind. We visited the site again this evening and there were at least 4 worn Monarchs - probably all males - sunning themselves in the trees at heights of 12-35'. David pointed out that hilltopping is consistent with migratory behavior in the fall. In fact, Lexie mentioned that the concentrations of Monarchs in these same trees in the fall exceeds anything he has seen elsewhere in eastern KS. Although hilltops appear to be risky sites from the standpoint of storms and high winds, they would have the effect of protecting the Monarchs from frosts in the fall as well as the spring. Perhaps when looking for early fall and spring concentrations of Monarchs, we should give more consideration to hilltops.

Chip Taylor
University of Kansas
Lawrence, KS

10 Mar 1999

The Monarch Butterfly Sanctuary Foundation (MBSF)

Lincoln Brower, Monica Missrie and I just returned from a trip to the overwintering sanctuaries where we met with many people on monarch conservation. A summary of some of the things we learned, and did for MBSF follows.

We worked with Mexican researchers who are conducting careful studies of

the relationship between forest structure and butterfly survival and condition; conditions required for forest regeneration; and mortality in all of the overwintering colonies. It is clear that these studies must be carried out over many years, and their results compared with data collected during the breeding and migratory stages of the monarchs' life cycle, before we will have a good understanding of how best to preserve the endangered phenomenon of monarch migration. However, we strongly feel that there are things that need to be done even before we have all of this information, and our goal is to continue to push for immediate preservation even as we support work that may suggest better ways to do this. We are working with WWF-Mexico on a joint project to provide a recommendation to the Mexican government for an immediate protection scheme, based on the best available scientific data.

We met with Mexican non-profit organizations who are working to improve conditions of the members of the ejidos and communities that own land in the Monarch Butterfly Reserve. There is exciting work going on that will promote more sustainable lifestyles, such as reforestation of steep slopes and growing crops that produce more food per hectare, using more efficient stoves to decrease the amount of firewood taken out of the forests, and encouraging water and soil conservation. We are exploring ways to best support these kinds of projects.

An important goal of MBSF is to promote environmental education - among the children of the Reserve, adult members of the communities and ejidos, and visitors to the Reserve. We will work with Mexican researchers and ejido guides to prepare scientifically accurate informational materials for adults and tourists, and are involved in an on-going program to develop and disseminate materials from all of the monarch education already going on in the US, Canada and Mexico for Reserve Schools.

We met with members of these ejidos and communities, and talked with them about what they think needs to

be done to allow long-term co-existence of the people, the butterflies, and the forests. We are working with the women of one ejido on a project to develop alternative sources of income, and are helping them to find ways to export crafts to markets that will pay them a fair value. We have purchased over 600 baskets from them to use as premiums for donations, so they are benefitting twice from their work - first when they sell the baskets, and second when donations to MBSF are used to support economic development, conservation, and education in their communities.

We also had some time to study the butterflies while we were there, climbing to colonies on Cerro Pelon, Sierra Chincua and El Rosario and comparing butterfly behavior and condition in the colonies. The data we collected will be part of a several year study of these measures of the health of the colonies. We had the opportunity to view the colonies from a helicopter, seeing from above the incredible phenomenon of millions of butterflies forming an orange cloud surrounding the trees.

Karen Oberhauser
University of Minnesota
St. Paul, MN

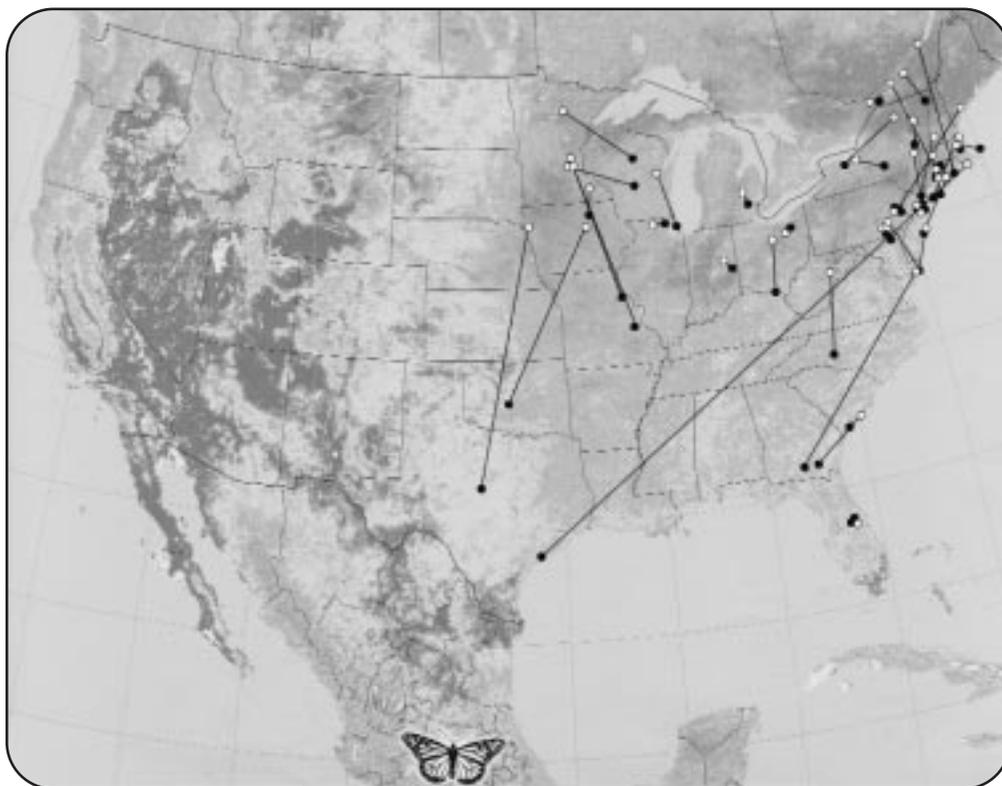
4TH OF JULY BUTTERFLY COUNTS

Each year, the North American Butterfly Association (NABA) sponsors the 4th of July Butterfly Count to track the butterfly populations of North America. Volunteers select a count area with a 15-mile diameter and conduct a one-day census of all butterflies sighted within that circle. These counts are usually held just before or after the 4th of July. During the 25th annual NABA count (summer, 1999) 387 counts were held. That's 10% more compared to the 352 counts in 1998. For more information on the program, counts in your area, or how to conduct a count, visit NABA's Web site at www.naba.org, or send a self-addressed, stamped business envelope to:

NABA-Butterfly Count • 4 Delaware
Road • Morristown, NJ 07960 USA

1999 MONARCH RECOVERY MAPS

RECOVERIES WITHIN THE UNITED STATES AND CANADA



This map represents Monarchs (N=46) tagged in 1999 and recovered at distances of 10 miles or greater within the United States and Canada. Recoveries lacking complete data are excluded (N=16).

Open circles = tagging sites
Closed circles = recovery sites

See recovery data on page 29.

ORIGINS OF TAGGED MONARCHS RECOVERED IN MEXICO

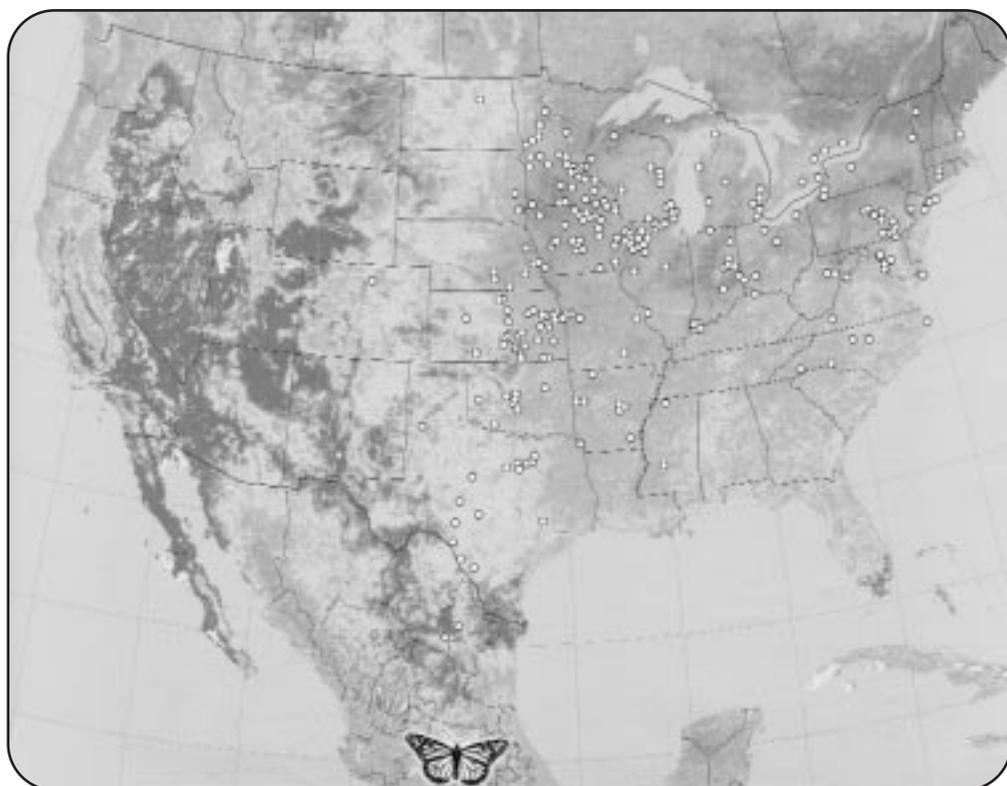
This map represents Monarchs (N=659) tagged in the United States, Canada, and Mexico recovered at the overwintering sites in Mexico during the winter of 1999-2000 (or previously unreported). Recoveries lacking complete data are excluded (N=30).

This was another record-breaking year for recoveries in Mexico!

Tagged in 1999: 638
*Tagged in 1998: 16
*Tagged in 1997: 5

*Previously unreported or recently acquired from local residents.

See recovery data on page 29.



1999 SEASON TAG RECOVERIES

This is a summary of tagged Monarchs recovered during the 1999-2000 season, listed by distance traveled. Due to space limitations, only Monarchs that traveled at least 10 miles are included here. A more complete data set may be found on our Web site. Recovery maps for the United States and Mexico generated using these data appear on page 28.

Please help by returning your data sheets. Our objective is to obtain accurate recovery data and use these data to establish the migratory routes taken by Monarchs. The ratio of recoveries to the numbers tagged helps us establish the effectiveness of our program. To obtain information on the numbers of Monarchs that were tagged, we need to have the data sheets returned to us. It is very time consuming and costly to track down recoveries without the data sheets. **Thanks!**

NUMBER OF MONARCH WATCH TAGGING KITS SENT OUT	1877
NUMBER OF MONARCH WATCH TAGS DISTRIBUTED	~ 248,000
ESTIMATED NUMBER OF MONARCHS TAGGED (BASED ON RETURNED DATA SHEETS)	63-74,000
MOST MONARCHS TAGGED BY ONE GROUP OR INDIVIDUAL (DON DAVIS, TORONTO, CA)	~ 1800
NUMBER OF MONARCH WATCH TAGS RECOVERED WITHIN THE UNITED STATES AND CANADA	62
NUMBER OF MONARCH WATCH TAGS RECOVERED IN MEXICO	689
TOTAL NEW MONARCH WATCH RECOVERIES REPORTED IN THIS SUMMARY.	751

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
972GM*	Heather Bellefleur	Durham, ME	08/19/99	02/00	El Rosario, MICH, MX	Bill Calvert	2421
097KD	Stephen Haydock	Salisbury, MA	09/12/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	2344
575NE	Nancy Smith	Essex Junction, VT	09/20/99	03/01/00	El Rosario, MICH, MX	David Marriott	2320
813GR	Edgar Caldwell	Bolton Landing, NY	09/24/99	01/14/00	El Rosario, MICH, MX	Carlos D. García	2258
117JC*	Edwin Wesely	Amherst, MA	09/01/99	02/00	El Rosario, MICH, MX	Bill Calvert	2255
007GO*	Lynn Frazier	Willimantic, CT	09/16/99	03/01/00	El Rosario, MICH, MX	David Marriott	2242
476KX*	Barbara Peck	West Hartford, CT	09/26/99	03/01/00	El Rosario, MICH, MX	David Marriott	2221
957GQ	David & Jayson Pambianchi	Flushing, NY	09/14/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	2136
421MU	Annie Mc Intyre	Long Island, NY	09/21/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	2130
448MU	Annie Mc Intyre	Long Island, NY	09/21/99	02/00	El Rosario, MICH, MX	Bill Calvert	2130
249KF	Donald Davis	Brighton, ONT	09/05/99	01/09/00	El Rosario, MICH, MX	Salvidor Soto Posadas	2128
418KF	Donald Davis	Brighton, ONT	09/06/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	2128
DX200	Donald Davis	Brighton, ONT	09/11/99	01/09/00	El Rosario, MICH, MX	Javier García Dominguez	2128
873KU	Donald Davis	Brighton, ONT	09/21/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	2128
925KU	Donald Davis	Brighton, ONT	09/21/99	03/01/00	El Rosario, MICH, MX	David Marriott	2128
657MI	James Kupcho	Sewaren, NJ	09/28/99	03/01/00	El Rosario, MICH, MX	David Marriott	2109
409GC*	Marisa Capuano	Brighton, NY	11/17/99	03/02/00	El Rosario, MICH, MX	David Marriott	2089
833KF	Donald Davis	Oshawa, ONT	09/12/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	2083
732KF	Donald Davis	Oshawa, ONT	09/12/99	01/11/00	El Rosario, MICH, MX	Saul Gonzales	2083
579KF	Donald Davis	Oshawa, ONT	09/12/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	2083
670NQ	Jane Bullis	Harmony, NJ	09/29/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	2080
946KF	Donald Davis	Toronto, ONT	09/18/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	2053
356KM	James Ellis	Toronto, ONT	09/12/99	03/01/00	El Rosario, MICH, MX	David Marriott	2053
718NW*	Celene Fidler	Pine Grove, PA	10/16/99	5/00	El Rosario, MICH, MX	David Marriott	2019
565JQ	Fred Habegger	Reinholds, PA	09/19/99	01/11/00	El Rosario, MICH, MX	Saul Gonzales	2018
044KO	Jerry Zeidler	Danville, PA	09/19/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	2016
366JN	Bill Ferguson	Jersey Shore, PA	09/13/99	03/01/00	El Rosario, MICH, MX	David Marriott	2012
577JQ	Fred Habegger	Akron, PA	09/20/99	03/08/00	El Rosario, MICH, MX	David Marriott	2010
799JN	Shafer	Mifflinburg, PA	09/06/99	03/08/00	El Rosario, MICH, MX	David Marriott	2009
393KP	Elizabeth & Donald Brobst	Woolrich, PA	09/04/99	02/00	El Rosario, MICH, MX	Bill Calvert	2008
723JM	Kari Snyder	Dunnville, ONT	09/03/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	2006
026JN	Kari Snyder	Dunnville, ONT	09/11/99	03/02/00	El Rosario, MICH, MX	David Marriott	2006
072JN	Kari Snyder	Dunnville, ONT	09/25/99	03/01/00	El Rosario, MICH, MX	David Marriott	2006
748KH	Mary Lou Kyle	Lock Haven, PA	09/15/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	2002
164JT	Michelle Ferris	Levering, MI	09/08/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	2000
254FD	Curt Huthens	Clear Lake, MN	09/17/99	01/09/00	El Rosario, MICH, MX	Baldomero S. Sanchez	1999
314GA	Virginia Foreman	Marquette, MI	08/26/99	01/14/00	El Rosario, MICH, MX	Jaime G. Gonzalez	1995
PG675	Karyl Mc Lean	Fredonia, NY	09/14/97	02/22/00	El Rosario, MICH, MX	Jessica Sheppard	1993
816GT	Karyl Mc Lean	Fredonia, NY	09/12/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1993
848GT	Karyl Mc Lean	Fredonia, NY	09/18/99	03/02/00	El Rosario, MICH, MX	David Marriott	1993
504GT	Karyl Mc Lean	Fredonia, NY	09/19/99	5/00	El Rosario, MICH, MX	David Marriott	1993

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
888KM	Gayle Steffy	Drumore, PA	09/10/99	01/09/00	El Rosario, MICH, MX	Carlos Hernandez Rivera	1992
835KM	Gayle Steffy	Drumore, PA	09/10/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1992
632NL	Jim Johnson	Teeterville, ONT	09/10/99	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	1992
835GX	Richard Humbert	Manchester, PA	09/06/99	03/01/00	El Rosario, MICH, MX	David Marriott	1985
851GX	Richard Humbert	Manchester, PA	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1985
221MJ	Kathy Arnold	Columbia, PA	09/19/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1980
348LQ*	Julie Clemens	Maple Springs, NY	09/05/99	03/01/00	El Rosario, MICH, MX	David Marriott	1978
260MP	Marsha Samson	Devil's Lake, ND	09/09/99	03/08/00	El Rosario, MICH, MX	David Marriott	1966
270MP*	Marsha Samson	Devil's Lake, ND	09/10/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1966
173MR*	Marsha Samson	Devil's Lake, ND	09/17/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1966
180MR	Marsha Samson	Devil's Lake, ND	09/17/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1966
571FC*	Locke	Bemedji, MN	09/02/99	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	1960
213JR	Denise Gibbs	Chincoteague, VA	09/30/99	5/00	El Rosario, MICH, MX	David Marriott	1959
767GY	Denise Gibbs	Chincoteague, VA	10/01/99	02/00	El Rosario, MICH, MX	Bill Calvert	1959
963GY	Denise Gibbs	Chincoteague, VA	10/02/99	02/00	El Rosario, MICH, MX	Bill Calvert	1959
348LZ	Denise Gibbs	Chincoteague, VA	10/02/99	02/24/00	Sierra Chincua, MICH, MX	Bill & Barbara Sheldon	1956
287ND	Frances Koontz	Bowie, MD	10/28/99	03/01/00	El Rosario, MICH, MX	David Marriott	1938
131GP	Ian Morris	Wallingford, CT	09/19/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1926
860KH	Patricia Ann Jaffray	Clarksburg, MD	09/19/99	03/01/00	El Rosario, MICH, MX	David Marriott	1926
891MZ	Jay Mc Roberts	Germantown, MD	09/04/99	01/11/00	El Rosario, MICH, MX	Maximo Dominguez Gonzalez	1924
825MW*	Tara Fletcher	Palisade, MN	09/02/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1907
129ID	Dexter Sharp	Clam Lake, WI	09/15/99	03/01/00	El Rosario, MICH, MX	David Marriott	1906
377HR	Judy Thoren	Osage, MN	08/26/99	03/07/00	El Rosario, MICH, MX	Nancy Greig	1903
337HR	Judy Thoren	Osage, MN	08/26/99	04/00	El Rosario, MICH, MX	Diego Castro Ruiz	1903
389KJ*	Judy Thoren	Osage, MN	08/27/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1903
255KJ*	Kathy Lentz	Capac, MI	08/31/99	02/00	El Rosario, MICH, MX	Bill Calvert	1903
993HI*	Susan Wilson	Bear Lake, MI	09/01/99	01/11/00	El Rosario, MICH, MX	Saul Gonzales	1894
433HA	Larry Brindza	Lorton, VA	09/19/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1892
312JL	Jerome Wiedmann	Painesville, OH	09/11/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1890
218JL	Jerome Wiedmann	Painesville, OH	09/19/99	02/00	El Rosario, MICH, MX	Bill Calvert	1890
186JL	Jerome Wiedmann	Painesville, OH	09/19/99	03/01/00	El Rosario, MICH, MX	David Marriott	1890
936MU	Carol Dutko	Washington, MI	09/13/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1884
109MC	Pam Owens	Mt Pleasant, MI	09/02/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1881
045MK	Pam Owens	Mt Pleasant, MI	09/09/99	03/01/00	El Rosario, MICH, MX	David Marriott	1881
179KN	Donna Haddon	Point Harbor, NC	09/26/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1880
397HH	Timothy Nowicki	Farmington Hills, MI	09/12/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1860
984HW	Gayle Beecher	Battle Lake, MN	08/16/99	01/09/00	El Rosario, MICH, MX	Modesto Gonzalez Gonzalez	1857
977HW	Gayle Beecher	Battle Lake, MN	08/16/99	03/01/00	El Rosario, MICH, MX	David Marriott	1857
376JY	Paul Viger	Campbell, MN	08/29/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1854
659FE	Renee Larsen	Fergus Falls, MN	09/19/99	02/00	El Rosario, MICH, MX	Bill Calvert	1853
684FE	Renee Larsen	Fergus Falls, MN	?	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1853
152HI*	Dana Wloch	Southgate, MI	09/14/99	02/00	El Rosario, MICH, MX	Bill Calvert	1850
613JI*	Audrey Kesson	Tigerton, WI	09/09/99	03/08/00	El Rosario, MICH, MX	David Marriott	1848
120MR	Susan Flynn	Alexandria, MN	?	01/25/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1847
149GA*	Sandy Segersin	Black Creek, WI	08/28/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1844
XA800*	Judy Thoren	Neenah, WI	09/11/98	01/09/00	Cerro Pelon, MEXICO, MX	Alejandro Malvaez	1839
544JY*	Paul Viger	Campbell, MN	08/25/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1838
392JY	Paul Viger	Campbell, MN	08/28/99	02/00	El Rosario, MICH, MX	Bill Calvert	1838
610FI	Paul Viger	Campbell, MN	09/06/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1838
597FI	Paul Viger	Campbell, MN	09/06/99	03/08/00	El Rosario, MICH, MX	David Marriott	1838
064JY	Tracey Piepenburg	Appleton, WI	09/08/99	03/02/00	El Rosario, MICH, MX	David Marriott	1832
004JY	Tracey Piepenburg	Appleton, WI	09/09/99	03/02/00	El Rosario, MICH, MX	David Marriott	1832
701HH	Dana Wloch	Monroe, MI	09/18/99	02/00	El Rosario, MICH, MX	Bill Calvert	1829
749HH	Dana Wloch	Monroe, MI	09/19/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1829
293MW	Potvin & Taber	Amery, WI	09/08/99	03/01/00	El Rosario, MICH, MX	David Marriott	1828
139NI	Andy Ziegler	Amery, WI	09/08/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1828
587KL	Judy Thoren	Neenah, WI	09/15/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1825
434KL	Judy Thoren	Neenah, WI	09/10/99	03/01/00	El Rosario, MICH, MX	David Marriott	1825
845HS	Kathryn Wedge	Neenah, WI	09/07/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1825
437FD	Madison School	St. Cloud, MN	09/27/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1821
936ON	Jean O' Brien	Glenwood, MN	09/19/99	02/00	El Rosario, MICH, MX	Bill Calvert	1816

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
775JP*	Sandy O'Brien	Glenwood, MN	09/12/99	03/01/00	El Rosario, MICH, MX	David Marriott	1816
588LF	Paula Waggy	Franklin, WV	09/20/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1814
974HQ	B. Reed	Oshkosh, WI	09/17/99	02/00	El Rosario, MICH, MX	Bill Calvert	1813
008JB	Malefut & Nylaan	Hudsonville, MI	09/11/99	5/00	El Rosario, MICH, MX	David Marriott	1809
935JI	Malefut & Nylaan	Hudsonville, MI	09/11/99	03/01/00	El Rosario, MICH, MX	David Marriott	1809
085FC	Jasken, Clark, Lhatka, & Schulz	Morris, MN	09/03/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1807
790HW	Anthony Jay	Morris, MN	08/23/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1807
850HW	Anthony Jay	Morris, MN	08/23/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1807
762HW	Anthony Jay	Morris, MN	08/23/99	02/00	El Rosario, MICH, MX	Bill Calvert	1807
934FB	Audre Ross	Morris, MN	09/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1807
839FB	Audre Ross	Morris, MN	09/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1807
944FB	Audre Ross	Morris, MN	09/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1807
933FB	Audre Ross	Morris, MN	09/99	03/01/00	El Rosario, MICH, MX	David Marriott	1807
882FB	Audre Ross	Morris, MN	09/99	03/01/00	El Rosario, MICH, MX	David Marriott	1807
690FB	Audre Ross	Morris, MN	09/99	02/00	El Rosario, MICH, MX	Bill Calvert	1807
851FB	Audre Ross	Morris, MN	09/02/99	02/00	El Rosario, MICH, MX	Bill Calvert	1807
307GB	Tom Kashmer	Fremont, OH	08/30/99	01/14/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1807
142GB	Tom Kashmer	Fremont, OH	08/31/99	01/11/00	El Rosario, MICH, MX	Modesto Gonzalez Gonzalez	1807
099NS*	Susan La Mora	Elkins, WV	09/22/99	02/00	El Rosario, MICH, MX	Bill Calvert	1806
558FC*	St Croix Nat'l Riverway	Stillwater, MN	09/02/99	03/01/00	El Rosario, MICH, MX	David Marriott	1805
504FO	M. Johnson	Mahtomedi, MN	10/06/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1803
673JC	Eastman Nature Center	Osseo, MN	09/05/99	01/09/00	El Rosario, MICH, MX	Jaime G. Gonzalez	1801
734JC*	Eastman Nature Center	Osseo, MN	09/15/99	02/00	El Rosario, MICH, MX	Bill Calvert	1801
749JC*	Eastman Nature Center	Osseo, MN	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1801
208FM*	Lori Funderburk	Brooklyn Park, MN	09/24/99	03/08/00	El Rosario, MICH, MX	David Marriott	1801
110FD*	Fernbrook Elementary	Maple Grove, MN	09/20/99	02/00	El Rosario, MICH, MX	Bill Calvert	1800
450JC	Dan Newbauer	Maple Grove, MN	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1800
310FN	Kelly Meyer	Maple Grove, MN	10/05/99	01/14/00	El Rosario, MICH, MX	Javier García Domínguez	1800
183HR	Judy Thoren	Buffalo, MN	08/23/99	03/01/00	El Rosario, MICH, MX	David Marriott	1800
569FO*	Adam Byer's 4th Grade Class	Mahtomedi, MN	09/24/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1799
216FN*	Prairie Woods Elem	New London, MN	10/06/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1796
808FN*	Bev Ramolae	Robbinsdale, MN	10/04/99	02/00	El Rosario, MICH, MX	Bill Calvert	1796
836FN*	Bev Ramolae	Robbinsdale, MN	10/08/99	03/01/00	El Rosario, MICH, MX	David Marriott	1796
631NI	Kelley Calhoon	Mansfield, OH	09/24/99	03/01/00	El Rosario, MICH, MX	David Marriott	1796
351FC	Teresa Root	St. Paul, MN	09/04/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1794
810FG*	Jane Reynolds	Plymouth, MN	11/05/99	01/14/00	El Rosario, MICH, MX	Javier García Domínguez	1794
741LF	Roianne Hackett	Buckhannon, WV	09/99	02/00	El Rosario, MICH, MX	Bill Calvert	1794
357FT*	Allen Fogel	Minneapolis, MN	09/29/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1793
476FJ*	Beth Ann Miller	Golden Valley, MN	10/06/99	03/08/00	El Rosario, MICH, MX	David Marriott	1793
956FF*	Sue Bauer	Minneapolis, MN	09/27/99	02/00	El Rosario, MICH, MX	Bill Calvert	1793
997FF*	Sue Bauer	Minneapolis, MN	09/30/99	03/08/00	El Rosario, MICH, MX	David Marriott	1793
208FQ*	Tammy Thelen	Minneapolis, MN	10/05/99	02/00	El Rosario, MICH, MX	Bill Calvert	1793
960FG	Terry Lee Terxoler	Minneapolis, MN	09/27/99	02/00	El Rosario, MICH, MX	Bill Calvert	1793
174FH	Terry Tervola	Minneapolis, MN	?	01/09/00	El Rosario, MICH, MX	Ramiro G. Martínez	1793
307FC	Dodge Nature Center	W St. Paul, MN	09/04/99	02/14/00	El Rosario, MICH, MX	Tom Pawlesh	1791
292FC	Dodge Nature Center	W St. Paul, MN	09/04/99	03/01/00	El Rosario, MICH, MX	David Marriott	1791
340FC	Dodge Nature Center	W St. Paul, MN	09/04/99	03/02/00	El Rosario, MICH, MX	David Marriott	1791
171FF	Chip Gulbranson	Edina, MN	?	02/00	El Rosario, MICH, MX	Bill Calvert	1787
165FF	Chip Gulbranson	Edina, MN	?	03/02/00	El Rosario, MICH, MX	David Marriott	1787
912FA	Farmington Elementary	Cannon Falls, MN	08/29/99	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	1783
551JC	Dan Newbauer	Bloomington, MN	09/05/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1783
580JC	Dan Newbauer	Bloomington, MN	09/06/99	03/01/00	El Rosario, MICH, MX	David Marriott	1783
124JD	Lowry Nature Center	Victoria, MN	09/11/99	03/01/00	El Rosario, MICH, MX	David Marriott	1781
122FC*	Lisa Tite	Chaska, MN	09/03/99	01/11/00	El Rosario, MICH, MX	Eliseo Gardino Martínez	1779
171FC*	Lisa Tite	Chaska, MN	09/07/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1779
468LL	Diane Falk	Antioch, IL	09/22/99	03/12/00	La Herrada, MEXICO, MX	David Marriott	1773
547FZ	Farmington Elementary	Farmington, MN	09/03/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1773
269JW	Logan Janka	Lake City, MN	09/04/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1772
264JW	Lucas Janka	Lake City, MN	09/04/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1772
204FA	Farmington Elementary	Cannon Falls, MN	08/20/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1768
614FA	Farmington Elementary	Cannon Falls, MN	08/25/99	03/01/00	El Rosario, MICH, MX	David Marriott	1768

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
725FA	Farmington Elementary	Cannon Falls, MN	08/25/99	03/08/00	El Rosario, MICH, MX	David Marriott	1768
131FZ	Farmington Elementary	Cannon Falls, MN	08/29/99	01/11/00	El Rosario, MICH, MX	Maximo Dominguez Gonzalez	1768
067FZ	Farmington Elementary	Cannon Falls, MN	08/29/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1768
442FZ	Farmington Elementary	Cannon Falls, MN	08/31/99	01/09/00	El Rosario, MICH, MX	Javier García Dominguez	1768
578FA	Tom Murphy	Cannon Falls, MN	08/25/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1768
CB013*	Linda Melton	Genesee Depot, WI	09/16/98	01/09/00	Cerro Pelon, MEXICO, MX	Alejandro Malvaez	1767
658LE	B. Ward Holz	Sparta, WI	?	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1764
661LE	B. Ward Holz	Sparta, WI	?	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1764
132LL*	Adeline Carlsen	Waukesha, WI	08/29/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1758
174LL*	Adeline Carlsen	Waukesha, WI	09/03/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1758
843JB	Cathy Chybowski	Wales, WI	09/24/99	03/08/00	El Rosario, MICH, MX	David Marriott	1755
549JI	Eric Howe	Racine, WI	09/03/99	01/11/00	El Rosario, MICH, MX	Maximo Dominguez Gonzalez	1751
275FB	Jim Gilbert	St. Peter, MN	09/16/99	5/00	El Rosario, MICH, MX	David Marriott	1742
204NP	Donna Mosca	Kansasville, WI	09/11/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1741
303JW	Greg & Linda Munson	Rochester, MN	?	02/00	El Rosario, MICH, MX	Bill Calvert	1741
121JW	Harvey Miller	Rochester, MN	08/31/99	03/01/00	El Rosario, MICH, MX	David Marriott	1741
847NE	Janice Quinn	Rochester, MN	09/12/99	02/00	El Rosario, MICH, MX	Bill Calvert	1741
196JW	Mae Miller	Rochester, MN	09/03/99	03/08/00	El Rosario, MICH, MX	David Marriott	1741
237JW	Ray Lundquist	Rochester, MN	09/08/99	03/08/00	El Rosario, MICH, MX	David Marriott	1741
427HE*	Pattie Minton	Dublin, OH	08/31/99	03/08/00	El Rosario, MICH, MX	David Marriott	1741
597JI	Eric Howe	Pleasant Prairie, WI	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1737
977JS*	Doug Kuehn	Granger, IN	08/18/99	01/09/00	El Rosario, MICH, MX	Javier García Dominguez	1736
250LK*	Doug Kuehn	Granger, IN	09/11/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1736
281LK*	Doug Kuehn	Granger, IN	09/13/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1736
315FU	Barb Frederick	Lake Elmo, MN	?	03/08/00	El Rosario, MICH, MX	David Marriott	1729
759HN	Bruce C. Adair	Chester, IA	09/06/99	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	1723
932GB	Rachel Kaufman	Durham, NC	09/25/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1720
006HO	Lee Zieke Lee	Burr Oak, IA	09/10/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1714
478HW	Harold Benecke	Belvidere, IL	09/13/99	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	1712
370HW	Larry Dolphin	Austin, MN	08/31/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1711
422HN*	The Larson Family	Decorah, IA	08/26/99	03/02/00	El Rosario, MICH, MX	David Marriott	1705
492HN	The Larson Family	Decorah, IA	08/28/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1705
512HN	Bruce C. Adair	Decorah, IA	08/28/99	03/02/00	El Rosario, MICH, MX	David Marriott	1705
920HN*	Lorraine & Harvey Houck	Decorah, IA	09/11/99	03/08/00	El Rosario, MICH, MX	David Marriott	1705
835HQ	Laura Lichtfuss	Oshkosh, WI	09/02/99	02/01/00	Palomas, MEXICO, MX	Eduardo Rendón	1705
137FU*	Cassie Swedlund	Juda, WI	09/23/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1704
402HW*	Harold Benecke	Marengo, IL	09/15/99	02/00	El Rosario, MICH, MX	Bill Calvert	1703
429HW*	Vera Benecke	Marengo, IL	09/10/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1703
789HR	The Outdoor Campus	Nunda, SD	?	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1702
822HR	The Outdoor Campus	Nunda, SD	?	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1702
773HR	The Outdoor Campus	Sioux Falls, SD	09/11/99	01/29/00	La Herrada, MEXICO, MX	Paul Cherubini	1702
479HW	Harold Benecke	Belvidere, IL	09/16/99	02/00	El Rosario, MICH, MX	Bill Calvert	1697
494HW	Harold Benecke	Belvidere, IL	09/23/99	03/01/00	El Rosario, MICH, MX	David Marriott	1697
244NE	Frank Taylor	Radford, VA	10/19/99	02/00	El Rosario, MICH, MX	Bill Calvert	1696
489HO	Jim, Linette, Grant & Lucas Langhus	Monona, IA	08/28/99	03/08/00	El Rosario, MICH, MX	David Marriott	1696
434HO	Jim, Linette, Grant & Lucas Langhus	Monona, IA	09/01/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1696
595HO	Jim, Linette, Grant & Lucas Langhus	Monona, IA	09/11/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1696
743HO	Jim, Linette, Grant & Lucas Langhus	Monona, IA	09/11/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1696
664HO	Jim, Linette, Grant & Lucas Langhus	Monona, IA	09/11/99	02/00	El Rosario, MICH, MX	Bill Calvert	1696
446HO	Jim, Linette, Grant & Lucas Langhus	Monona, IA	09/11/99	02/00	El Rosario, MICH, MX	Bill Calvert	1696
770HO	Jim, Linette, Grant & Lucas Langhus	Monona, IA	09/11/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1696
688HO	Jim, Linette, Grant & Lucas Langhus	Monona, IA	09/11/99	03/01/00	El Rosario, MICH, MX	David Marriott	1696
286KH	Cynthia Marino	Blue Earth, MN	08/31/99	01/11/00	El Rosario, MICH, MX	Eliseo Gardino Martinez	1694
350FE	Joan Stadel	Rockford, IL	09/99	02/00	El Rosario, MICH, MX	Bill Calvert	1694
497JR	Ruth Little	Rockford, IL	09/07/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1694
486JR	Ruth Little	Rockford, IL	09/07/99	01/14/00	El Rosario, MICH, MX	Ramiro G. Martinez	1694
788JR	Ruth Little	Rockford, IL	09/10/99	01/11/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1694
102FS*	Cheri Drever	Fairmont, MN	10/07/99	03/08/00	El Rosario, MICH, MX	David Marriott	1690
049HH	Lori Bareiss	Hartford City, IN	09/25/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1686
066LQ	Charles Cameron	Greensboro, NC	09/20/99	5/00	El Rosario, MICH, MX	David Marriott	1683
YD108	Joseph Bertolini	Waynesville, OH	09/12/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1678

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
XH198	The Outdoor Campus	Sioux Falls, SD	08/31/98	01/09/00	Cerro Pelon, MEXICO, MX	Alejandro Malvaez	1677
XH300	The Outdoor Campus	Sioux Falls, SD	09/04/98	01/25/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1677
680HR	The Outdoor Campus	Sioux Falls, SD	09/18/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1677
507NQ	Judy Younger & Marge Blake	Nora Springs, IA	09/20/99	01/27/00	El Rosario, MICH, MX	Paul Cherubini	1676
399HK	Lisa Ralls	ForeSt. City, IA	09/11/99	02/00	El Rosario, MICH, MX	Bill Calvert	1674
5D614	Jerry Wiedmann	Magnolia, MN	09/06/99	01/09/00	San Andres, MICH, MX	Hector Silva R.	1672
283KY	Chris Kline	Modoc, IN	09/19/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1671
260KY	Chris Kline	Modoc, IN	09/25/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1671
307JR	Sara Roy	Nashua, IA	09/05/99	02/00	El Rosario, MICH, MX	Bill Calvert	1670
142OO	Sheila Swift	Clear Lake, IA	09/18/99	03/08/00	El Rosario, MICH, MX	David Marriott	1670
183KY	Chris Kline	New Burlington, IN	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1669
292KY	Chris Kline	New Burlington, IN	09/18/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1669
411KD	Tricia Sheppard	Westport, MA	09/19/99	11/05/99	Palacios, TX	Karen Sikora	1667
706MR	Carole Lines	Marble Rock, IA	09/16/99	03/08/00	El Rosario, MICH, MX	David Marriott	1666
808HK	Stacey Newbrough	Tripoli, IA	09/06/99	03/08/00	El Rosario, MICH, MX	David Marriott	1665
548JP	Stacey Newbrough	Tripoli, IA	09/09/99	02/00	El Rosario, MICH, MX	Bill Calvert	1665
382NG	Monica Beitzel	Mt Carroll, IL	09/10/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1663
313HS	The Outdoor Campus	Sioux Falls, SD	08/31/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1662
303HS	The Outdoor Campus	Sioux Falls, SD	08/31/99	02/00	El Rosario, MICH, MX	Bill Calvert	1662
290HT	The Outdoor Campus	Sioux Falls, SD	08/31/99	03/08/00	El Rosario, MICH, MX	David Marriott	1662
333HS	The Outdoor Campus	Sioux Falls, SD	09/01/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1662
399HS	The Outdoor Campus	Sioux Falls, SD	09/01/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1662
332HS	The Outdoor Campus	Sioux Falls, SD	09/01/99	5/00	El Rosario, MICH, MX	David Marriott	1662
372HT	The Outdoor Campus	Sioux Falls, SD	09/02/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1662
991HR	The Outdoor Campus	Sioux Falls, SD	09/02/99	01/14/00	El Rosario, MICH, MX	Ramiro G. Martinez	1662
367HT	The Outdoor Campus	Sioux Falls, SD	09/02/99	5/00	El Rosario, MICH, MX	David Marriott	1662
043HS	The Outdoor Campus	Sioux Falls, SD	09/03/99	03/01/00	El Rosario, MICH, MX	David Marriott	1662
443HR	The Outdoor Campus	Sioux Falls, SD	09/03/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1662
637HR	The Outdoor Campus	Sioux Falls, SD	09/03/99	03/08/00	El Rosario, MICH, MX	David Marriott	1662
307HT	The Outdoor Campus	Sioux Falls, SD	09/04/99	01/11/00	El Rosario, MICH, MX	Baldomero S. Sanchez	1662
873HR	The Outdoor Campus	Sioux Falls, SD	09/06/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1662
162HS	The Outdoor Campus	Sioux Falls, SD	09/06/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1662
152KY	Chris Kline	New Burlington, IN	09/11/99	03/02/00	El Rosario, MICH, MX	David Marriott	1660
229KY	Chris Kline	New Burlington, IN	09/15/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1660
099MQ	Franklin County Conservation Bd	Sheffield, IA	09/07/99	02/00	El Rosario, MICH, MX	Bill Calvert	1656
304HG*	Joan Finney	Anderson, IN	09/03/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1656
320HG*	Joan Finney	Anderson, IN	09/06/99	03/01/00	El Rosario, MICH, MX	David Marriott	1656
111OT	Tom Kashmer	Liberty, IN	10/01/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1655
280HT	The Outdoor Campus	Tea, SD	08/30/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1654
278HT	The Outdoor Campus	Tea, SD	08/30/99	03/01/00	El Rosario, MICH, MX	David Marriott	1654
897HF	Richard Lee	Oxford, OH	09/13/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1654
599LU	Margaret Bausman	Thomson, IL	09/14/99	03/08/00	El Rosario, MICH, MX	David Marriott	1651
608LU	Margaret Bausman	Thomson, IL	09/23/99	5/00	El Rosario, MICH, MX	David Marriott	1651
255HN	Janice Gray	Preston, IA	10/05/99	03/08/00	El Rosario, MICH, MX	David Marriott	1651
110HX	Barry Bopes	Rock Falls, IL	09/04/99	02/00	El Rosario, MICH, MX	Bill Calvert	1649
124HX	Barry Bopes	Rock Falls, IL	09/06/99	5/00	El Rosario, MICH, MX	David Marriott	1649
794HM	Ann Burns	Maquoketa, IA	08/28/99	01/11/00	El Rosario, MICH, MX	Carlos Hernandez Rivera	1646
247HL	Shawn Gehlsen	Sanborn, IA	09/07/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1646
492KL	Tom Newman	Kewanee, IL	09/18/99	01/29/00	La Herrada, MEXICO, MX	Paul Cherubini	1644
650JW	Carol Boyce	Waterloo, IA	09/11/99	02/00	El Rosario, MICH, MX	Bill Calvert	1643
430JU	David Thompson	Waterloo, IA	09/06/99	03/01/00	El Rosario, MICH, MX	David Marriott	1643
255JU	David Thompson	Waterloo, IA	09/08/99	02/00	El Rosario, MICH, MX	Bill Calvert	1643
127HL	Mickey Johnson	Waterloo, IA	09/03/99	5/00	El Rosario, MICH, MX	David Marriott	1643
085HL	Mickey Johnson	Waterloo, IA	09/04/99	5/00	El Rosario, MICH, MX	David Marriott	1643
019HL	Mickey Johnson	Waterloo, IA	09/10/99	03/08/00	El Rosario, MICH, MX	David Marriott	1643
272JR	Sara Roy	Waterloo, IA	09/10/99	01/11/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1643
222JR	Sara Roy	Waterloo, IA	09/10/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1643
274JR	Sara Roy	Waterloo, IA	09/10/99	02/14/00	El Rosario, MICH, MX	Tom Pawlesh	1643
276JR	Sara Roy	Waterloo, IA	09/10/99	02/14/00	El Rosario, MICH, MX	Tom Pawlesh	1643
311JR	Sara Roy	Waterloo, IA	09/10/99	5/00	El Rosario, MICH, MX	David Marriott	1643
380NA	Mark Roberts	Baldwin, IA	09/24/99	02/00	El Rosario, MICH, MX	Bill Calvert	1643

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
956NL	Carla Hilgenberg	Clinton, IA	09/14/99	01/14/00	El Rosario, MICH, MX	Ramiro G. Martinez	1641
ZK011	Kelsey Johnson	Butler, KY	?	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1641
761HX	Stephanie Rickman	Geneseo, IL	09/15/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1633
574HK	Cindy Reher	Humboldt, IA	?	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1631
036JI	David Schanze	Grand Mound, IA	09/14/99	03/02/00	El Rosario, MICH, MX	David Marriott	1631
031JI	David Schanze	Grand Mound, IA	09/14/99	03/08/00	El Rosario, MICH, MX	David Marriott	1631
131JI	David Schanze	Grand Mound, IA	09/15/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1631
125JI	David Schanze	Grand Mound, IA	09/15/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1631
085JI	David Schanze	Grand Mound, IA	09/15/99	5/00	El Rosario, MICH, MX	David Marriott	1631
650X	Mary Ann Schanze	Grand Mound, IA	09/06/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1631
577X	Mary Ann Schanze	Grand Mound, IA	09/12/99	01/09/00	El Rosario, MICH, MX	Modesto Gonzalez Gonzalez	1631
867NA	Mark Roberts	Calamus, IA	09/10/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1629
563NA	Mark Roberts	Calamus, IA	09/11/99	03/01/00	El Rosario, MICH, MX	David Marriott	1629
071HP	Steve Gottschalk	Lowden, IA	09/10/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1628
939HK	Carol Groen	Grundy Center, IA	09/06/99	5/00	El Rosario, MICH, MX	David Marriott	1628
243JI	David Schanze	Long Grove, IA	09/22/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1625
208JX	Mary Ann Schanze	Long Grove, IA	09/10/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1625
251JX	Mary Ann Schanze	Long Grove, IA	09/10/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1625
814KZ	Cheryl Brooks	Dixon, IA	09/14/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1624
865JW	Carol Boyce	Dysart, IA	09/05/99	01/11/00	El Rosario, MICH, MX	Maximo Dominguez Gonzalez	1623
820HO	Cathy Irvine	Dysart, IA	09/11/99	02/00	El Rosario, MICH, MX	Bill Calvert	1623
821HO	Cathy Irvine	Dysart, IA	09/11/99	02/00	El Rosario, MICH, MX	Bill Calvert	1623
847HO	Cathy Irvine	Dysart, IA	09/12/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1623
846HO	Cathy Irvine	Dysart, IA	09/12/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1623
250HP	Dennis Herrick	Mount Vernon, IA	09/07/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1623
308HP	Dennis Herrick	Mount Vernon, IA	09/11/99	02/00	El Rosario, MICH, MX	Bill Calvert	1623
400OX	Dennis Herrick	Mount Vernon, IA	09/25/99	03/01/00	El Rosario, MICH, MX	David Marriott	1623
377OX	Dennis Herrick	Mount Vernon, IA	09/25/99	03/03/00	El Rosario, MICH, MX	David Marriott	1623
744HX	Stephanie Rickman	Geneseo, IL	09/05/99	03/01/00	El Rosario, MICH, MX	David Marriott	1618
730LB	Cheryl Brooks	EaSt. Moline, IL	09/14/99	01/11/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1616
849KZ	Cheryl Brooks	EaSt. Moline, IL	09/22/99	03/01/00	El Rosario, MICH, MX	David Marriott	1616
459NG	Monica Beitzel	Davenport, IA	09/16/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1615
501ND	JoAnn Whitmore	Milan, IL	09/15/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1609
939HO	Joan Felkner	Iowa City, IA	09/13/99	02/14/00	El Rosario, MICH, MX	Tom Pawlesh	1603
219IW	Mt Healthy School	Columbus, IN	09/26/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1600
907MC	Shauna Rogers	Nevada, IA	09/03/99	02/00	El Rosario, MICH, MX	Bill Calvert	1595
277HD	Bill Hilton Jr.	Belmont, NC	10/02/99	02/00	El Rosario, MICH, MX	Bill Calvert	1594
218HL	Marian Mc Nabb	Ames, IA	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1592
613LK	Royce Bitzer	Ames, IA	09/18/99	01/14/00	El Rosario, MICH, MX	Felipe Berrio Dominguez	1592
657LK	Royce Bitzer	Ames, IA	09/24/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1592
066JB	Nancy Kurrle	Boone, IA	09/06/99	02/00	El Rosario, MICH, MX	Bill Calvert	1591
EO012	Nancy Kurrle	Boone, IA	09/10/99	01/11/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1591
459MK*	Betty Kinzinger	Bloomington, IL	09/17/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1586
555LK	Royce Bitzer	Huxley, IA	09/06/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1584
342KZ	Deb Williams	Huxley, IA	09/07/99	01/14/00	El Rosario, MICH, MX	Carlos D. García	1584
350KZ	Deb Williams	Huxley, IA	09/07/99	02/00	El Rosario, MICH, MX	Bill Calvert	1584
335KZ	Deb Williams	Huxley, IA	09/07/99	03/01/00	El Rosario, MICH, MX	David Marriott	1584
382KZ	Deb Williams	Huxley, IA	09/09/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1584
414KZ	Deb Williams	Huxley, IA	09/10/99	5/00	El Rosario, MICH, MX	David Marriott	1584
547KZ	Deb Williams	Huxley, IA	09/14/99	01/09/00	El Rosario, MICH, MX	Baldomero S. Sanchez	1584
593KZ	Deb Williams	Huxley, IA	09/14/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1584
620KZ	Deb Williams	Huxley, IA	09/16/99	03/01/00	El Rosario, MICH, MX	David Marriott	1584
728KZ	Deb Williams	Huxley, IA	09/18/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1584
776KZ	Deb Williams	Huxley, IA	09/18/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1584
637LB	Deb Williams	Huxley, IA	09/18/99	5/00	El Rosario, MICH, MX	David Marriott	1584
539MY	Marge Middaugh	Glidden, IA	09/06/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1580
495HL	Dave Bowman	Carroll, IA	09/13/99	03/02/00	El Rosario, MICH, MX	David Marriott	1579
515KN	Kyle Harrigan	Altoona, IA	09/09/99	03/01/00	El Rosario, MICH, MX	David Marriott	1570
098OJ	Kyle Harrigan	Altoona, IA	09/24/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1570
273MO	Aaron Hershberger	Manning, IA	09/10/99	03/01/00	El Rosario, MICH, MX	David Marriott	1566
TT463	Susan Jahn	Des Moines, IA	09/15/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1563

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
350OU	Susan Jahn	Des Moines, IA	09/23/99	02/00	El Rosario, MICH, MX	Bill Calvert	1563
328OU	Susan Jahn	Des Moines, IA	09/23/99	5/00	El Rosario, MICH, MX	David Marriott	1563
213NG*	Maurice Le Master	Mt Pleasant, IA	10/02/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1553
958IN	Dale Mundil	Oakland, NE	09/09/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1547
944IN	Dale Mundil	Oakland, NE	09/09/99	03/08/00	El Rosario, MICH, MX	David Marriott	1547
022IO	Dale Mundil	Oakland, NE	09/10/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1547
052IO	Dale Mundil	Oakland, NE	09/10/99	03/01/00	El Rosario, MICH, MX	David Marriott	1547
041IO	Dale Mundil	Oakland, NE	09/10/99	03/08/00	El Rosario, MICH, MX	David Marriott	1547
053IO	Dale Mundil	Oakland, NE	09/10/99	02/00	El Rosario, MICH, MX	Bill Calvert	1547
926IN	Dale Mundil	Oakland, NE	09/13/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1547
191HY	Cathy Palm- Gessner	Macomb, IL	09/12/99	01/11/00	El Rosario, MICH, MX	Jorge Cruz de Jesús	1545
816OJ	Cathy Palm- Gessner	Macomb, IL	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1545
792MO	Cindi Pollmann	Drakesville, IA	09/10/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1531
310GD	Carlton Burke	Brevard, NC	09/29/99	03/09/00	Sierra Chincua, MICH, MX	David Marriott	1515
727JE*	Ken Staroska	Omaha, NE	09/22/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1512
OL507	Craig Hensley	Omaha, NE	09/25/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1512
094HM	Nancy Hubbard	Council Bluffs, IA	09/08/99	01/14/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1512
167HM	Nancy Hubbard	Council Bluffs, IA	09/11/99	03/08/00	El Rosario, MICH, MX	David Marriott	1512
282HM	Nancy Hubbard	Council Bluffs, IA	09/23/99	03/08/00	El Rosario, MICH, MX	David Marriott	1512
294HM	Nancy Hubbard	Council Bluffs, IA	09/24/99	01/09/00	El Rosario, MICH, MX	Javier García Dominguez	1512
328HM	Nancy Hubbard	Council Bluffs, IA	09/28/99	02/00	El Rosario, MICH, MX	Bill Calvert	1512
160HM	Nancy Hubbard	Council Bluffs, IA	09/11/99	03/10/00	Sierra Chincua, MICH, MX	David Marriott	1508
016JU	Kathleen Tack	Malvern, IA	09/17/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1500
313NH	Paul Opler & Evi Buckner	Ft. Collins, CO	09/18/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1486
037KL	Lynda Johnston	Newburgh, IN	09/03/99	5/00	El Rosario, MICH, MX	David Marriott	1482
272HH	Jeanne Brown	Evansville, IN	10/01/99	03/01/00	El Rosario, MICH, MX	David Marriott	1479
752NL	Sondra Cabell	Geneva, KY	09/18/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1478
530OR	Pam Mueller & Jennifer O'Brien	Lincoln, NE	09/24/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1473
550NO	Jan Tell	Grand Island, NE	09/24/99	02/00	El Rosario, MICH, MX	Bill Calvert	1472
426NH	Paul Opler & Evi Buckner	Ft. Collins, CO	09/15/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1470
450NH	Paul Opler & Evi Buckner	Ft. Collins, CO	09/17/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1470
098IK	Jane Koch	Hastings, NE	09/20/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1449
044IK	Jane Koch	Hastings, NE	09/20/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1449
051IK	Jane Koch	Hastings, NE	09/21/99	03/01/00	El Rosario, MICH, MX	David Marriott	1449
077IK	Jane Koch	Hastings, NE	09/23/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1449
069IK	Jane Koch	Hastings, NE	09/23/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1449
311IK	Jane Koch	Hastings, NE	09/27/99	02/00	El Rosario, MICH, MX	Bill Calvert	1449
562HY*	Tom Bratkowski	St. Louis, MO	09/21/99	02/00	El Rosario, MICH, MX	Bill Calvert	1442
679LP	Hebron Taggers	Hebron, NE	09/25/99	03/01/00	El Rosario, MICH, MX	David Marriott	1425
301LH	Gerald Axelbaum	Gray Summit, MO	09/13/99	5/00	El Rosario, MICH, MX	David Marriott	1419
411NZ	Ramo Decker	Formoso, KS	09/23/99	03/02/00	El Rosario, MICH, MX	David Marriott	1396
434KY	Chris Kline	Ft. Wayne, IN	09/13/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1393
571IA	Dan Dickinson	Kansas City, MO	10/06/99	01/09/00	El Rosario, MICH, MX	Jaime G. Gonzalez	1387
051IA	Suzette Slocomb	Kansas City, MO	09/25/99	01/09/00	El Rosario, MICH, MX	Modesto Gonzalez Gonzalez	1387
618KG	Michael Hicks	Blue Springs, MO	09/13/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1384
OX413	Karen De Victor	Lawrence, KS	?	01/09/00	Cerro Pelon, MEXICO, MX	Alejandro Malvaez	1381
729OT	Pat Wakeman	Tonganoxie, KS	08/23/99	5/00	El Rosario, MICH, MX	David Marriott	1378
735OT	Pat Wakeman	Tonganoxie, KS	08/24/99	03/02/00	El Rosario, MICH, MX	David Marriott	1378
565HZ*	Thompson & Seward	Centerview, MO	09/01/99	02/00	El Rosario, MICH, MX	Bill Calvert	1373
160IC	Harry McDonald	Overland Park, KS	08/28/99	5/00	El Rosario, MICH, MX	David Marriott	1371
394NU	Brian Blue	Wamego, KS	09/28/99	03/08/00	El Rosario, MICH, MX	David Marriott	1370
741IE	Marsha Collins	Wamego, KS	09/17/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1370
750IE	Marsha Collins	Wamego, KS	09/19/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1370
738IE	Marsha Collins	Wamego, KS	09/19/99	5/00	El Rosario, MICH, MX	David Marriott	1370
TA148	Megan McAfee	Wamego, KS	09/16/97	03/01/00	El Rosario, MICH, MX	David Marriott	1370
387NU	Terry Callender	Wamego, KS	09/28/99	01/14/00	El Rosario, MICH, MX	Ramiro G. Martinez	1370
380NU	Terry Callender	Wamego, KS	09/28/99	03/01/00	El Rosario, MICH, MX	David Marriott	1370
631MK	Kelly Borders	Olathe, KS	09/17/99	5/00	El Rosario, MICH, MX	David Marriott	1367
822NG	Kelly Gillespie	Lee's Summit, MO	09/24/99	02/00	El Rosario, MICH, MX	Bill Calvert	1367
642MM	Ken Schaid	Olathe, KS	09/23/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1367
994MP	Ken Schaid	Olathe, KS	09/26/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1367

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
781MN	Ken Schaid	Olathe, KS	09/26/99	02/00	El Rosario, MICH, MX	Bill Calvert	1367
552MU	Kyle Spears	Olathe, KS	09/26/99	01/09/00	El Rosario, MICH, MX	Jaime G. Gonzalez	1367
877MS	Melissa MacDonnel	Olathe, KS	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1367
701MK*	Micheal Steddium	Olathe, KS	09/21/99	03/01/00	El Rosario, MICH, MX	David Marriott	1367
020MQ*	Paula Donham	Olathe, KS	?	02/00	El Rosario, MICH, MX	Bill Calvert	1367
703MK	Thomas Powell	Olathe, KS	09/22/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1367
547OW	Carol Williamson	Olathe, KS	09/29/99	03/01/00	El Rosario, MICH, MX	David Marriott	1367
961MK	John Downing	Olathe, KS	09/23/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1367
104NU	Stone Nature Center	Topeka, KS	09/28/99	01/11/00	El Rosario, MICH, MX	Saul Gonzales	1366
114NU	Stone Nature Center	Topeka, KS	09/28/99	02/00	El Rosario, MICH, MX	Bill Calvert	1366
538NN	Briana Emst	Lawrence, KS	09/16/99	02/00	El Rosario, MICH, MX	Bill Calvert	1366
598OT	Bob Hagen	Lawrence, KS	09/15/99	5/00	El Rosario, MICH, MX	David Marriott	1366
536NN	Briana Emst	Lawrence, KS	09/16/99	5/00	El Rosario, MICH, MX	David Marriott	1366
586NN	Chris Tumberger	Lawrence, KS	09/16/99	02/00	El Rosario, MICH, MX	Bill Calvert	1366
151OM**	Dana Wilfong	Lawrence, KS	09/22/99	01/11/00	El Rosario, MICH, MX	Carlos Hernandez Rivera	1366
679MU**	Dana Wilfong	Lawrence, KS	09/22/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1366
499LZ**	Dana Wilfong	Lawrence, KS	09/22/99	02/00	El Rosario, MICH, MX	Bill Calvert	1366
821LZ**	Danny Umscheid	Lawrence, KS	09/22/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1366
322NP	Jerry Carbrey	Lawrence, KS	09/17/99	02/00	El Rosario, MICH, MX	Bill Calvert	1366
490NN	John Slater	Lawrence, KS	09/16/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1366
722NN	Josh Lye	Lawrence, KS	09/16/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1366
352NI	Karen De Victor	Lawrence, KS	09/23/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1366
403JZ	Kathy Davis	Lawrence, KS	09/21/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1366
399JZ	Kathy Davis	Lawrence, KS	09/21/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1366
417JZ	Kathy Davis	Lawrence, KS	09/22/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1366
467JZ	Kathy Davis	Lawrence, KS	09/23/99	02/00	El Rosario, MICH, MX	Bill Calvert	1366
115NC	Kelly Barth & Lisa Grossman	Lawrence, KS	09/11/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1366
870JZ*	Ken Highfill	Lawrence, KS	09/17/99	03/02/00	El Rosario, MICH, MX	David Marriott	1366
447NN	Mackenzie Wiglesworth	Lawrence, KS	09/16/99	02/14/00	El Rosario, MICH, MX	Tom Pawlesh	1366
451NN	Mandy Meister	Lawrence, KS	09/16/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1366
183MX	Marty Birrell	Lawrence, KS	09/18/99	03/01/00	El Rosario, MICH, MX	David Marriott	1366
209MX	Marty Birrell	Lawrence, KS	09/22/99	02/00	El Rosario, MICH, MX	Bill Calvert	1366
302MX	Marty Birrell	Lawrence, KS	09/24/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1366
314MX	Marty Birrell	Lawrence, KS	09/25/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1366
337MX	Marty Birrell	Lawrence, KS	09/26/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1366
198KA	Sandy Collins	Lawrence, KS	?	03/01/00	El Rosario, MICH, MX	David Marriott	1366
TO885	Walter Knapp	Lawrence, KS	10/04/97	01/14/00	El Rosario, MICH, MX	Jesús Hernandez	1366
415E	Diane Kent & Roger Gibson	Manhattan, KS	09/30/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1366
710JD	Kirk Hafliker	Wakeeney, KS	09/27/99	12/30/99	Valle de Bravo, MEXICO, MX	Alex García	1366
SL170	Beverly Mortimer	Delphos, KS	09/17/97	03/01/00	El Rosario, MICH, MX	David Marriott	1362
224IB	Calvin Cink	Baldwin City, KS	09/16/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1355
963IG	John Wachholz	Salina, KS	09/19/99	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	1348
430IH	John Wachholz	Salina, KS	09/30/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1348
129KY	Chris Kline	Modoc, IN	09/19/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1343
705JD	Kirk Halfiger	Wakeeney, KS	09/27/99	03/01/00	El Rosario, MICH, MX	David Marriott	1337
923IG	John Wachholz	Salina, KS	09/09/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1332
917IG	John Wachholz	Salina, KS	09/09/99	02/00	El Rosario, MICH, MX	Bill Calvert	1332
972IG	John Wachholz	Salina, KS	09/19/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1332
937IG	John Wachholz	Salina, KS	09/19/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1332
013IH	John Wachholz	Salina, KS	09/22/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1332
023IH	John Wachholz	Salina, KS	09/22/99	5/00	El Rosario, MICH, MX	David Marriott	1332
041IH	John Wachholz	Salina, KS	09/23/99	01/09/00	El Rosario, MICH, MX	Baldomero S. Sanchez	1332
097IH	John Wachholz	Salina, KS	09/24/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1332
056IH	John Wachholz	Salina, KS	09/24/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1332
222IH	John Wachholz	Salina, KS	09/27/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1332
296IH	John Wachholz	Salina, KS	09/27/99	02/00	El Rosario, MICH, MX	Bill Calvert	1332
482IH	John Wachholz	Salina, KS	10/01/99	03/01/00	El Rosario, MICH, MX	David Marriott	1332
981NJ	W. I. Wells	Summersville, MO	09/29/99	01/25/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1331
781MP	Stattelman Family	Reading, KS	09/18/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1328
857MP	Anna Sielert & Kristen Garcia	Lebo, KS	09/18/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	1322
PO227	Patty Delmott	Melvern Lake, KS	09/13/97	01/09/00	El Rosario, MICH, MX	Javier García Dominguez	1322

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
934MP	William Kimble	Melvorn Lake, KS	09/18/99	03/01/00	El Rosario, MICH, MX	David Marriott	1322
CQ162	Michael Craig	McPherson, KS	09/18/98	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1317
CR439	Michael Craig	McPherson, KS	09/27/98	01/09/00	Cerro Pelon, MEXICO, MX	Alejandro Malvaez	1317
139KM	Charles Green	El Dorado, KS	09/19/99	03/12/00	La Herrada, MEXICO, MX	David Marriott	1307
659II	Loretta Snelling	Marion, KS	10/04/99	02/00	El Rosario, MICH, MX	Bill Calvert	1305
EN129	Karen Fulk	Hesston, KS	09/24/98	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1303
943OH	Case Family	McPherson, KS	09/23/99	03/01/00	El Rosario, MICH, MX	David Marriott	1301
900OH	Case Family	McPherson, KS	09/26/99	02/00	El Rosario, MICH, MX	Bill Calvert	1301
099JS	Michael Craig	McPherson, KS	09/17/99	03/01/00	El Rosario, MICH, MX	David Marriott	1301
179MM	Bruce Stucky	Goessel, KS	09/21/99	5/00	El Rosario, MICH, MX	David Marriott	1295
030ML	Bruce Stucky	Goessel, KS	09/27/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1295
979MK	Bruce Stucky	Goessel, KS	09/27/99	03/02/00	El Rosario, MICH, MX	David Marriott	1295
769ML	Bruce Stucky	Goessel, KS	?	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1295
009MM	Felicia Goertzen	Goessel, KS	09/21/99	01/11/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1295
006MM	Felicia Goertzen	Goessel, KS	09/21/99	01/14/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1295
021MM	Felicia Goertzen	Goessel, KS	09/21/99	01/27/00	El Rosario, MICH, MX	Paul Cherubini	1295
148NK	Kelly Jost	Goessel, KS	09/13/99	03/08/00	El Rosario, MICH, MX	David Marriott	1295
063NH	Kelly Jost	Goessel, KS	09/19/99	01/09/00	El Rosario, MICH, MX	Baldomero S. Sanchez	1295
058NH	Kelly Jost	Goessel, KS	09/19/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1295
009NH	Kelly Jost	Goessel, KS	10/16/99	5/00	El Rosario, MICH, MX	David Marriott	1295
EL766	Lance Hiebert	Goessel, KS	09/24/98	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1295
840ML	Ryan Janzen	Goessel, KS	09/27/99	01/09/00	El Rosario, MICH, MX	Carlos Hernandez Rivera	1295
841ML*	Ryan Janzen	Goessel, KS	09/27/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1295
844ML	Ryan Janzen	Goessel, KS	09/27/99	01/11/00	El Rosario, MICH, MX	Jorge Cruz de Jesús	1295
038ML	Ryan Janzen	Goessel, KS	09/27/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1295
055ML	Ryan Janzen	Goessel, KS	09/27/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1295
814ML	Ryan Janzen	Goessel, KS	09/27/99	03/01/00	El Rosario, MICH, MX	David Marriott	1295
506MT	Dixie Quincy	Iola, KS	?	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1295
178MX	Marty Birrell	Topeka, KS	09/18/99	02/01/00	San Francisco, MEXICO, MX	Eduardo Rendón	1294
468MY	Night	Wichita, KS	09/23/99	03/12/00	La Herrada, MEXICO, MX	David Marriott	1284
ED305	Megan Harris	Moundridge, KS	09/30/98	01/16/99	El Rosario, MICH, MX	Thomas Emmel	1291
200NL	Al Neufeld	Moundridge, KS	09/28/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1291
192NL	Al Neufeld	Moundridge, KS	09/29/99	5/00	El Rosario, MICH, MX	David Marriott	1291
030OZ	Al Neufeld	Moundridge, KS	10/07/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1291
121MN	Bev Regehr	Inman, KS	09/25/99	01/17/00	El Rosario, MICH, MX	Leah Smiths	1291
134MN	Bev Regehr	Inman, KS	09/25/99	03/08/00	El Rosario, MICH, MX	David Marriott	1291
538JR	Karen Engle	Hamilton, KS	09/20/99	01/11/00	El Rosario, MICH, MX	Eliseo Gardino Martinez	1289
187ID	Lou Didier	Newton, KS	09/30/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1282
599OC	Chanda Regier	Hutchinson, KS	10/04/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1279
442OR	Ellis Miller	Hutchinson, KS	09/24/99	02/00	El Rosario, MICH, MX	Bill Calvert	1279
512OR	Ellis Miller	Hutchinson, KS	09/24/99	02/00	El Rosario, MICH, MX	Bill Calvert	1279
481LY	Mary Clark	Hutchinson, KS	10/05/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1279
030NW	Janice Adams	El Dorado, KS	10/06/99	5/00	El Rosario, MICH, MX	David Marriott	1271
047KM	Charles Green	El Dorado, KS	09/18/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1271
723KB	Darrell Terbush	Valley Center, KS	09/24/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	1267
789KB	Darrell Terbush	Valley Center, KS	09/29/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1267
EK121	Doris Mc Clure	Pretty Prairie, KS	09/25/98	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1258
178MY	Anderson	Wichita, KS	09/24/99	03/01/00	El Rosario, MICH, MX	David Marriott	1257
032MY	Dora	Wichita, KS	10/06/99	03/01/00	El Rosario, MICH, MX	David Marriott	1257
437MY	Barbara Yarnall	Wichita, KS	09/20/99	01/09/00	El Rosario, MICH, MX	Baldomero S. Sanchez	1257
768LK	Karla Jahn	Wichita, KS	09/24/99	02/00	El Rosario, MICH, MX	Bill Calvert	1257
542LS	Karla Jahn	Wichita, KS	09/25/99	01/26/00	El Rosario, MICH, MX	Paul Cherubini	1257
501LS	Karla Jahn	Wichita, KS	09/29/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1257
298MY	Pat Mc Kernan	Wichita, KS	10/05/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1257
288LO	Tammy Decker	Wichita, KS	09/25/99	01/27/00	El Rosario, MICH, MX	Paul Cherubini	1257
045NO	Nicholas Rau	Elk City, KS	09/17/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1246
075NO	Nicholas Rau	Elk City, KS	09/19/99	03/01/00	El Rosario, MICH, MX	David Marriott	1246
056NO	Nicholas Rau	Elk City, KS	?	03/08/00	El Rosario, MICH, MX	David Marriott	1246
882MG	Cheryl Haley	Independence, KS	09/17/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	1244
394OY	Linda Koehn	Mullinville, KS	?	02/00	El Rosario, MICH, MX	Bill Calvert	1239
067JS	Sharon Howard	Udall, KS	09/30/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1239

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
412HP	Sherry Middlemis	WeSt. Branch, IA	09/16/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1239
Z1591	Amanda Rhymer	Olive Branch, MS	09/20/98	01/11/00	El Rosario, MICH, MX	Eliseo Gardino Martinez	1235
108LI	Josh Arnold & Donna Hill	Oak Grove, AR	09/20/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1232
321II	Shawn Silliman	Arkansas City, KS	09/30/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1218
344II	Shawn Silliman	Arkansas City, KS	10/01/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1218
587LK	Royce Bitzer	Ames, IA	09/08/99	03/01/00	El Rosario, MICH, MX	David Marriott	1214
726LK	Royce Bitzer	Ames, IA	09/25/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1214
510KZ	Deb Williams	Huxley, IA	09/13/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1206
065OJ	Kyle Harrigan	Altoona, IA	09/18/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1193
497LE	Judy Cox's Class	Vilonia, AR	09/23/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1174
524LE	Judy Cox's Class	Vilonia, AR	09/24/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1174
219LE	Carmen Tharp	Cabot, AR	09/24/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1172
429JJ	Pat Mc Donald	N Little Rock, AR	09/25/99	03/08/00	El Rosario, MICH, MX	David Marriott	1155
056LF*	Pat Mc Donald	N Little Rock, AR	10/04/99	01/09/00	El Rosario, MICH, MX	Baldomero S. Sanchez	1155
488JJ	Pat Mc Donald	Little Rock, AR	09/29/99	01/09/00	El Rosario, MICH, MX	Javier García Dominguez	1148
395LG	Charleston Elementary	Charleston, AR	10/05/99	03/01/00	El Rosario, MICH, MX	David Marriott	1145
393LG	Charleston Elementary	Charleston, AR	10/05/99	03/01/00	El Rosario, MICH, MX	David Marriott	1145
487KC	Carol Bricker	Ft. Smith, AR	09/23/99	03/01/00	El Rosario, MICH, MX	David Marriott	1143
903KB	Carol Bricker	Ft Smith, AR	09/23/99	5/00	El Rosario, MICH, MX	David Marriott	1143
801LG	Amy Newman	Henderson, KY	09/08/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1142
A5555	Washington Irving Elementary	Edmond, OK	10/26/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1135
881IO	Rosemary Smith	Logan City, OK	09/24/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	1131
883IO	Rosemary Smith	Logan City, OK	09/24/99	02/00	El Rosario, MICH, MX	Bill Calvert	1131
478LX	Bob Melton	Oklahoma City, OK	09/23/99	01/29/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	1120
406GC	Sharon Norris	Okarche, OK	10/02/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1118
566IQ	Paul Southerland	Oklahoma City, OK	09/23/99	01/14/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1105
618IQ	Paul Southerland	Oklahoma City, OK	09/23/99	5/00	El Rosario, MICH, MX	David Marriott	1105
503ME	Scott Martin	Oklahoma City, OK	09/30/99	03/01/00	El Rosario, MICH, MX	David Marriott	1105
448ME	Scott Martin	Oklahoma City, OK	10/01/99	03/08/00	El Rosario, MICH, MX	David Marriott	1105
344LU	Scott Martin	Oklahoma City, OK	?	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1105
873OB	Sharon Shrum	Oklahoma City, OK	?	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1105
120LS	Sharon Shrum	Oklahoma City, OK	?	02/00	El Rosario, MICH, MX	Bill Calvert	1105
462IS	Brenda Christian	Hammon, OK	10/02/99	01/09/00	El Rosario, MICH, MX	Jaime G. Gonzalez	1104
582LN	Jim Edson	Monticello, AR	09/21/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	1098
412LH*	Jim Edson	Monticello, AR	09/25/99	03/02/00	El Rosario, MICH, MX	David Marriott	1098
143IP	Pat & Walter Reif	Norman, OK	09/27/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	1090
352IP	Pat & Walter Reif	Norman, OK	09/30/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	1090
101HB	Pat & Walter Reif	Norman, OK	10/01/99	01/09/00	El Rosario, MICH, MX	Modesto Gonzalez Gonzalez	1090
925HC	Pat & Walter Reif	Norman, OK	10/01/99	03/01/00	El Rosario, MICH, MX	David Marriott	1090
369JA	Bill Stark	Clinton, MS	10/02/99	03/01/00	El Rosario, MICH, MX	David Marriott	1072
ZK327	Kathleen Hargis	Cache, OK	10/09/98	01/09/00	Cerro Pelon, MEXICO, MX	Alejandro Malvaez	1055
027IS	Randy Laurence	Dimmit, TX	10/08/99	03/01/00	El Rosario, MICH, MX	David Marriott	1035
830LE	Anita Brisco	Texarkana, AR	10/03/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	1028
ZL024	David Palmer	McKinney, TX	10/15/98	01/26/00	El Rosario, MICH, MX	Paul Cherubini	962
579LW	Bob Adams	Addison, TX	10/01/99	03/01/00	El Rosario, MICH, MX	David Marriott	943
772LW	Bob Adams	Addison, TX	10/05/99	03/01/00	El Rosario, MICH, MX	David Marriott	943
873LW	Bob Adams	Addison, TX	10/08/99	02/00	El Rosario, MICH, MX	Bill Calvert	943
953LW	Bob Adams	Addison, TX	10/20/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	943
674LW	Bob Adams	Addison, TX	?	03/01/00	El Rosario, MICH, MX	David Marriott	943
DL523	Richard Sitora	Addison, TX	10/08/98	01/09/00	San Andres, MICH, MX	Takashi Miyagawa	943
696GR*	Jenny Singleton	Grapevine, TX	10/15/99	01/09/00	El Rosario, MICH, MX	Baldomero S. Sanchez	938
761LA	Marvin Phillips	Eagle Mountain, TX	10/03/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	931
790GG	David Powell	Fort Worth, TX	09/30/99	01/09/00	El Rosario, MICH, MX	Jaime G. Gonzalez	923
459KT	David Powell	Fort Worth, TX	10/04/99	01/14/00	El Rosario, MICH, MX	Javier García Dominguez	923
442KT	David Powell	Fort Worth, TX	10/04/99	03/08/00	El Rosario, MICH, MX	David Marriott	923
601KT	David Powell	Fort Worth, TX	10/06/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	923
322OQ	Rome Milan	Fort Worth, TX	09/30/99	01/09/00	El Rosario, MICH, MX	Antonio García García	923
542OQ	Rome Milan	Fort Worth, TX	10/03/99	03/01/00	El Rosario, MICH, MX	David Marriott	923
291LL	Paul Duesterheft	Mineral Wells, TX	10/01/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	919
175LT	Paul Duesterheft	Mineral Wells, TX	10/03/99	5/00	El Rosario, MICH, MX	David Marriott	919
212LT	Paul Duesterheft	Mineral Wells, TX	10/04/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	919

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
UX531	Paul Duesterheft	Mineral Wells, TX	10/06/99	03/08/00	El Rosario, MICH, MX	David Marriott	919
498KS	Gary Musgrove	Abilene, TX	10/07/99	03/12/00	La Herrada, MEXICO, MX	David Marriott	914
390KS	Gary Musgrove	Abilene, TX	10/07/99	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	900
637KS	Gary Musgrove	Abilene, TX	10/07/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	884
500KS	Gary Musgrove	Abilene, TX	10/07/99	01/14/00	El Rosario, MICH, MX	Javier García Domínguez	884
532KS	Gary Musgrove	Abilene, TX	10/07/99	02/00	El Rosario, MICH, MX	Bill Calvert	884
001KR	Gary Musgrove	Abilene, TX	10/08/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	884
844KR	Gary Musgrove	Abilene, TX	10/08/99	01/29/00	La Herrada, MEXICO, MX	Paul Cherubini	884
449KS	Gary Musgrove	Abilene, TX	10/08/99	02/00	El Rosario, MICH, MX	Bill Calvert	884
652KR	Gary Musgrove	Abilene, TX	10/09/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	884
140KS	Gary Musgrove	Abilene, TX	10/09/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	884
343KR	Gary Musgrove	Abilene, TX	10/14/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	884
221KR	Gary Musgrove	Abilene, TX	10/14/99	02/00	El Rosario, MICH, MX	Bill Calvert	884
337KR	Gary Musgrove	Abilene, TX	10/14/99	5/00	El Rosario, MICH, MX	David Marriott	884
317KR	Gary Musgrove	Abilene, TX	10/15/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	884
976KR	Gary Musgrove	Abilene, TX	10/15/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	884
509KR	Gary Musgrove	Abilene, TX	10/15/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	884
479KR	Gary Musgrove	Abilene, TX	10/15/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	884
443KR	Gary Musgrove	Abilene, TX	10/15/99	02/00	El Rosario, MICH, MX	Bill Calvert	884
495KR	Gary Musgrove	Abilene, TX	10/15/99	02/00	El Rosario, MICH, MX	Bill Calvert	884
460KR	Gary Musgrove	Abilene, TX	10/16/99	03/08/00	El Rosario, MICH, MX	David Marriott	884
624IT	Julia Baker	Abilene, TX	10/04/99	03/02/00	El Rosario, MICH, MX	David Marriott	884
YC353	Julia Baker	Abilene, TX	10/05/98	01/27/00	El Rosario, MICH, MX	Paul Cherubini	884
352GI	Central High	San Angelo, TX	10/11/99	02/00	El Rosario, MICH, MX	Bill Calvert	814
398GI	Ladonna Kirby	San Angelo, TX	10/06/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	814
399GI	Ladonna Kirby	San Angelo, TX	10/06/99	03/02/00	El Rosario, MICH, MX	David Marriott	814
036GJ	Mary Pilsitz	San Angelo, TX	10/11/99	01/14/00	El Rosario, MICH, MX	Fortino Sanchez Romero	814
160GI	Monica Vinfranco & Stacy Trevino	San Angelo, TX	10/16/99	03/01/00	El Rosario, MICH, MX	David Marriott	814
683LX	David Gibo	Snook, TX	10/16/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	786
612GK	Jenny Singleton	Hext, TX	10/08/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	776
916GF	Jenny Singleton	Hext, TX	10/09/99	02/00	El Rosario, MICH, MX	Bill Calvert	776
633GK	Jenny Singleton	Hext, TX	10/08/99	02/21/00	El Rosario, MICH, MX	Mary Kennedy	776
922GF	Jenny Singleton	Hext, TX	10/09/99	01/09/00	El Rosario, MICH, MX	Javier García Domínguez	776
CU880	Carol Love	Sonora, TX	10/06/99	01/09/00	El Rosario, MICH, MX	Ramiro G. Martinez	754
TX051	Carol Love	Sonora, TX	10/06/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	754
TX089	Carol Love	Sonora, TX	10/06/99	02/00	El Rosario, MICH, MX	Ignacio Alonso Guadalupe Mejia	754
161NP	Doug Herman	Sioux City, IA	09/18/99	10/11/99	Lake Brownwood, TX	M. Dryden	752
812IR*	St. James Episcopal School	Del Rio, TX	10/08/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	673
857IR	St. James Episcopal School	Del Rio, TX	10/13/99	01/14/00	El Rosario, MICH, MX	Javier García Domínguez	673
389JM	David Larson	Del Rio, TX	10/12/99	01/14/00	El Rosario, MICH, MX	Guadalupe de Jesús Hernandez	673
378JM	David Larson	Del Rio, TX	10/12/99	5/00	El Rosario, MICH, MX	David Marriott	673
969JL	David Larson	Del Rio, TX	10/13/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	673
964JL	David Larson	Del Rio, TX	10/13/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	673
027JM	David Larson	Del Rio, TX	10/14/99	01/09/00	El Rosario, MICH, MX	Javier García Domínguez	673
988JL	David Larson	Del Rio, TX	10/14/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	673
006JM	David Larson	Del Rio, TX	10/14/99	03/01/00	El Rosario, MICH, MX	David Marriott	673
058JM	David Larson	Del Rio, TX	10/15/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	673
092JM	David Larson	Del Rio, TX	10/20/99	5/00	El Rosario, MICH, MX	David Marriott	673
996IR	Randy Laurence	Quemado, TX	10/15/99	01/25/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	659
891GY	Denise Gibbs	Chincoteague, VA	10/01/99	10/14/99	Nashville, GA	Gavin Adams	647
284IS	Randy Laurence	Quemado, TX	10/10/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	643
296IS	Randy Laurence	Quemado, TX	10/10/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	643
103IS*	Randy Laurence	Quemado, TX	10/13/99	01/09/00	El Rosario, MICH, MX	Martin Mondragón Hernandez	643
962IR	Randy Laurence	Quemado, TX	10/15/99	01/09/00	El Rosario, MICH, MX	Javier García Domínguez	643
179IS	Randy Laurence	Crystal City, TX	10/08/99	02/08/00	El Rosario, MICH, MX	Cathy Wertz	625
045IS	Randy Laurence	Crystal City, TX	10/08/99	02/00	El Rosario, MICH, MX	Bill Calvert	625
903HK	Carol Groen	Grundy Center, IA	09/06/99	09/26/99	Norman, OK	Walter & Pat Reif	550
911FQ*	Linda Chaffee-Hampton	Minneapolis, MN	10/05/99	10/17/99	Blackwell, MO	Nicole Peppers	497
031FE*	Jacob Reed	Andover, MN	08/27/99	09/22/99	Bowling Green, MO	Jody Green	423
DL875	Rocío Treviño	Saltillo, MX	10/28/98	01/25/00	Cerro Pelon, MEXICO, MX	Paul Cherubini	418
518OB	Sonia Ortiz	Monterrey, MX	10/24/99	01/09/00	El Rosario, MICH, MX	Javier García Domínguez	416

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
225JQ	Sonia Ortiz	Monterrey, MX	10/25/99	01/14/00	El Rosario, MICH, MX	Jaime G. Gonzalez	416
275JQ	Sonia Ortiz	Monterrey, MX	10/25/99	02/14/00	El Rosario, MICH, MX	Tom Pawlesh	416
214JQ	Sonia Ortiz	Monterrey, MX	10/25/99	5/00	El Rosario, MICH, MX	David Marriott	416
537OB	Sonia Ortiz	Monterrey, MX	10/27/99	01/14/00	El Rosario, MICH, MX	Felipe Berrio Dominguez	416
358NW	Sonia Ortiz	Monterrey, MX	10/27/99	03/01/00	El Rosario, MICH, MX	David Marriott	416
642OB	Sonia Ortiz	Monterrey, MX	10/27/99	03/01/00	El Rosario, MICH, MX	David Marriott	416
524OB	Sonia Ortiz	Monterrey, MX	10/27/99	5/00	El Rosario, MICH, MX	David Marriott	416
648OB	Sonia Ortiz	Monterrey, MX	10/28/99	01/28/00	El Rosario, MICH, MX	Paul Cherubini	416
358LL	Sonia Ortiz	Monterrey, MX	10/28/99	03/01/00	El Rosario, MICH, MX	David Marriott	416
362LL	Sonia Ortiz	Monterrey, MX	10/28/99	5/00	El Rosario, MICH, MX	David Marriott	416
385NW	Sonia Ortiz	Monterrey, MX	10/29/99	01/09/00	El Rosario, MICH, MX	Fortino Sanchez Romero	416
396NW	Sonia Ortiz	Monterrey, MX	?	03/08/00	El Rosario, MICH, MX	David Marriott	416
930MW	La Maison des Insectes	Charlesbourg, QUE	09/04/99	09/22/99	Charlestown, RI	Anne Doyle	378
599KE	Jenny Howard	Cumberland Foreside, ME	08/25/99	09/06/99	Bethlehem, PA	Michael Scholl	343
507KK	Johanne Landry	Montreal, QUE	09/12/99	10/26/99	Newington, CT	Joe Duggan	267
049LC*	Greg Hawkinson	Grand Rapids, MN	08/31/99	09/20/99	Wausau, WI	Cori Harvey	243
538NR*	Susan La Mora	Elkins, WV	?	10/02/99	Kannapolis, NC	Zachary Fesperman	241
588JQ	Fred Habegger	Reinholds, PA	09/26/99	10/05/99	Kiptopeke, VA	Mark Garland	216
391GY*	Colleen Snook	Bernville, PA	?	01/28/00	El Rosario, MICH, MX	Paul Cherubini	206
250KD	Stephen Haydock	Salisbury, MA	09/24/99	10/01/99	W. Babylon, NY	Walter Westhoff	196
993GS	Joanne Henry	Oswego, NY	09/22/99	10/13/99	Slatington, PA	Kistler	192
535FJ*	Beth Ann Miller	Golden Valley, MN	10/06/99	10/06/99	Adams, WI	Olive Turek	189
490OL*	Billy Mc Cord	Folly Beach, SC	10/22/99	11/06/99	Manor, GA	Greg & Jill Burkett	189
142OE	Randy Korb	Appleton, WI	10/02/99	10/11/99	Chicago, IL	Natalia Castro	172
598GM	Michael Nerrie	Walpole, NH	09/14/99	09/26/99	Bronx, NY	Lorraine Speros	171
381GP	Ian Morris	Wallingford, CT	09/25/99	10/04/99	Leeds Point, NJ	Clare Unger	160
265MN*	Mike Carney	Jenks, OK	09/24/99	01/11/00	El Rosario, MICH, MX	Carlos Hernandez Rivera	159
820HF*	Kelley Calhoon	Mansfield, OH	08/17/99	08/27/99	Franklin Furnace, OH	Amanda Dingess	150
962LM	Nathan Blakemore	Troy, NY	09/02/99	09/28/99	Staten Island, NJ	Robert Bernabe	147
412GQ	Mary Ann Manaresi	Tuckerton, NJ	09/20/99	09/23/99	Chincoteague, VA	Denise Gibbs	126
310JW	Greg & Linda Munson	Rochester, MN	09/04/99	09/14/99	Plainfield, IA	Paul Cherubini	111
615MS	John Bowe	Florence, MA	09/23/99	09/26/99	Patchogue, NY	Laura Oettinger	110
143LA	Danny Growald	Shelburne, VT	09/08/99	09/13/99	Greenwich, NY	Howard Romack	90
113OM	Burnell Sayers	North Rose, NY	10/15/99	10/30/99	Norwich, NY	Bill Smith	83
642MA	Manon Tardit	St. Hyacinthe, QUE	09/22/99	10/10/99	Sutton, VT	David and Lorraine Kaunellis	82
060ON	Daniel Jenkins	Saranac Lake, NY	09/27/99	10/01/99	Chippewa Bay, NY	Eleanor Sharp	81
126NT	Matt Kelley	Wakefield, MA	10/06/99	10/09/99	North Truro, MA	Thor Hanson	59
DJ123	Billy McCord	Folly Beach, SC	10/28/99	11/08/99	Beaufort, SC	Lorri Fletcher	48
782JR	Ruth Little	Rockford, IL	09/08/99	09/09/99	Carpentersville, IL	Frances Covarrubias	42
565IW*	Polly Irwin	Lancaster, PA	09/29/99	10/04/99	Kingsville, MD	Jeffrey Buler	41
518JF	Robbie Marshall	Old Saybrook, CT	09/19/99	09/25/99	South Windsor, CT	Debra Schuster	39
238HI*	Karen O' Neil	Fenton, MI	09/07/99	09/12/99	Plymouth, MI	Fred & Annette Sanchagrin	32
178KY	Chris Kline	Muncie, IN	09/06/99	09/09/99	Williamsburg, IN	Michael Turner	27
537HF*	Hawks	Rittman, OH	09/27/99	09/29/99	Ellet, OH	Tom Daniel	19
UY644	Mary Beth Leason	Schnecksville, PA	06/03/99	09/06/99	Hellertown, PA	Michael Scholl	16
650GN*	Norma Snow	WeSt. Hartford, CT	09/05/99	09/09/99	Meriden, CT	Ivy Patrick	16
240GO*	James Kupcho	Woodbridge, NJ	08/18/99	08/20/99	Belford, NJ	Irma Jean Smith	14
338KD*	Susan Gilbert	Lexington, MA	?	10/23/99	Boston, MA	Bill Smith	13
930GG	Tom Todd	Ingleside, ONT	08/18/99	11/11/99	Cornwall, ONT	Lyne Seguin	13
055GH*	Tom Todd	Ingleside, ONT	08/29/99	09/05/99	Cornwall, ONT	Pat Anderson	13
915NW*	Jana Harris	Orlando, FL	01/09/00	03/18/00	Lake Buena Vista, FL	Hector Roman	12
481GP*	George Kustka	Marlboro, NJ	08/13/99	08/14/99	Sayreville, NJ	Reena Banerjee	11
427HD	Jana Harris	Orlando, FL	03/29/00	04/11/00	Ocoee, FL	Christopher Halliday	11
288MJ*	Kathy Arnold	Columbia, PA	09/28/99	10/02/99	Conestoga, PA	Heather Smith	10
EW777	Steve Tennison	Mission, TX?	?	01/20/00	Valle de Bravo, MEXICO, MX	Colin Gilles	?
QN937	St. James Episcopal School	Del Rio, TX?	?	01/26/00	El Rosario, MICH, MX	Paul Cherubini	?
565LD	?	?	?	01/26/00	El Rosario, MICH, MX	Paul Cherubini	?
806FW	?	?	?	01/28/00	El Rosario, MICH, MX	Paul Cherubini	?
690MT	?	?	?	03/01/00	El Rosario, MICH, MX	David Marriott	?
176FK	Amanda Scheurer	St. Paul, MN?	?	01/14/00	El Rosario, MICH, MX	Javier Garcia Dominguez	?
015MH	Chanute Public Schools	Chanute, KS?	?	03/25/00	El Rosario, MICH, MX	Richard, Stringer	?

Tag No.	Tagger	Tag City, State	Tag Date	Report Date	Report Location	Reporter	Miles
040FI	Cristine Cyr	Arden Hills, MN?	?	02/00	El Rosario, MICH, MX	Bill Calvert	?
999KE	Donald Davis	Toronto, ONT?	?	02/00	El Rosario, MICH, MX	Bill Calvert	?
MS181	Greg & Linda Munson	Rochester, MN?	?	02/25/00	El Rosario, MICH, MX	Proyecto Correo Real	?
312FS	Jane Blumer	St. Paul, MN?	?	02/00	El Rosario, MICH, MX	Bill Calvert	?
363FS	Jane Blumer	St. Paul, MN?	?	02/00	El Rosario, MICH, MX	David Marriott	?
BL614	Jill Sullins	Edmond, OK?	?	01/26/00	El Rosario, MICH, MX	Paul Cherubini	?
947LG	Jim Edson	Monticello, AR?	?	01/26/00	El Rosario, MICH, MX	Paul Cherubini	?
859LN	Jim Edson	Monticello, AR?	?	01/28/00	El Rosario, MICH, MX	Paul Cherubini	?
854FP	Karen Newell	Minnetonka, MN?	?	01/28/00	El Rosario, MICH, MX	Paul Cherubini	?
678NG	Kelly Gillespie	Lee's Summit, MO?	?	02/00	El Rosario, MICH, MX	Bill Calvert	?
177JJ	Matthew Douglas	Grand Rapids, MI?	?	01/11/00	El Rosario, MICH, MX	Felimon Mayen	?
008JJ	Matthew Douglas	Grand Rapids, MI?	?	02/21/00	El Rosario, MICH, MX	Mary Kennedy	?
937JI	Matthew Douglas	Grand Rapids, MI?	?	02/00	El Rosario, MICH, MX	Bill Calvert	?
211JJ	Matthew Douglas	Grand Rapids, MI?	?	03/10/00	Sierra Chincua, MICH, MX	David Marriott	?
690MX	Lori Siegfried	Wichita, KS?	?	01/09/00	El Rosario, MICH, MX	Modesto Gonzalez Gonzalez	?
DA380	Kevin Abbott	New Carrollton, MD?	?	02/21/00	El Rosario, MICH, MX	Mary Kennedy	?
EQ861	Melanie Pavlas	Austin, TX?	?	02/21/00	El Rosario, MICH, MX	Mary Kennedy	?
EW733	Steve Tennison	Mission, TX?	?	03/02/00	El Rosario, MICH, MX	David Marriott	?
353IS	Randy Laurence	Quemado, TX?	?	5/00	El Rosario, MICH, MX	David Marriott	?
347FR	Karen Oberhauser	St. Paul, MN?	?	5/00	El Rosario, MICH, MX	David Marriott	?
253FS	Karen Oberhauser	St. Paul, MN?	?	5/00	El Rosario, MICH, MX	David Marriott	?
909JX	Laura Barreras	Madison, WI?	?	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	?
JH719	Peter Stangel	Vienna, VA?	?	03/03/00	Cerro Pelon, MEXICO, MX	David Marriott	?
019OF	Laura Feinberg-Smith	Riverdale, NY?	?	11/11/99	Coconut Grove, FL	Regina Grossman	?
YK824	Greg & Linda Munson	Rochester, MN?	?	08/29/99	Rochester, MN	Hannah Bellinger	?
376FS	Jane Blumer	N. Stillwater, MN?	?	10/01/99	St. Paul, MN	Diane Olson's Class	?
283FS	Jane Blumer	N. Stillwater, MN?	?	10/08/99	St. Paul, MN	Margaret Martin	?
005FM	Jean Kochevar	St. Paul, MN?	?	10/21/99	Minneapolis, MN	Michael Kephart	?
269FF	Judith Borer	Hopkins, MN?	?	10/15/99	Maple Plain, MN	Karen May	?
622FQ	Ken Jeddelloh	Minneapolis, MN?	?	10/02/99	Minneapolis, MN	Anonymous	?
232FR	Ken Jeddelloh	Minneapolis, MN?	?	10/04/99	Minneapolis, MN	Mary Schroeder	?
457FR	Ken Jeddelloh	Minneapolis, MN?	?	10/09/99	Minneapolis, MN	Madeline Stevens	?
AJ144	Karen Oberhauser	St. Paul, MN?	?	09/16/99	Mendota, MN	Abigail Silverman & Kelsey Jacobucci	?
MS538	Greg & Linda Munson	?	?	09/16/99	Pittsfield, MA	Tom Tynning	?
AB106	Jerry Zeidler	?	?	09/22/99	Brown Deer, WI	Pierce Nealy	?
597NJ	Lichtfuss Family	Oshkosh, WI?	?	09/17/99	Oshkosh, WI	The Bergers	?
034GA	Matthew Douglas	Grand Rapids, MI?	?	08/24/99	Pellston, MI	Kathy Claerr	?
914LB	Casey Anderson	Saratoga Springs, NY?	?	10/15/99	Schuylerville, NY	Molly Harro	?
754MK	Randall Warner	Olathe, KS?	?	10/10/99	Olathe, KS	Sue Bleigh	?
The following is an update to a recovery that appeared in the 1998 Season Summary.							
NK068*	Donn Byrne	Tyler, TX	09/28/98	09/28/98	Buffalo, TX	Billie Gee	75

*These Monarchs were reared under various conditions.

**These Monarchs were captured in Toledo, OH (3) and Lancaster, PA (1) and were released as part of a transfer experiment.

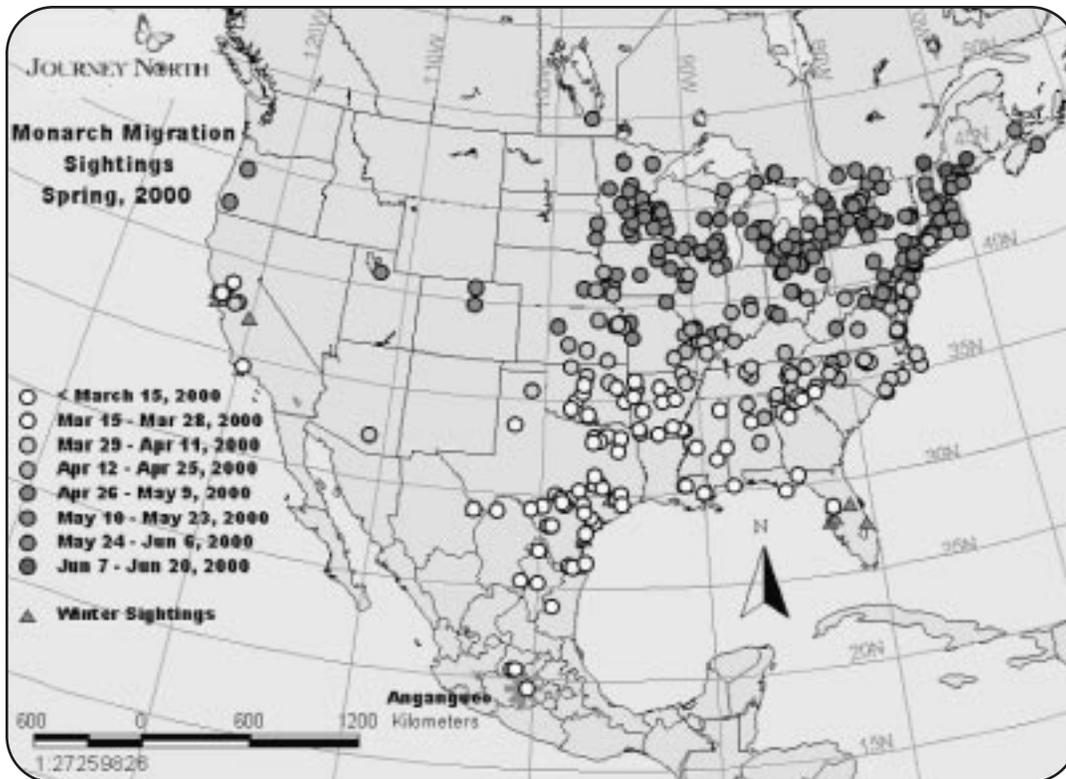
? in the Tag Location field denotes unreturned data sheets. Locations given indicate where the tags were sent, NOT actual tag sites.

WINNING THE MONARCH LOTTERY

The odds of winning one of the recent state lotteries were 1 in 76 million - not too good to say the least. Monarch Watch offers much better odds. If you tag with us, there is a good chance one of your tagged Monarchs will be recovered in Mexico. If you win the Monarch Watch lottery, you won't get rich but you will have contributed to our knowledge of Monarchs and this information can be used to further Monarch conservation. This past season if you tagged in MN, IA, KS, OK, TX, or Monterrey Mexico, the odds of having one of your Monarchs recovered were respectively 1/67, 1/54, 1/63, 1/75, 1/62, and 1/27. Across the country there is a tendency for greater numbers recovered per 100 butterflies tagged as distance to the overwintering sites decreases. This pattern is one we might expect since many Monarchs die or are blown off course while en route.

The recovery rates for taggers in the Midwest are considerably higher than the average rate of 1/130 for the United States east of the Rockies. Again, the differences in these rates can be explained by increasing mortality rates with increasing distance from the overwintering sites. Additionally, Monarchs along the eastern shore often travel to Florida - thus reducing their chances for recovery. As funds become available, we will analyze the recovery records in greater detail.

OTHER RECOVERIES AND REPORTS



The Monarch Spring Migration through 14 June 2000.

Map reproduced with permission from Journey North (www.learner.org/jnorth)

The following are additional recoveries and updated records reported to Monarch Watch during the 1999 tagging season. Please note that the tags listed below are not Monarch Watch tags (SEE FOOTNOTE).

Tag No.	Tag*	Tagger	Tag City, State	Tagged	Reported	Report City, State	Reporter	Miles
135640	B	Louise Zemaitas	Stone Harbor Point, NJ	09/24/99	03/02/00	El Rosario, MX	Monarch Program	2027
8369	S	Gayle Steffy	East Point Light, NJ	9/19/1999	05/00	El Rosario	Monarch Program	2024
118031	B	Gayle Steffy	Cape May, NJ	10/03/98	03/24/99	El Rosario, MX	Lincoln Brower	2017
180327	B	Louise Zemaitas	Cape May, NJ	10/01/99	02/00	El Rosario, MX	Bill Calvert	2017
135423	B	Meghan Walker	Cape May, NJ	09/23/99	02/00	El Rosario, MX	Bill Calvert	2017
180579	B	Meghan Walker	Cape May, NJ	10/01/99	02/27/00	El Rosario, MX	Lincoln Brower	2017
182129	B	Meghan Walker	Cape May, NJ	10/04/99	03/02/00	El Rosario, MX	Monarch Program	2017
182157	B	Meghan Walker	Cape May, NJ	10/04/99	01/11/00	El Rosario, MX	Monarch Watch	2017
8201	S	Gayle Steffy	Drumore, PA	09/18/99	03/02/00	El Rosario, MX	Monarch Program	1992
105247	B	Ruth Gifford	Penninsula Point, MI	09/04/98	03/24/99	El Rosario, MX	Lincoln Brower	1953
75196	U	Unknown	Appleton, WI	?	03/04/99	El Rosario, MX	Monarch Program	1832
110667	B	Doris Stifel	Ottawa County, OH	09/09/99	02/00	El Rosario, MX	Bill Calvert	1818
113243	B	Doris Stifel	Oregon, OH	09/17/99	03/08/00	El Rosario, MX	Monarch Program	1814
155683	B	Doris Stifel	Oregon, OH	09/08/98	03/01/00	El Rosario, MX	Monarch Program	1814
155742	B	Doris Stifel	Oregon, OH	09/10/99	02/00	El Rosario, MX	Bill Calvert	1814
113235	B	Dorris Stifel	Oregon, OH	09/16/99	03/03/00	El Rosario, MX	Mary Kennedy	1814
152371	B	Doris Stifel	Muskingum Co, OH	09/01/00	01/11/00	El Rosario, MX	Monarch Watch	1772
100549	B	Elizabeth Hunter	Spruce Pine, NC	09/17/98	02/19/99	El Rosario, MX	Julian Donahue	1578
100665	B	Elizabeth Hunter	Bakersville, NC	09/07/99	03/24/99	El Rosario, MX	Lincoln Brower	1578
100707	B	Elizabeth Hunter	Bakersville, NC	09/17/99	01/11/00	El Rosario, MX	Monarch Watch	1578
182748	B	Louise Zemaitas	Cape May, NJ	10/11/99	10/23/99	St Marks, FL	Dan & Jill Parker	804
182240	B	Louise Zemaitas	Cape May, NJ	10/06/99	10/07/99	Fisherman's Island, VA	Mark Garland	140

*B=Lincoln Brower Tag, S=Gayle Steffy Tag, U=Fred Urquhart Tag

ECOTOURISM: BLESSING OR CURSE?

Deforestation of the oyamel fir forests within and adjacent to the Monarch overwintering sites in Mexico is seen as *the* major threat to Monarch populations. Without oyamel forests, the overwintering Monarchs would lack the protection



It didn't take long for a crowd of guides to form around Chip, Dana and Cathy as they purchased tags and entered recovery data at El Rosario. Photo by Jim Lovett.

required to properly overwinter en masse at 19-20°N latitude in Mexico and the population could easily collapse. Monarchs would persist but the migration as we know it would become increasingly small. Without the forests, the resource base for the human population in the region will also diminish. The challenge in Mexico is to create an infrastructure and value system to protect the forests, the watersheds they provide, and the Monarchs. How can this be accomplished? Ecotourism is one possible solution. In theory, the tourism provides employment and incentive to protect the resource since the welfare of the community is linked to the success of the tourism. In some cases, ecotourism works well and even though, in the opinions of some observers, it is associated with negatives such as increased traffic and the proliferation of unsightly shops and annoying vendors, the resource is protected rather than exploited. Difficulties arise when the tourism is so successful that it threatens the species or system being protected. This may be happening at the two main overwintering sites, El Rosario and Chincua.

In an email report we received from Erika Vazquez Espinosa who is in charge of monitoring tourism at the "Biosferade la Mariposa Monarca" there were 160,000 visitors to El Rosario in 1998 (the last year for which data is available). This is a substantial increase from the 101,000 visitors in 1994-1995. Chincua, which was first open to the public in 1996-1997 with 21,000 visitors, had 37,000 visitors in 1998-1999. Certainly, the figures for both locations will be even higher for the season just ended. An increase in visitation will inevitably be accompanied by more litter along the trails, an increase in dust as

the dry season progresses each year, rutting of the roads (at Chincua), trampling of the butterflies that sun themselves on the trails, as well as increases in carbon dioxide, noise, and movement. The latter two are probably of little consequence to the Monarchs since they do not appear to detect sound and their distance vision is too poor for movement to be a factor. The other factors are of some concern. The issue is whether these factors will have a significant impact on the forest habitat and the Monarchs themselves.

Monarch Watch Program Assistant Cathy Walters took time out to enjoy watching thousands of Monarchs at a watering hole at El Rosario.

Photo by Jim Lovett.



We visited both El Rosario and Chincua in January, relatively early in the season, and were very impressed with the training and care shown by the guides at El Rosario. They picked up the trash, kept the tourists at a reasonable distance from the butterflies and were able to keep most of the tourists from handling the butterflies. The trail was long and the guides couldn't be everywhere but generally the tourists were managed effectively and the Monarchs were protected. An article by Mary Beth Sheridan in the Los Angeles Times (29 Feb. 2000) provides a different perspective. Focusing on the conditions at Chincua, the article emphasizes handling of the butterflies by children, trash, dust, potential erosion in the rainy season, and the glut of unsightly vending stalls. According to the article, discussions are underway about limiting the size of the groups taken to the butterflies and placing a seasonal cap on the total number of visitors. Both proposals, if implemented, would be disruptive to the local residents and the tourists. The local leaders could see this as a threat to the well-being of their communities and tourists, being refused passage to see the butterflies after the long trip to El Rosario or Chincua, would certainly complain bitterly. It is evident that as tourism increases, it will be more difficult to protect the habitat and the Monarchs while meeting the needs of local communities and demands of the tourists.

40 YEARS OF TAGGING

One of our research objectives at Monarch Watch is to discern the patterns of the fall migration. Patterns often lead to hypotheses about how a system works and these hypotheses can later be tested through specific experiments or analytical procedures. The following is a preliminary analysis of tag recovery data (Rogg et al. 1999). This study was conducted in 1997. Over the last three years we have quadrupled the data set and another analysis is underway.

To determine whether there are distinct patterns in the fall migration, Kari Rogg, former program assistant to Monarch Watch, assembled all of the recovery records from "The Insect Migration Studies Program" (1964-1994) run by Fred and Norah Urquhart and from the first five years of Monarch Watch (1993-1997 Season Summaries). She was ably assisted by Don Davis who provided many records by carefully going through the annual reports produced by the Urquharts. After thoroughly screening the data to exclude cases where butterflies had been transferred or where the records were otherwise confusing or incomplete, Kari found 519 records for which the distance flown by the butterfly from point of capture to location of recapture was greater than 10 miles (16 km). Only 86 of these tagged butterflies had been recovered at the overwintering sites in Mexico.

Our first approach to analysis of the recovery data was to draw lines from point of origin to point of recapture of records from specific periods or locations (e.g., www.Monarchwatch.org/grafx/tagmig/u81map.gif). The results were very confusing. Butterflies were frequently recovered in directions which did not seem to make sense with the respect to the Monarchs' presumed goal of reaching Mexico. Some of the flights out of the midwest were to the north, others to the southeast and so on. To examine the problem more systematically, we decided to ask the following question.

What was the distribution of directions as well as the mean direction for all the recoveries for each of the six regions of the country (Fig 1.)?

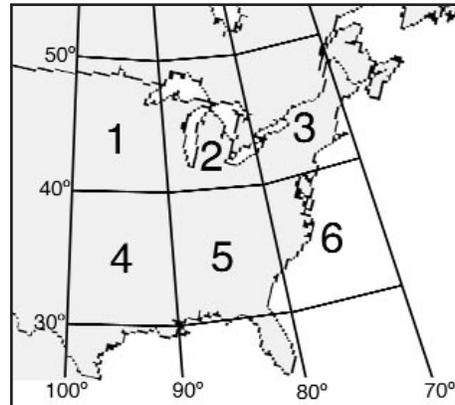


Figure 1. Map of the six geographical regions used to analyze these tagging data.

HOW ARE RECAPTURES RELATED TO LONGITUDE AND LATITUDE?

To determine if there was a relationship between longitude and mean direction, we lumped the six regions into three regions defined by longitude (Fig 2.). This analysis showed that the mean direction of flight shifted from S to SW as the origin of flight moved from west to east. If the overall objective for the butterflies is to reach Mexico, this is the pattern we would expect to see in the recaptures. A similar result might be expected for lati-

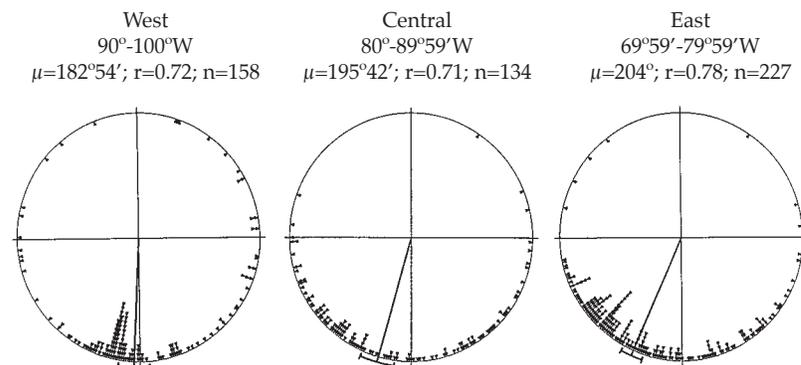


Figure 2. Relationship of direction of recoveries to longitude.

tude. In other words, the farther south the butterflies find themselves, the more we might expect them to turn to the SW. In Georgia, for example, and in the mid-region of the Gulf States, they should be flying to the W-SW. The

trend in the data is in the predicted direction but the sample sizes are small and the means do not differ significantly. Therefore, based on these data, we cannot say that the butterflies are responding to latitude even though it seems probable they are doing so. This expectation is supported by Dr. David Gibo's observations of the mean direction (247.5 degrees, N=64) taken by low flying Monarchs as they move through Calhoun, GA (for details, visit www.TacticsAndVectors.org).

HOW CAN WE EXPLAIN THE SCATTER IN THE DATA?

If the fall Monarchs are supposed to head S-SW, why do so many of them apparently fly in the wrong direction? We can't answer this question. We can only speculate that some may have been carried on winds in the wrong directions. If so, we would expect such misplaced butterflies to make course corrections, weather permitting, and that most of the "wrong way" flights would be relatively short. To establish the relationship between distance and direction, the recaptures were sorted into short, medium, and long distances between place of marking and location of recapture (Fig 3). As you can see, all the "wrong way" (i.e. northerly) recoveries occurred in the short distance category. At intermediate distances (up to

760 miles) there were captures of butterflies to the SE. In some of these cases it is known that the butterflies were tagged a few days preceding strong fronts from the NW. All the long distance (>760 miles) recoveries occurred

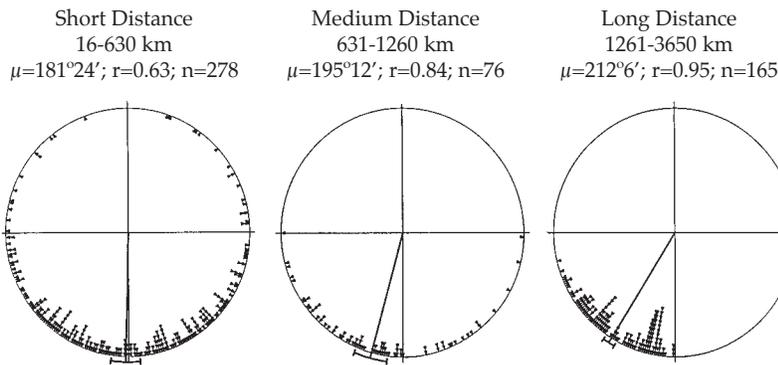


Figure 3. Relationship of Monarch flight direction to distance traveled.

in the SW sector. Recaptures of butterflies tagged in Toronto (42-43°N and 78-79°W), many due to the tagging efforts of Don Davis, are particularly interesting. Although these recoveries range from the east coast (to the SE) to Mexico, the mean direction for these recoveries, 194.9° (N=72) does not differ significantly from the eastern region (40-50°N, 70-80°W), 200.9° (N=233). This suggests that the mean direction for a region is generally valid for locations within the region and that Monarchs integrate environmental information in a manner that gives them a generalized rather than a specific directional heading.

ARE MONARCHS BLOWN OFF COURSE?

Several lines of evidence suggest that Monarchs are displaced to the SE during the fall migration. Monarchs are not strong fliers and show little ability to compensate for cross winds (Gibo 1986, Schmidt-Koenig 1993). Observations of vanishing bearings, i.e. the compass headings at which Monarchs disappear from view, show that they are displaced to the S-SE by relatively light winds from the W, NW and N. (Gibo 1986, Schmidt-Koenig 1993, Taylor unpublished data). In the midwest, conspicuous migratory flights are associated with fronts frequently bearing strong winds from the NW and N which rapidly displace the butterflies to the SE. The number of short and intermediate recoveries SE of the tagging points is consistent with such displacements.

CAN MONARCHS RECOVER IF THEY ARE BLOWN OFF COURSE?

We don't know the answer to this

question but it seems probable that Monarchs have to make course adjustments. Observations of directions taken by Monarchs in the absence of wind at numerous locations suggest that the butterflies have a preferred direction and that this direction is related to the longitude and latitude at which the observations are made. This pattern appears to indicate the butterflies are adjusting their navigational system and headings as they migrate. Given that much of the migratory flight occurs with winds from the NW and N, which displace the butterflies to the SE, we might imagine that the flight of most Monarchs across the midwest is not linear but a highly irregular zigzag. For example, a butterfly might start the morning with a heading of 210° when there are no winds but later have a vanishing bearing of 160° with winds of 12 miles per hour from 340°. After four hours of flight in which the butterfly is displaced approximately 40-50 miles to the SE, the wind may die and the butterfly resumes a heading of 210°. The same pattern may occur over several days. But what might happen if a Monarch is displaced by a strong front some 800 miles to the SE during the course of one day. If the headings of the local Monarchs at the new location are 280°, what will the displaced butterfly do the next morning? Will it retain the 210° heading it started with during the previous day or will it immediately "recognize" that it is in a new environment and take a heading of 280°? We may have the answer and, if we can get the paper published, we will summarize observations on the orientation of displaced butterflies next year.

WHAT ARE THE LIMITATIONS OF RECAPTURE DATA?

As we can see from the above discussion, the recaptures do not represent the true course of the butterflies. We tend to think of and analyze the recapture data in linear terms but it is likely the flights are not linear. The analysis is also limited by low numbers of Monarchs tagged and recovered in the southern states. Nevertheless, the general pattern of the recoveries is consistent with the expectation that most of the butterflies move in a direction that will enable the survivors to reach the overwintering sites in Mexico. The directions indicated by the recoveries for different regions of the country are also similar to headings data obtained within these regions.

Additional Reading

Brower, L. P. 1995. Understanding and misunderstanding the migration of the Monarch butterfly (*Nymphalidae*) in North America: 1857-1995. *J. Lep. Soc.* 49:304-385.

Gibo, D. 1986. Flight strategies of migrating monarch butterflies (*Danaus plexippus* L.) in Southern Ontario. In: Danthanarayana, W. (Ed.). *Insect Flight: Dispersal and migration*. Springer-Verlag: Berlin. pp.172-184.

Knight, A., L.P. Brower and E. H. Williams 1999. Spring remigration of the Monarch butterfly, *Danaus plexippus* (Lepidoptera: Nymphalidae) in north-central Florida: estimating population parameters using mark-recapture. *Biol. J. Linn. Soc.* 68:531-556.

Rogg, K.A., O.R. Taylor and D.L. Gibo. 1999. Mark and recapture during the monarch migration: A preliminary analysis. 1997 *North American Conference on the Monarch butterfly*. Commission for Environmental Cooperation, eds: J. Hoth, et al. Montreal, Quebec. pp. 133-138.

Schmidt-Koenig, K. 1993 Orientation of autumn migration in the Monarch butterfly. In: S. B. Malcolm and M. P. Zalucki (Eds.). *Biology and Conservation of the Monarch Butterfly*. Natural History Museum of Los Angeles County: Los Angeles. pp. 275-283.



A Monarch tagged with an alar "over the wing" tag used in Urquhart's program.

Photo by Judith Brawley.

PROMOTIONAL & EDUCATIONAL ITEMS

MEMBERSHIPS AND TAGGING KITS

The **2000 Membership Kit** includes a welcome kit, all Monarch Watch mailings (2000 Premigration Newsletter, 2000 Season Summary, and Adopt-A-Classroom Annual Report) and a 5% discount on Monarch Watch promotional and educational items (discount given Jan-Dec 2000).

The **2000 Tagging Membership Kit** is a combination of the Membership Kit and the Tagging Kit. It includes the 2000 Tagging Kit, a welcome kit, and a 5% discount on Monarch Watch promotional and educational items (discount given Jan-Dec 2000).

The **2000 Tagging Kit** includes 25 self-adhesive tags with detailed instructions in a short Premigration Newsletter (sent in August), the Season Summary (spring/summer 2001), and an Adopt-A-Classroom Annual Report.

Additional 100-tag sheets are available to those who purchase either a Tagging Membership Kit or a Tagging Kit.

PROMOTIONAL AND EDUCATIONAL ITEMS

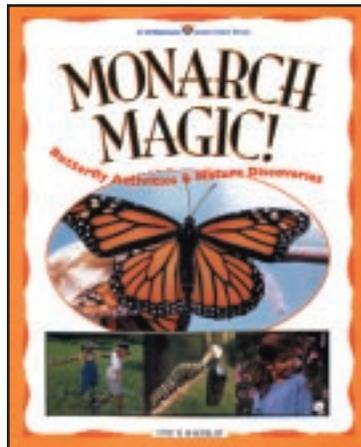
Premiums Monarch Watch is funded through contributions made by individuals and organizations interested in promoting science education in primary and secondary schools. For a contribution of \$25 (\$10 tax-deductible) we will send either a Rearing Kit or a Millennium Butterfly Garden Kit to the student or school of your choice. The **Rearing Kit** contains twelve 3-5 day-old Monarch larvae which must be transferred to milkweed plants to feed. Pupation will occur in 10-12 days and adults will emerge 10-14 days after pupation. These butterflies can be used for classroom instruction, student projects or to start a classroom breeding population. Instructions included.

Our **Millennium Butterfly Garden Kit** contains 25 seed packets (~100

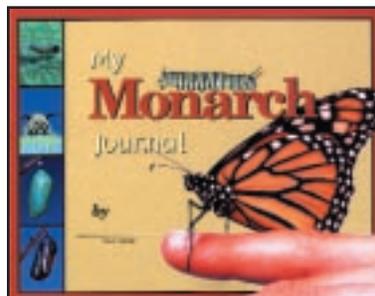
seeds each) of annuals and perennials which are known butterfly nectar plants and/or host plants for butterfly larvae. A 24-page gardening guide is included (also available separately).

Milkweed Seeds Individual packets of five varieties of milkweed: common, swamp, tropical, showy, and butterfly weed - an instruction sheet is included to get you started. (~100 seeds/pack)

Monarch Magic! Butterfly Activities & Nature Discoveries More than 100 stunning full-color photos with easy to follow text let you experience the Monarch's complete life cycle and spectacular migration. Lots of fun activities and projects are also included! Ages 4-12, 96 pp.



NEW! **My Monarch Journal** This book will guide you in raising Monarchs and allow you to record your experiences. It's filled with more than 150 beautiful photos that illustrate the Monarch's transformation from egg to larva to pupa to adult. The 52-page Parent-Teacher Edition builds upon the Student Edition (32pp).



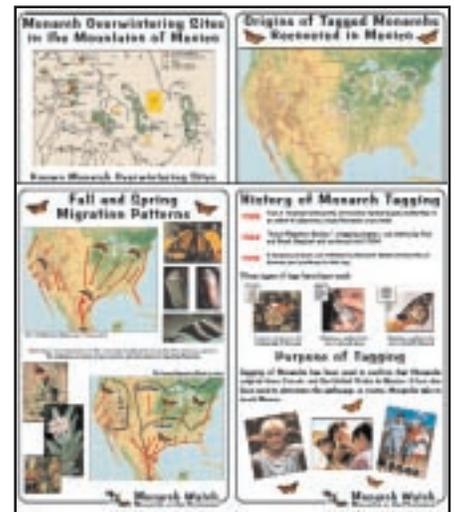
Please note: some order forms mistakenly list "My Monarch Journal" as having more pages than it does. The numbers of pages listed above are correct. Please accept our apologies for the confusion. Thanks!

The Butterfly King Video The life history of the Monarch, as "told" by a caterpillar as he progresses from one life stage to the next. Bundled with this video is "Gulliver's Story" an active learning exercise for grades 2-4. 20min.

The Monarch: A Butterfly Beyond Borders Video This is the most up-to-date treatment of the dilemmas we face in trying to maintain Monarch populations and their migration in eastern North America. The footage obtained at the Monarch overwintering sites in Mexico is truly spectacular. Licensed for home use only. 47min.



Educational Posters There are now six educational posters available from Monarch Watch! Four of the posters depict various aspects of the Monarch migration and our newest poster illustrates the Monarch Annual Cycle with several stunning photos. The Life Cycle Poster illustrates the transforma-



tion of the Monarch from egg to adult and includes the approximate age at each stage. All posters are printed in full-color and laminated - see the order form for poster dimensions.

Migration T-shirt This 100% cotton T-shirt is printed on both sides in black and brilliant Monarch orange with lots



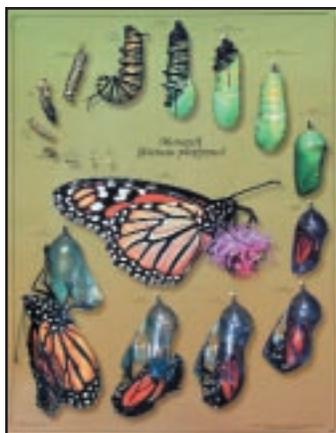
of migrating Monarchs! Adult sizes M, L, XL, and XXL.

Adult Monarch Watch Logo T-shirt This 100% cotton T-shirt features Gulliver on the upper left chest and two large Monarch butterflies on the back. Adult sizes M, L, and XL.

Youth Monarch Watcher T-shirt This 100% cotton T-shirt features Gulliver and "I'm a Monarch Watcher!" on the front and two large Monarch butterflies on the back. Sizes: Youth S and Adult S.



Season Summary This publication is available in the spring/summer following the tagging season and contains tag recovery data, tips and ideas for teachers and students, observations on Monarch populations, new infor-



mation on Monarch biology and a whole lot more! Summaries from previous tagging seasons (1994-1999) are also available while they last.



Monarch Watch Canvas Tote This 15" x 22" canvas tote bag with zipper closure features Gulliver "watching" Monarchs and includes an inside zippered pocket.

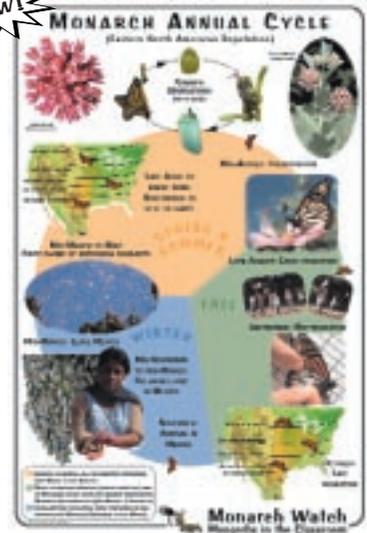
Butterfly Condo This 24" x 24" x 24" white mesh and clear plastic collapsible tent is perfect for raising and observing Monarchs or other insects at home or in the classroom.



Butterfly Nectar Mix This mix includes everything you wouldn't normally find in your kitchen. Makes 1 liter of nectar and will not ferment.

Game of Monarch Life Learn about the Monarch life cycle and migration of in this challenging board game. Includes large laminated game board, dice, playing pieces, challenge cards and instructions. Ages 6-12.

Gulliver Pin This 1" x 1" three-color gold pin features Gulliver, our "logopillar," and represents a dedication to the conservation of the Monarch and its migration.



CONTRIBUTIONS

Monarch Watch relies on the sale of promotional items and donations for funding. We do not rely on grants or federal funding. To recruit taggers, the tagging kit fee is kept low; so low, in fact, that it doesn't cover the cost of the tagging program. The sale of promotional items helps to cover the remaining costs of the tagging program. However, Monarch Watch needs your contributions to successfully direct and expand the Adopt-A-Classroom program, the development of educational materials and projects, as well as the tag recovery effort.

A contribution in the amount of \$100 or more to any of the funds listed below entitles you to a premium. For more information or to contribute to any of these funds, please use the enclosed contribution and order form.

Monarch Watch Adopt-A-Classroom Fund

We have pledged to provide educational resources to the communities (ejidos) in the vicinity of the overwintering areas in Mexico. The schools within the Monarch Reserve are simple, cinder block buildings. The classrooms are crowded with crude, uncomfortable desks. Most have poor lighting and some have no electricity. While basic textbooks are supplied by the Mexican government, workbooks, writing materials, even paper and pencils are scarce. Library resources and supplemental teaching aids - a requirement for teaching math and science

PLEASE NOTE: ALL TAG ORDERS MUST BE RECEIVED BY 10/10/2000. WE DO NOT SHIP TAGS OR MONARCHS TO AREAS WEST OF THE ROCKY MOUNTAINS. ALSO, DUE TO HIGH SHIPPING COSTS AND THE NEED FOR PERMITS, MONARCH WATCH WILL NO LONGER BE ABLE TO SEND REARING KITS TO CANADA. HOWEVER, IF YOU CONTACT US, WE WILL BE GLAD TO DIRECT YOU TO SIMILAR PROGRAMS IN YOUR AREA. THANKS!

concepts effectively - are also lacking in these schools.

Providing these children with a better education will enable them to make informed decisions. With the help of several teachers, we have designed a basic math and science kit (in Spanish), which includes many hands-on activities appropriate for the classrooms in Mexico. Each kit costs \$100 and we need your help raising funds for their purchase and delivery.

Monarch Watch Education Fund

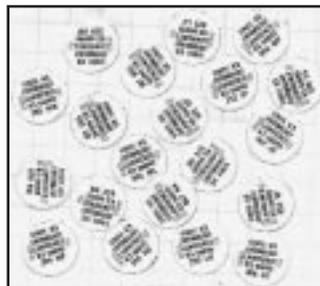
Monarch Watch is always working to create new educational materials and projects. However, our income barely covers the daily expenses of operation, so very little remains for development. Many projects are unfinished due to lack of funding. Among these are an interactive CD-ROM, an activity guide, and a roadside vegetation management project. Donations to the Monarch Watch Education Fund will

facilitate the completion of these and other projects.

Monarch Watch Tag Recovery Fund

Monarch Watch taggers have enjoyed record numbers of recoveries in Mexico during the last two tagging seasons. The increased recovery rate is due to the 50 peso (~US\$5) reward that Monarch Watch offers the Mexican guides at the reserve for each recovered tag. Each season, Monarch Watch pays thousands of dollars for this valuable information. We have created a Tag Recovery Fund for those who wish to assist with the purchase of these tags.

These tags were recovered by a guide at El Rosario last winter.



ALERT FOR ONTARIO TAGGERS

The following information came to us via Dplex-L, our email discussion list, from Don Davis in Toronto, Ontario regarding the need for permits to tag Monarchs in Ontario.

For the information of those tagging monarch butterflies in Ontario, you will require a Wildlife Scientific Collector's Permit. I am posting, below, the letter I received today. This Permit is required because monarch butterflies (and other large and colorful [butterfly] species, such as swallowtails) were given protected status last year under our new Fish and Wildlife Conservation Act. I've also inquired as to how some of the many questions and concerns raised by the Ontario entomological community have been responded to. For example, what about the school teacher who would like to rear a few monarchs in their classroom?

It is indeed unfortunate that our legislators did not have the foresight to add these procedures to the Act as regulations that could easily be modified or changed, as opposed to putting them directly into the Act, which now has to be changed by the Legislature. While MNR officials say that there is nothing that can be done about the present situation and the newly passed Act will not be changed for, say, five years, others say that if the entomological community and others complain and advocate effectively to our elected legislators, changes will be made sooner than later.

[To obtain a permit, Ontario taggers should contact: Wilma Miyasaki, Wildlife in Captivity Biologist, Wildlife Section, Fish & Wildlife Branch, Ontario Ministry of Natural Resources, Box 7000, Peterborough, Ontario K9J 8M5 Phone 705-755-1999, Fax 705-755-1900, Email wilma.miyasaki@mnr.gov.on.ca]

THANK YOU FOR YOUR CONTRIBUTIONS!

Monarch Watch would like to thank all those who made contributions to our program this past year. Contributors of \$100 or more are listed below. Please notify us with corrections or updates to our list.

TAG RECOVERY FUND

Lincoln Brower, David Gibo, Carl Kamp, Mary Kennedy, Michael's Fluttering Wings, Southern Butterfly Breeders' Association, Paul Viger, and Randy Warner.

EDUCATION FUND

Field Life Inc., Houston Museum of Natural Science, Bill Main, David Marriott, James Moffitt, National Science Teachers' Association, and Randy Warner.

ADOPT-A-CLASSROOM FUND

John Beck, Jr.; Tom Birt, Alliance for Social Awareness; The Cloud Foundation; Northampton Community College; Becky Collins, David Lipscomb Elementary; Vicki Dietz; Nancy Dott; Heather Drew, Mast Way Elementary; Laurel Godley; Donna Haddon; Floya Hawkins; Jane Hill-Rosato and Charlene Koehl, Knowlton Township Elementary; Judith Jackson; Marlene Krug, Bickerdyke Elementary; Dona Little; Idell Ludwig, Lyter Elementary; Kelly Martin, Berwick Academy; Patricia Morse; Gard Otis; Cathy Palm-Gessner, Macomb High School Ecology Club & Environmentally Concerned Citizens; Frank Porter Graham Elementary; Karen Rieser, Amberly Elementary; Chuck Safris; Sara Throop; Victor Volkman, E. Klopp Library; Frances Welden; and Shelby Wilber, Butterfly Society of Virginia.

We would also like to thank the following organizations and individuals who donated school supplies:

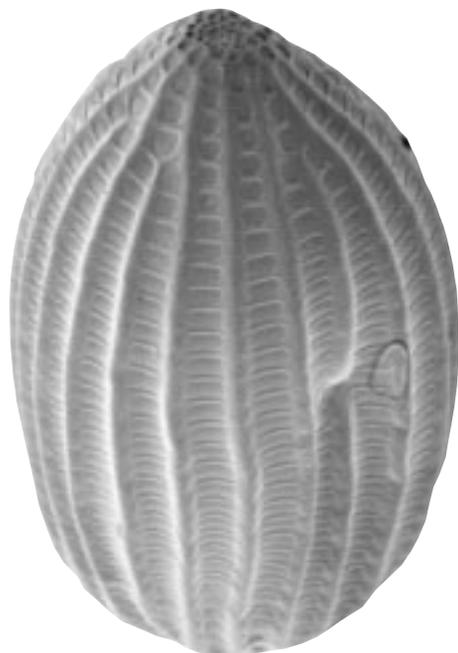
Audubon Society; Becky Collins, David Lipscomb Elementary; Janis Lentz, Jackson Elementary; The McAllen, Texas School District; Morton School; Randi & Lina Reed, Chantry Elementary School; The Summit School; and Victor Volkman, E. Klopp Library.

NEW PROJECT FOR SPRING 2001

Tracking the return migration of the overwintering Monarchs has become increasingly important. In 1999, 25 million acres of Bt corn were planted within the corn belt (prime Monarch breeding habitat). The rapid adoption of Bt corn, which produces pollen that can kill Monarch larvae or delay their development, has inspired two related lines of research. The goal of one project is to establish the extent to which immature stages of Monarchs are present at the time corn pollen is shed (anthesis). The second project is an attempt to develop a comprehensive understanding of the factors that determine the size of the fall migratory population. The latter study requires knowledge of the birth rates of Monarchs during the growing season as well as the factors that contribute to mortality throughout the year. Both studies will be facilitated by public reports of the following:

1. First adults of the season

The following information is needed for these sightings: date, location, weather conditions, observer, behavior of the butterfly(ies) and if possible condition and sex of each specimen seen.



SEM (Scanning Electron Micrograph) image of a Monarch egg (80x).

Photo by Monarch Watch.

2. First eggs of the season

Because Monarchs are often present but not seen, eggs are another valuable indicator that Monarchs have arrived. To observe first eggs, it is useful to identify emerging milkweeds that can be visited on a regular basis to determine if eggs are present on the shoots or the undersides of the new leaves.

NEW PROJECT FOR SPRING 2001
Spring observations (1 March-1 June)
We need your help!

3. First new adults to emerge (under natural conditions) in your area

Relatively little is known about the dates of emergence of the first Monarchs produced from eggs laid by the overwintering females. We need to know when this first generation emerges and begins to move northward. Observations of first adults can be made by rearing late instar larvae outdoors in cages designed to protect the larvae and pupae while maintaining a temperature which is close to that of the natural environment.

4. Developmental rates of first generation Monarchs

Not all Monarch immatures develop at the same rate. Due to subtle differences in microclimate and possible genetic differences, a group of 20 eggs might produce adults that emerge over a 6 day period. Although developmental rates for Monarchs have been determined in the laboratory, the variation of developmental times is not known in the field. These data are needed to develop models of the successive generations and to predict the arrival of new adults at more northerly latitudes. Determination of developmental rates requires rearing Monarchs in special cages outdoors.

ADDITIONAL BACKGROUND

Although the majority of overwintering Monarchs do not leave the mountains in Mexico until the middle of March, Monarchs are usually reported at many locations in Texas and Louisiana by March 15th. This suggests that some Monarchs leave the

overwintering sites in mid to late February. The 600 mile journey from the overwintering sites to south Texas probably takes a Monarch 2-3 weeks under favorable conditions. Based on our calculations, the earliest spring migrants could reach south Texas during the first few days of March.

The overwintered Monarchs or "oldies" can usually be distinguished because of their faded and tattered condition. The females tend to fly low to the ground, moving in a more or less northeasterly direction as they search for newly emerged milkweed.



This modified laundry hamper may be used to rear Monarch larvae outdoors.

Photo by O.R. Taylor.

If you are interested in helping us define first adults and first eggs, you can report your observations directly to us at Monarch@ukans.edu. These messages will be posted to Dplex-L, the email discussion list for Monarch Watch. First sightings are picked up from Dplex-L by Journey North and are incorporated into a database they update weekly throughout the spring.

If you would like to assist us with first emergences and/or variation in rates of development, please email us your name, phone number, location, and rearing experience. We will select about twenty cooperators distributed through the southern states and up to 40° north latitude (imagine an E-W line just north of Kansas City). We will provide each cooperator with a protocol and a cage in which to rear the Monarchs over plants outdoors.

ORANGE MONARCH PUPAE

How did orange Monarch pupae appear in my laboratory? Actually, the story is quite simple. On the 31st of March, Janis Lentz and her 5th grade students at Jackson Elementary in McAllen, TX sent me 25-30 eggs and larvae collected from *Asclepias oenotheroides*, a milkweed which occurs on their school playground. I set these eggs and larvae up on tropical milkweed in my window so I could observe them frequently and take good care of them. When the larvae reached the fifth instar, I noted that 7-8 of them were extremely black. In my experience, most black colored larvae feed slowly and die before or during pupation. However, these larvae looked healthy and so unique that we took several pictures.



Photo by Chris Haufler.

I kept track of the pupae from the black larvae and bred adults, eventually producing several hundred mostly black larvae which were reared separately to determine if this form is an inherited trait. (The black larval form *does* appear to be inherited but that's another, more complicated story). I was impressed by the black larvae and wanted to show the students at Jackson Elementary what they had sent me so I shipped some back to them.

On the 24th of June 1999, I was feeding these larvae when something caught my eye in a cage where they were beginning to pupate. One of the pupae was yellow, maybe even orange, rather than the usual jade green. I groaned because color anomalies in larvae and pupae are usually associated with diseases or developmental problems. My first reaction was that the culture had a disease I hadn't seen before. This put me in a bad mood but I tried not to think about it as I busied myself with

other things. A few hours later I passed the cage again and this time there were eight orange pupae and a closer look indicated they appeared normal and healthy. Wow! This wasn't a disease, this was a color form (phenotype) that I had never heard of in Monarchs. Actually, I wasn't the first to notice an orange pupa. A few hours earlier, Janis Lentz and her students spotted an orange pupa from the larvae that I sent them. Shortly after I realized the pupae were unique, an email arrived from Janis Lentz's students asking me to explain this strange new finding. All I could tell them was that it looked like an inherited characteristic.

I started research on the orange pupae by consulting a few references. As it turns out, light colored pupae have been reported in Queens (*Danaus gillippus*), in Black and White Tigers (*Danaus affinis*) in Australia, and in several other African and Asian members of the genus but apparently not in Monarchs (Brower 1984). This quick review of the literature suggested that for some species, the pupae are polymorphic (have more than one color form). However, I couldn't find any references indicating that the inheritance of this phenotype had been investigated. We were in a good position to do this; by the time the special larvae had completed pupation, we

had more than 30 orange pupae.

Orange pupae in Monarchs is not really a "new" phenotype. It is only new in the sense that it has not been described before. Although this form certainly occurs in natural Monarch populations, it must be exceedingly rare. It is likely that such an extraordinary color form would have been recorded in the literature had it been encountered by any of the hundreds of people who rear Monarchs. So, why did the orange pupae suddenly show up in this generation?

Here's my interpretation. It seems possible that the black larvae in the original sample were all from eggs scattered by one female throughout the playground. By selecting these larvae for a breeding program, brothers and sisters mated with each other. If either the mother or father of these larvae were heterozygous (an allele for wild-type and an allele for orange) for pupal color, up to 50% of the offspring could be heterozygous as well. All would be expected to be normal in color if the orange was recessive to the normal (jade colored) pupal form. Indeed, they were. The black larvae formed perfectly normal and healthy jade green pupae. However, some of them must have been heterozygotes, since the breeding of these butterflies, that



A "normal" green Monarch pupa and the unusual orange form. Photo by Jim Lovett.

were probably brothers and sisters, produced orange pupae.

In order to learn more about this phenotype, the next step was to breed the butterflies from the orange pupae together and make other crosses to determine how this form was inherited. If orange is recessive to normal as suggested above, then the oranges (adults from orange pupae) should breed true. In other words, all the offspring of oranges crossed with oranges should be orange. Crosses between oranges and homozygotes (two alleles for wild-type) or oranges and heterozygotes should produce 1 wild-type:0 orange or 1 wild-type:1 orange, respectively. Crosses between two heterozygotes should produce both types in a 3:1 ratio.

Nellie Kim, an undergraduate who worked in my laboratory on the inheritance of white Monarchs, made the crosses and tested the observed and expected ratios to determine if orange is inherited as a simple recessive trait. Some of the results fit the expectation, others did not. The orange form breeds true; i.e., crosses between two oranges always produce orange progeny. This indicates there is a simple genetic control of the orange phenotype. However, there appear to be other genetic interactions since the broods that should have produced 1:1 and 3:1 ratios had too few wild-type pupae. At first glance, it looks like some of the heterozygotes don't survive, but there could be other genetic interactions that could give unusual ratios. More crosses are planned for this summer to work out the details.

Monarchs are an outbreeding species and apparently one with a high degree of genetic variability according to the studies of Eanes (Eanes and Koehn 1978). Matings between closely related individuals are probably rare. This means that a recessive allele for a rare trait can be carried or maintained in a population at a low frequency (in a heterozygous condition) from generation to generation without being expressed in a homozygote. For example, what is the probability that a recessive allele with a frequency of .01 will be expressed as a homozygote (white

adult or orange pupa) in a random mating system? We can work out this expectation with the Hardy-Weinberg equilibrium model. If we know the allele frequencies, in this case .99 vs. .01, we can use $p^2 + 2pq + q^2 = 1$ to calculate the expected frequencies of the genotypes and phenotypes. For our example, $(.99)^2 + 2(.99 \times .01) + (.01)^2 = .9801 + .0198 + .0001 = 1$. The .0001 indicates that only one individual in ten thousand will be homozygous for the rare allele. If our rare allele has a frequency of .001, then only one individual in a million ($.001^2$) would express the trait. How rare is the allele for the orange pupal form? I don't know, but it is probably less than .01.

Why do such traits exist and why are they so rare? This is a difficult question. If a trait is slightly deleterious and is selected against, it can be maintained in the population due to recurrent mutation. This is probably the case with the white Monarch. This form has been reported in many Monarch populations but is extremely rare. Preliminary studies by Megan Sumpter, a student who worked in my laboratory, suggest that white Monarchs are not as fit as "wildtype" or normal Monarchs. This form appears to be maintained in populations only when it is favored by selection, as it is in Hawaii by bird predation (read more about this white form on our Web site). When the heterozygote is at a selective disadvantage, which may be the case with the orange pupae, there is a tendency for the recessive allele to be maintained but at a low frequency. In some cases, if the heterozygote has a higher fitness (i.e., it survives better) than either of the homozygotes, a balanced polymorphism can be maintained in the population. In this case, two forms and the underlying three genotypes can be maintained at equilibrium (at the same frequencies) from generation to generation.

The appearance of the orange pupae in our Monarch culture immediately raised two questions. One question is fairly obvious: what is the adaptive significance of the jade green color of the Monarch pupa? The immediate

answer is that the pupa, by blending in with green foliage, is less conspicuous to predators than it would be if it were some other color. This sounds good and it fits our expectations based on our experience with other species. In fact, most organisms match their background fairly well with the exception of those that appear to gain an advantage by advertising their distastefulness or ability to sting, etc. It follows that an orange pupa might be more conspicuous against a green background. This surely seems to be the case in our rearing cages. These pupae really stand out against the background. But not all is green in nature. In dry habitats, with yellowed leaves and grasses, orange may be less conspicuous than green against the background. Curiously, the other Monarch relatives (Danaines) which have orange pupae come from environments which are dryer than those typically experienced by Monarchs throughout the breeding season.

The second question is: why is the normal pupa color jade green? It hadn't occurred to me that the pupa is green because it has a blue-green pigment. I just hadn't thought about it. I assumed that the coloration was some form of carryover from feeding on milkweed leaves which contain chlorophyll. The occurrence of the orange pupa made it clear to me that a blue-green pigment is synthesized late in larval development and is deposited beneath the cuticle of the pupa that develops under the last larval skin. The orange phenotype may simply be a case in which an enzyme that normally converts precursors to blue-green is missing. This is a good project for an undergraduate who is interested in pigment biosynthesis.

Many questions remain about the orange pupae. How rare is the allele for this form? Is this form at a selective disadvantage in the wild? Why is there a deficiency of heterozygotes in many of the crosses? We will address some of these questions in future studies.

REFERENCE

Eanes, W. F. and Koehn, R. K. 1978. An analysis of genetic structure in the monarch butterfly, *Danaus plexippus* L. *Evolution*. 32(4): 784-797.



De's students working hard to take care of their Monarchs.

Photo contributed by De Cansler.

I have been using Monarchs in my classroom for 8 years. They have not only changed the way I teach, they have changed the way I think. Monarchs have enriched my life in multiple ways. Directly and indirectly they have led me to a Masters degree; travels to Montana, Texas and Mexico; networking with other teachers throughout Minnesota and Rochester...who I otherwise would have never met...September is always CRAZY...with so many people...becoming involved in the rearing process. But - it is also incredibly exhilarating to watch so many people connect to this organism...and learn science...and love learning. This tiny insect has truly enriched my life!

De describes her goal:

To use one of nature's most beautiful creatures and its amazing life history to capture the attention, curiosity and affection of students...thereby giving relevancy to issues and topics we cover throughout the year and providing a springboard for student exploration and research.

To accomplish this goal, De gives each student their own Monarch egg on the first day of class to raise in the classroom. The students keep a journal on the development and metamorphosis of their Monarch. De teaches her student how to observe, hypothesize, develop experiments, measure, record data, and interpret results. Her students also maintain a Monarch population in the classroom to study the behavior of the adults. In addition to all of these activities, De's students participate in Monarch Watch,

Monarchs in the classroom, and Journey North (www.learner.org/jnorth). The most recent addition to De's classroom activities is her participation in research fairs with Dr. Karen Oberhauser in Minnesota.

Dr. Oberhauser comments on De Cansler's skills as a teacher:

De is an excellent teacher; this applies equally when the audience is students or fellow teachers. She cares intensely about her students...Her students have won awards for research projects, and she organized a trip for two students to the monarch overwintering sites in central

Mexico. De has co-taught workshops with me in which her "students" are teachers. Comments from workshop participants make it clear that other teachers are inspired by her.

Congratulations to all of our featured teachers for making an impact on your students through the use of Monarch butterflies.

If you would like to nominate someone to be a featured teacher in next year's Season Summary, send us a letter explaining how they use Monarchs in their classroom and why you think they are a good teacher. Photos are also appreciated! Letters should be addressed to:

Monarch Watch
c/o O.R. Taylor
Department of Entomology
Haworth Hall
University of Kansas
Lawrence, KS 66045

MONARCH HIGH SCHOOL PROJECT

The Monarch High School Project (MHSP) is a school in downtown San Diego for homeless and unattended youth that serves 60-75 students in two classrooms. MHSP was started in 1988 "to provide an environment where homeless and at-risk teenagers can reclaim their lives and achieve their dream of a normal, productive life through education". Formerly known as "The P.L.A.C.E." the Monarch High School Project was renamed in 1999. The name "Monarch" was chosen to symbolize the goal for students to change their status, to improve, to metamorphose into an adult. Monarch biology is part of the curriculum and many students raise Monarchs. Caring for living creatures often has a profound effect on these disadvantaged students.

The students attend school when they are able to get there. However, MHSP gives the students every reason to attend. Hot meals, showers, laundry facilities, clothing, bus tokens, toothpaste, hair spray, pre-natal vitamins, diapers, and drug and alcohol information are provided free of charge. Some students come for the survival needs provided by MHSP, but others learn that education is their escape from the streets and stay with the program. This program has such an impact on the students' lives that the current students do the recruiting for new students.

A basic curriculum is not enough for these special students. In addition to a curriculum that leads to a high school diploma, the students are offered literacy programs, computer science programs, street survival skills, family planning, and AIDS education.

"Walking, crawling, grasping, falling, trying, striving, emerging, flying!" This is how Jason N., a student at MHSP, envisions his life and his future, a future broadened and attainable through the education and training available to him only through MHSP. MHSP is currently trying to raise funds for a new school. To help these homeless and forgotten children realize their potential, contact Craig F. Robinson at Monarch High School Project, PO Box 927989, San Diego, CA, 92192-7989 or by phone at 858-483-4834.

MORELIA MEETING UPDATE

The North American Conference on the Monarch Butterfly was held at Morelia, Michoacan, Mexico in November 1997. It generated papers on a variety of Monarch related topics including Biology, Conservation, Sustainability and Development, and Environmental Education. The papers presented at the conference are now available free of charge under the title *1997 North American Conference on the Monarch Butterfly, Paper Presentations* from the CEC (Commission for Environmental Cooperation). Request the book by visiting their Web site at www.cec.org or by sending an email request to: jstoub@cceintl.org. You may also obtain a copy from Monarch Watch by calling us at 1-888-TAGGING (toll-free) or 1-785-864-4441. There will be a shipping charge when you order the book from Monarch Watch. Quantities are limited and will only be distributed as single copies on a first come, first serve basis. If you are interested, please get your requests in as soon as possible.

1997 North American Conference on the Monarch Butterfly, Paper Presentations

The following is a very brief summary of the publication's four chapters.

CHAPTER 1: BIOLOGY

The Biology chapter contains thirteen papers on the following topics: the mysteries of the migration, parasite interactions, conservation biology, reproduction, behavior and population biology.

CHAPTER 2: CONSERVATION

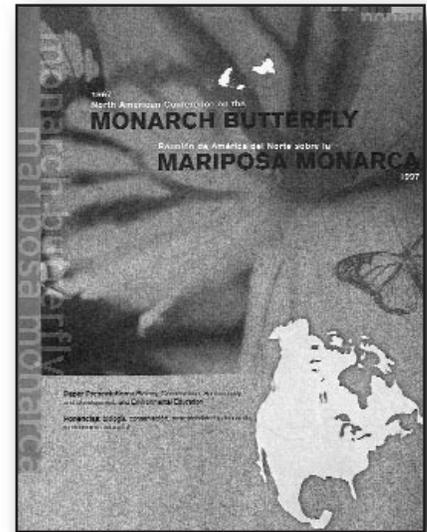
The Conservation chapter contains four papers. These papers focus on local involvement in conservation of the overwintering sites, a California case study of the restoration of an overwintering site, an assessment of the vegetation found near the overwintering sites, and the problems facing Monarch conservation in the US.

CHAPTER 3: SUSTAINABILITY AND DEVELOPMENT

The papers presented in this chapter can be divided into two groups: socioeconomic challenges and ecological conditions of the Monarchs' habitat. Eleven of the fifteen papers in this chapter are in Spanish.

CHAPTER 4: ENVIRONMENTAL EDUCATION

Most of the ten papers in this chapter describe programs dedicated to using the Monarch butterfly as an educational tool including: Journey North, Monarchs in the Classroom, Monarch Watch, the Canadian Centre for



Biodiversity, and Proyecto Correo Real. Other papers focus on the Urquhart Butterfly Garden, community participation in resource management, evaluation of Monarch environmental education programs, Monarch larval monitoring, and small-scale habitat enhancement.

This book is loaded with information on Monarchs and many well-known Monarch specialists present their views on Monarch conservation and biology. This is a worthwhile acquisition if you are interested in finding out more about Monarch conservation efforts. You should be aware that some of the papers presented in this volume are in Spanish.

FLIGHT OF THE MONARCHS

Those interested in the history of the discovery of the overwintering sites in Mexico will be fascinated by Alex Shoumatoff's article "Flight of the Monarchs" in the November issue of *Vanity Fair* (pp 268-273, 295-300). Based on thorough research and extensive interviews, Shoumatoff summarizes the historical search for the Monarch overwintering sites and describes the impact the discovery had on the relationships of the researchers involved. The search was a race between two camps, one led by Fred & Norah Urquhart who were assisted by Kenneth Brugger and his wife Cathy, and the other led by Lincoln Brower with the assistance of Bill Calvert. The article describes the disputes between the Urquharts and Brower from early on when Fred Urquhart disagreed with Brower about the toxicity of milkweeds and even rejected the entire theory of Batesian mimicry. The disputes continued and intensified when the overwintering sites were discovered and Fred Urquhart withheld the location of the sites from Brower, forcing Brower and Calvert to conduct an independent search for these locations.

Others mentioned in the article are Mexican conservationists Carlos Gottfreid, Rodolfo Oggario, and Homero Aridjis, all of whom played key roles by lobbying the Mexican government to make the overwintering sites into a reserve. The article provides an excellent history of the events leading up to and following the discovery of the sites. Included are beautiful images of Monarchs together with pictures of Lincoln Brower and Fred Urquhart.

MONARCH RECORDS

The following records were selected from the annual reports of the Insect Migration Association, a program run by Fred and Norah Urquhart from 1963-1993, and from the records of Monarch Watch (seasons 1992-1999). If we have overlooked an important record or made any mistakes in these reports, please let us know!

Longest Known Flight: 2880 miles (4608 kilometers); tagged by Don Davis near Brighton, Ontario, on 10 September 1988 (in Urquhart's tagging program) and recaptured on 8 April 1989 in Austin, TX. It is assumed that this Monarch spent the winter in Mexico.

Longest Known Flight to Mexico: 2421 miles (3896 kilometers); tagged by Heather Bellefleur in Durham, ME on 19 August 1999 and recaptured in El Rosario in February 2000.

Most Migrating Monarchs Tagged by One Individual or Group in One Year: 12,397; Terry Callender and his students at Wamego High School (Wamego, KS) tagged these Monarchs in 1996.

Highest Total Number of Monarchs Recovered in Mexico, Tagged by One Group/Individual: 58; Terry Callender and his Wamego High students (Wamego, KS): 1993 (1); 1994 (1); 1995 (1) 1996 (3); 1997 (4); 1998 (42); 1999 (6)

Don Davis (Ontario, Canada) has 33 recoveries: 1985 (1); 1986 (2); 1990 (1); 1991 (10); 1992 (2); 1994 (2); 1997 (1); 1998 (4); 1999 (10).

The Outdoor Campus (Sioux Falls, SD) has 33 recoveries: 1997 (1); 1998 (9); 1999 (23).

Most Western Origin of a Monarch Reported in Mexico: Three Monarchs tagged in Ft. Collins, CO (longitude 105:04:07W) were recovered in Mexico. They were tagged by Paul Opler and Evi Buckner (15-18 September 1999).

Most Eastern Origin of a Monarch Reported in Mexico: Durham, ME (longitude 70:13:00W); tagged by Heather Bellefleur on 19 August 1999.

Most Northern Origin of a Monarch Reported in Mexico: Devil's Lake, ND (latitude 48:06:46N). Four Monarchs tagged by Marsha Samson in September 1999 were recovered.

Most Southern (U.S.) Origin of a Monarch Reported in Mexico: Corpus Christi, TX (latitude 27:42:21N). Tagged by Lionel & Sylvia White on 17 October 1998.

Most Northern Origin of a Recovered Monarch: Millburn, Newfoundland; tagged in conjunction with Urquhart's tagging program in 1972, recovered in Fairhope, AL.

Most Unusual Recovery Site: Havana, Cuba; tagged by E.R. McDonald of Port Hope, Ontario (Urquhart's program) on 25 September 1968.

Earliest and Latest Tagging Dates Known for a Monarch Reported at Overwintering Sites in Mexico:

North America

Earliest: 12 August (1998) Tagged by Megan, Alison & Conner Key in Minnetonka, MN; Monarch Watch Tag ZN931 **Latest:** 17 November (1999) Tagged by Marisa Capuano in Brighton, NY; Monarch Watch Tag 409GC

Kansas Alone

Earliest: 24 August (1999) Tagged by Tonganoxie High School in Tonganoxie, KS; Monarch Watch Tag 735OT
24 August (1998) Tagged by Kristen Beck at Mankato High School Mankato, KS; Monarch Watch Tag CH013 **Latest:** 11 October (1998) Tagged by Jacalyn Goetz in Overland Park, KS; Monarch Watch Tag XM260

First Recoveries in Mexico for Monarchs Tagged in the Following States (tagging data in parentheses):

Kentucky (Sondra Cabell, Geneva, KY 18 September 1999)
North Carolina (Rachel Kaufman, Durham, NC 25 September 1999) (Donna Haddon, Point Harbor, NC 26 September 1999)

Colorado (Paul Opler & Evi Buckner, Ft. Collins, CO 15, 17, & 18 September 1999)

Massachusetts (Ed Wesely, Amherst, MA 1 August 1999) (Stephen Haydock, Salisbury, MA 12 September 1999)

Maine (Heather Bellefleur, Durham, ME 19 August 1999)

Mississippi (Amanda Rhymer, Olive Branch, MS 20 August 1998) (Bill Stark, Clinton, MS 2 October 1999)

States East of the Rockies without Recovered Monarchs in Mexico: RI, DE, VT, NH, SC, AL, NM, WY, MT

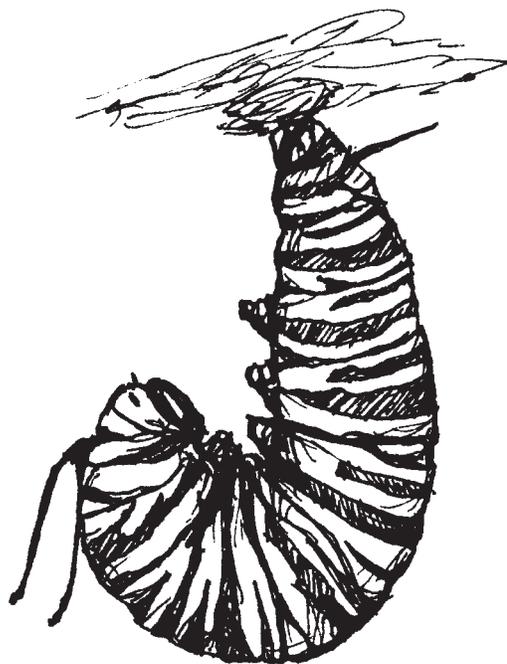


Illustration by Cara Weeks.

MILKWEED RESTORATION

In the 1998 Season Summary, I drew attention to the issue of milkweed restoration. Time to work on this issue has been limited but I have given several talks and interviews in which I've promoted habitat and milkweed restoration. Although I've spoken to several experts in habitat restoration and have discussed this issue with the Kansas Department of Transportation, I haven't made significant progress in forming a coalition of groups with similar interests. I was therefore surprised and gratified to receive the following letter from David King of the North Carolina Department of Transportation.

Dr. Taylor:

You were referenced and quoted in an article from a recent issue of "The Furrow" magazine, published by John Deere. The article said you are "focusing on improving habitat as a way to boost Monarch numbers" and that you are "trying to urge highway departments in the U.S. to be environmentally friendly in maintaining roadsides." I am pleased to inform you that the North Carolina Department of Transportation has started a Monarch Butterfly Program this spring. We have planted ten acres of designated Roadside Wildlife Habitat plots with two species of milkweed; another five acres of wild-flower beds have been planted with butterfly weed. We are interested in learning all we can about feeding habits and preferences, migratory patterns, etc. We have utilized the Web site www.MonarchWatch.org, and have acquired considerable information from Michelle Prysby at the University of Minnesota....

Thank you for your help.

David King NCDOT Roadside Environmental Unit

Discussions with members of Departments of Transportation indicate that sensitivity to maintaining biologically diverse roadside habitats is increasing. A general awareness of biodiversity issues, declining bird populations, and higher costs of fuel can be used by coalitions of interest groups in each state to argue for wiser and less costly management of these habitat fragments. --*Chip Taylor*

CHASING MONARCHS: MIGRATING WITH THE BUTTERFLIES OF PASSAGE

There is an enduring tenet that Monarch butterflies (*Danaus plexippus*) west of the Rocky Mountains migrate to wintering grounds in California, while those east of the Rockies migrate to Mexico. The mountains have long been considered a barrier to the two populations. Dr. Robert Michael Pyle artfully takes his readers on a 57-day trek through western North America in search of Monarchs in his book "Chasing Monarchs: Migrating with the Butterflies of Passage". His most intriguing find is that some Monarchs west of the Rockies but east of the coastal ranges move in a southeasterly direction. Pyle followed these Monarchs to the Arizona/Mexico border, suggesting that some Monarchs west of the Rocky Mountains do indeed make it to the overwintering sites in Mexico.

Pyle's 9,500-mile trip began in late summer in British Columbia. He worked his way south through mountains, rivers, creeks, pastures, and the western canyons in search of Monarchs. Pyle spent much of his time near creeks, rivers and meadows where the sought after host plant, milkweed, rarely goes undiscovered by the Monarchs. When asked how he follows butterflies, Pyle responded: "I'll find a Monarch. I will watch it. If it flies, I'll follow it as far as I can. When I lose it, I'll take its vanishing bearing..." Then he moved on in the direction of the vanishing bearing to search the surrounding countryside for the next Monarch. Monarch by Monarch, he followed their flight.

On his journey south, Pyle stopped frequently on back roads and river edges to identify many of nature's creatures. He is knowledgeable in his identifications of birds, insects, plants and trees. During many of his stops, he was successful at locating the yellow, black, and white Monarch caterpillars munching on milkweed, fueling up for their life journey. Pyle also located the green pupae hanging camouflaged beneath the leaves of the milkweed plant. These discoveries assured him that Monarchs were in the area and gave him the drive to continue his chase. When he had trouble locating the migratory butterfly, he interacted with local people and passers-by asking them if they have seen any Monarchs, and involved many in the mysteries and wonders of the migration.

This book doesn't just inform us about the mysterious migration patterns to the southwest coast and southern United States (and possibly Mexico) by the western population of *Danaus plexippus*. "Chasing Monarchs" puts us behind the wheel of Pyle's Honda "Powdermilk", and allows us to see the chase through his eyes. With exceptional knowledge and details, Pyle shares his love and respect for the Monarch butterfly as he takes us on the Monarch's journey, and his own, through the beautiful and less traveled intermountain region of the western states. --*Review by Daniel Umscheid*

Pyle, R.M. 1999. Chasing Monarchs: A Migration with the Butterflies of Passage. Houghton Mifflin Company. Boston, MA.

FREQUENTLY ASKED QUESTIONS

WHAT IS THE CLASSIFICATION OF MONARCHS?

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Lepidoptera
Family: Danaidae*
Genus: *Danaus*
Species: *plexippus*

*Some classifications place Monarchs in the family Nymphalidae.

WHY ARE ADULT MONARCHS SO FUZZY?

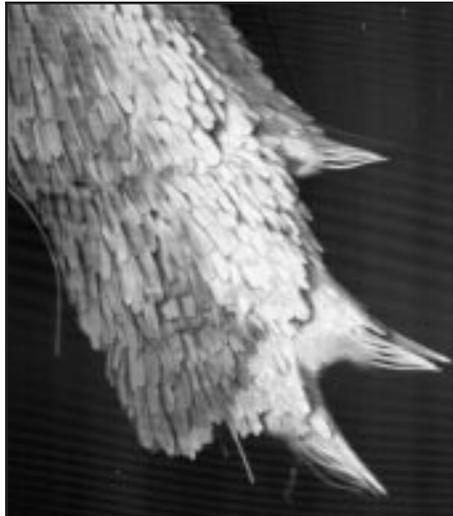
Here is a hypothesis contributed by David Gibo. The long hairs, which are actually modified scales, function as insulation and as fairings (i.e., structures that smooth the airflow over the body) - particularly where the wings join the thorax and where the two hind wings form a pocket for the abdomen.

Assuming that the hairs trap a layer of air next to the body, this will reduce the rate of heat loss during flight due to convective cooling. Judging from the length of the hairs, this layer of trapped air should be about 2-3 mm thick. Sunlight can still reach the body because the hairs are thin and widely separated. Consequently, Monarch butterflies should be able to bask in the sun in a moderate wind and still heat up rapidly. They should also be able to remain warm while gliding in bright sunlight in cool air. Smoothing airflow over the wing roots and at the hindwing-abdomen junction should reduce drag, allowing for longer glides and increased efficiency during flapping flight.

WHY DO ADULT MONARCHS ONLY HAVE FOUR LEGS?

Adult Monarchs have six legs like all other insects, but their first pair of legs is very reduced and folded up tightly beneath the thorax, making them difficult to see. Sensors extending from the tip (tarsus) of these forelegs appear to be used by females in choosing host plants. Mated females rapidly extend

their forelegs several times during short intervals (1-2 seconds) when first coming in contact with a milkweed plant. The rapid extension of the forelegs has been referred to as "drumming".



SEM (Scanning Electron Micrograph) image of a female Monarch's foreleg (120x). Photo by Monarch Watch.

WHY DO MALE MONARCHS SOMETIMES ATTEMPT TO MATE WITH OTHER MALES?

Male-male courtships are very common in Monarchs in both the field and the lab. Many of these courtships are quite long in caged situations. Usually such courtships end quickly in the field but a few are quite long. This behavior raises many questions about how the courting males recognize females and/or males. Evidently they don't do this as well as we might expect. Do they recognize the sexes on the basis of pattern, color, odor, or behavior? And if the wrong sex is courted, can the male being courted enhance his "maleness" by some particular behavior? You could get some answers to these questions by careful comparison of the courtships by males to both males and females. You might use model Monarchs of different colors or size, etc. Stopwatches, tape recorders and/or a video camera would be helpful for such studies. To avoid problems of cross reference to human behavior, keep the focus of the

study on "mate recognition" signals and behavior. See the "Challenges to Students" in the 1998 Season Summary for more hints.

DOES POLLEN FROM BT CORN AFFECT ADULT MONARCHS?

Adult Monarchs are not likely to be affected by Bt pollen. Adult butterflies feed on fluids such as nectar, water, moisture from feces, decaying matter, etc. and are therefore unlikely to consume Bt pollen. Only the subtropical and tropical longwing (Heliconine) butterflies are known to intentionally seek out, collect and digest pollen.

WILL MONARCHS EVOLVE RESISTANCE TO THE TOXIN IN BT CORN POLLEN?

Monarchs are unlikely to evolve resistance to Bt toxins or insecticides in general. As a migratory species with a large breeding area and 3-4 generations per year, only small portions of the population are exposed to such selective agents for one or at most two generations per year. For selection to act rapidly on a population, and for pesticide resistance to evolve, a population should be relatively sedentary and exposure should occur almost continuously over many generations. The portion of the Monarch population feeding as larvae on pollen-dusted milkweeds within and adjacent to Bt corn fields would be exposed to Bt toxins for only one generation during the two-week pollen shedding in each location. Even if traits appeared in the population for Bt resistance, the alleles responsible would not be likely to increase in frequency since the probability that carriers of these alleles, due to the temporal and spatial distribution of progeny, are not likely to be exposed to the same condition in subsequent generations.

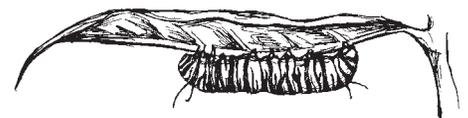


Illustration by Cara Weeks.

MAGNETIC ORIENTATION: A CORRECTION

An axiom of science is that it is a self correcting process. Hypotheses are tested in an objective fashion and in a manner such that other investigators can replicate the results. If, in subsequent tests, the results cannot be replicated, an earlier result is questioned and rejected. In November, we published a paper which provided experimental evidence for magnetic orientation in Monarchs (Etheredge, et al. 1999). This paper has been retracted, which means that the results obtained in this study were not evidence for magnetic orientation.

In September 1999 we initiated a series of experiments based on the previous findings (after this paper had gone to press but before it was actually published). Unfortunately, our attempts to modify and extend these studies failed and we came to realize that the original study was flawed. The results were validly obtained but they did not seem to represent magnetic orientation. After 16 trials, in which we tested over 500 butterflies during a two month period, we determined that the original result was due to an artifact of the experimental conditions. A paper describing the subsequent experiments and the reasons for the false positive results has been accepted for publication (*Journal of the Kansas Entomological Society*).

In an earlier paper (Perez, et al. 1999) we showed that Monarchs subjected to a strong magnetic pulse are disoriented, indicating a response to magnetic stimuli. These results have been replicated and it still seems likely that Monarchs utilize magnetic orientation as they traverse the continent during the migration. Additional experiments to test this possibility will be conducted this fall.



SEM image of a pollinarium (60x), part of a milkweed flower. It consists of two connected sacs (the pollinia) which contain pollen. (See page 19 for further discussion.) Photo by Cathy Walters.

Each fall, Pinellas County hosts the Florida Birding Festival & Nature Expo largely because many of the migratory bird species gather at the tip of Pinellas County before crossing the Gulf of Mexico. Monarchs also gather in Pinellas County. In anticipation of their arrival, Pinellas County planted 13,086 one gallon milkweed plants in 5 of their parks in 1999. The milkweeds planted were tropical milkweed (*Asclepias curassavica*), both the orange and yellow varieties and the remaining plants were Calotrope (*Calotropis gigantea*). In addition to milkweed, nectar plants have been placed nearby for the butterflies. According to Debbie Chayet of the Pinellas County Parks Department, 3-4 generations of Monarch larvae feed on the milkweeds from October until Spring. Periodically, the milkweed patches end up as stalks due to defoliation by Monarch larvae.



The planting of these milkweeds each year has become a community event for Pinellas County. One young man achieved his Eagle scout ranking by organizing 75 volunteers to plant 2700 assorted milkweeds in Fort DeSoto Park. In addition, Temple B'nai Israel spent their Mitzvah day in 1999 planting 9000 seeds in flats. Then in November, they returned to plant the mature plants in Lake Seminole Park. We would like to congratulate Pinellas County for a great job on creating an interesting community wide project to help protect Monarch butterflies.

The 2000 Florida Birding Festival will be held in Clearwater, Florida on October 5th through October 8th. If you would like to receive a registration packet about the Birding Festival, call 1-877-FLA-BIRD (352-2473) or contact Debbie Chayet at 727-464-5111 for details on Butterfly workshops and field trips. The butterfly speakers at the 2000 Florida Birding Festival will include Dr. Lincoln Brower (October 6th) and Dr. Marc Minno (October 7th).

TECH NOTES

WEB SITE STATISTICS

Our Web site continues to attract an increasing number of visitors. The number of unique visitors has increased 167% if we compare the usage from October 1998 through April 1999 (54,019) to October 1999 through April 2000 (90,416). This trend reflects a general increase in internet use, but also shows that interest in Monarchs is expanding.

More than 90% of the visitors to the site are from the United States and the remainder are distributed over 90 countries. As you might expect, our Canadian colleagues are the next highest group to connect with us but ranking of the next five is somewhat surprising: New Zealand, Australia, Japan, Mexico and the United Kingdom. There is a strong interest in Monarchs in New Zealand and Australia and we receive many email inquiries from these countries toward the end of their summer season. For an article on Monarchs in Australia and the Pacific, see the 1998 Season Summary which you can order for \$4 (see the order form for details) or download as a PDF file from our Web site.

CYBERSURFARI 2000



Monarch Watch has once again been invited to participate in the latest educational internet treasure hunt presented by DiscoverySchool.com. This will mark our third appearance in these games. To participate, "CyberSurfarians" must first sign up and choose a division in which they will compete (individual, family team, school team, etc.). Then the hunt is on as players race to find the answers to clues given throughout several "CyberStations" - such as DiscoverySchool.com, ALFY.com,

NEA.org, and Education-World.com. The clues provided on these sites send players to other "Outpost" sites such as MonarchWatch.org. When the answer is found, a treasure page is displayed and players enter their keycode to receive credit for a successful hunt. There are several ways to win and over \$100,000.00 in cash and prizes are awarded to schools, families and individuals. Contests are held year-round, so if you'd like to join the hunt or would just like more information, surf on over to www.CyberSurfari.org

DIGITAL MONARCH WATCH

Thanks to Steve Case and Tom Baker at KanCRN (the Kansas Collaborative Research Network), it is now possible to record your tagging data on the Internet. The Digital Monarch Watch is a data collection site for Monarch Watch tagging data and is located at www.kancrn.org/monarch. Last year we advertised this Web site on Dplex-L, our email discussion list, and a number of the subscribers submitted test data using this Web form. These test data enabled Steve and Tom to work out the "bugs" and make the site more user friendly. The site is now ready for your data!

Electronic data submission will enable us to make queries and summarize the tagging data more efficiently. In addition, you can view your data and those of other taggers on the Web site. These data could be used in numerous classroom projects. You can record the data electronically as you tag your Monarchs or after the end of the tagging season. You can also download your data in Excel or other formats so that you have a hard copy for your records. We encourage you to use this tool to submit your tagging data; however, we still need you to send us a copy of your datasheets to ensure

that your data is included in our records.

To use the Digital Monarch Watch, you must first register. You can register as a teacher or as a citizen, but it is important that you register properly because this is how the system determines your latitude and longitude. After registering, select the "Data Submission" link under the heading "Creating the Context". There, you simply fill in your assigned KanCRN ID number, the first tag number you were issued, and then your tagging data on the Web forms. To review your data, click "Results of Study" and enter your ID again to view the data you've entered. You can also view or download the data entered by other taggers if you leave the ID field blank and click on "Retrieve Data".

If you tag in a rural location and you do not know your latitude and longitude (or zip code), KanCRN has Global Positioning System (GPS) units to loan so that you can determine your latitude and longitude. For information on obtaining a GPS unit, contact Steve Case by email at scase@kancrn.org.

In addition to submitting your tagging data, the Digital Monarch Watch Web site is collecting flight direction data for Monarchs. To learn more about this project, visit the KanCRN Web site at: www.KanCRN.org/monarch

NEXT TIME YOU'RE OUT SURFING THE WEB, BE SURE TO STOP BY THESE SITES AND SEE WHAT'S NEW:

MONARCH WATCH
WWW.MONARCHWATCH.ORG

JOURNEY NORTH
WWW.LEARNER.ORG/JNORTH

TACTICS AND VECTORS
WWW.TACTICSANDVECTORS.ORG

MONARCHS IN THE CLASSROOM
WWW.MONARCHLAB.UMN.EDU

MONARCH MONITORING PROJECT
WWW.CONCORD.ORG/~DICK/MON.HTML

MONARCH SPEAKERS

Below is a list of speakers who present programs on Monarchs for organizations or schools.

Arkansas

Jim Edson
870.460.1966 • edson@uamont.edu
Fees are negotiable.

Colorado

Evi Buckner & Paul Opler
PO Box 2227
Loveland, CO 80539-2227
paulevi@webaccess.net

Illinois

Suzanne Cook, Master Gardener
309.346.6619 • bdcspc@mtco.com
Evenings and weekends
1hr program w/slides, live specimens
fee negotiable

Kansas

Stephanie Darnell
913.433.5229
Kansas City area
Jackie Goetz
Johnson County Extension
913.764.6300 • goetz1@swbell.net
Jo. Co. area; honorariums appreciated

Jim Mason
Great Plains Nature Center
316.683.5499 • jmason@ink.org
Wichita area; donations accepted

Brad Williamson
913.780.7120 work
913.764.6036 home
bwilliam@sound.net
Fees depend on program.

Kentucky

Sondra Cabell (Western KY)
270.826.4424
jaudubon@henderson.net
Fees: \$10-25

Laura Lang (Eastern KY)
800.858.1549
Laura.Lang@mail.state.ky.us

Maine

Kathy Jewett
207.878.5724 • kjewett1@maine.rr.com
Preschool-grade 5; fees negotiable

Maryland

Denise Gibbs
Black Hill Regional Park
301.916.0220
Washington DC area; fees vary

Michigan

Matt Douglas
616.234.3893
mmrd2@ix.netcom.com
Fees depend on location.

Anne Okonek
Monarch Butterfly Project
906.474.6442 x 119 • No fee.

Lee Petersen
616.874.7140
Donations given to Monarch Watch.

Minnesota

Karen Oberhauser
612.624.8706
karen.s.oberhauser-1@tc.umn.edu
Fee: \$60-100

Michelle J. Solensky
612.625.5735 • wats0094@tc.umn.edu
Fees include travel costs incurred.

Elizabeth Goehring
612.624.8706 • egoeh0005@tc.umn.edu
Fee: \$60

Michelle Prysby
651.645.7072 • prys0004@tc.umn.edu
Fee: \$60

Missouri

Dan Dickinson
816.943.0079
ddickins@gwe.leesummit.k12.mo.us
Kansas City area; fees negotiable

Maria Stuerke
8354 Mercier
Kansas City, MO 64114
816.363.5859
Available nights and weekends

New Jersey

Jim Kupcho
732.634.8674 • LP63044@home.com
No fees; donations accepted for
handout expenses

New York

Chantal Detlefs, Rye Nature Center
914.967.5150 • nature@ci.rye.ny.us
Fee: \$60 (1hour presentation)

North Carolina

Nina Elshiekh, Ph.D.
919.967.3027 • naeban@hotmail.com
Fee: \$40 (1 hour presentation)

Ohio

Sarah Dalton
Blendon Woods Metro Park
1069 West Main St.
Westerville, Ohio 43081
msdalton@earthlink.net

Doris Stifel
3331 Hughes Dr.
Toledo, Ohio 43606
dstifel@pop3.utoledo.edu
Ohio and S. Michigan
Adult programs: \$50-100+

Oklahoma

Bob Melton
405.495.5200 x 284
bmelton@putnamcityschools.org
Fees are negotiable.

Pennsylvania

Judith Levicoff
215.576.1359
thebutterflylady@juno.com
Fees: \$150-250 plus materials

Ba Rea
412.487.2214
barea@schiffprinting.com
Pittsburgh area; Fees depend on
length of presentation.

Jane Ruffin
1013 Great Springs Road
Rosemont, PA 19010

Kathleen Shafer
570.966.6193 • fourks@ptd.net
all age groups

Richard Stringer
610.371.5260 or 610.670.1163
stringerrichard@msn.com

West Virginia

Kris Gesner
304.645.7069
oma00034@mail.wvnet.edu
donations for expenses appreciated

Wisconsin

Randy Korb, Biophilia
PO Box 5025
Appleton, WI 54912-5025
920.734.6595
rkorb@aol.com
www.MonarchMagic.com
Fees: \$350/day plus travel

THE MONARCH PROGRAM

If you have been following the saga of the recoveries in Mexico over the last several years, you will recall that Dr. David Marriott has played a key role in increasing the number of recoveries at



David Marriott

the overwintering sites in Mexico. David is the founder and director of the Monarch Program in San Diego. The program was established in 1990 to preserve Monarch breeding and overwintering habitat, monitor Monarch migrations, and to promote public education through outreach activities. The Monarch Program education center and butterfly vivarium, and the monthly newsletter help to promote public education. David sustains the program with the assistance



Christian Manion

of a dedicated group of volunteers who give their time to help maintain and improve the facility as well as assist in all of the education programs. The Monarch Program staff consists of David Marriott, Executive Director; Christian Manion, President; Leana Bulay, Treasurer/Secretary; and Christina White and Christian Manion, Assistant Directors.

In addition to operating the educational center and the vivarium, the Monarch Program sponsors an annual survey of the number of Monarchs at the California overwintering sites, organizes trips to the overwintering locations in Mexico, and underwrites a two-day fall meeting with outside speakers and trips to overwintering sites. This year David graciously invited me to be the speaker for the fall meeting. I arrived on a Thursday evening and on Friday David led about 20 Monarch Program members and myself on a tour along the coastal highway in Baja California. We visited several eucalyptus groves where we tagged a small number of Monarchs and had a fine lunch at an elegant



Leana Bulay

restaurant adjacent to the ocean. Saturday morning was filled with meetings but we stopped long enough to visit clustering sites at the nearby campus and a residential area in the afternoon. In the evening it was my turn to perform. After an incredible dinner at the education center, I gave a

The Monarch Program's Butterfly Vivarium is a 1200 sq. ft. x 14 ft. high structure that houses various species of butterflies in all stages of life.

Photo by O.R. Taylor.



Christina White

presentation entitled "Monarch Butterflies: Orientation and Navigation on the Fall Migration." It was great fun and there was a lively discussion. Since the audience consisted of a number of people who are knowledgeable about Monarchs, there were many excellent questions, interesting observations and valuable suggestions. I really enjoyed this trip. It was a wonderful chance to see the Monarch Program in action and it was an inspiration to see the effectiveness of the program's volunteer staff. I was also pleased to get to know a number of people with whom I've communicated many times but had never met and to become better acquainted with others interested in Monarchs. If you would like to become a member of the Monarch Program, dues are \$25, payable to Monarch Program, PO Box 178671, San Diego, CA, 92117. For additional contact information, visit our resource section online at www.MonarchWatch.org/resource.

--Chip Taylor

("ADOPT" CONTINUED FROM PAGE 26)

carded supplies at the end of the school year. My students sorted the donations, and our classroom smelled like crayons for a week as we packed school boxes and bags with supplies. Not all the supplies we collected were used. Children gave me crayons for my birthday, crayons to send on to the students in the Monarch reserves.

Some of my students began school in Mexico and most others have relatives there. Many of our migrant students spend summers in Minnesota or Michigan and are familiar with Monarchs. Although most of my students have been classified as economically disadvantaged, whatever they have, they want to share because they know that students in Mexico have very few extras in the classroom to supplement the curriculum.

We have visited in person or by email with Monarch enthusiasts in Mexico. I wanted my children to understand that people on both sides of the border care about the Monarchs. My students have told me:

"We're the same people except they live in a different place."

"He has hair the same as mine!"

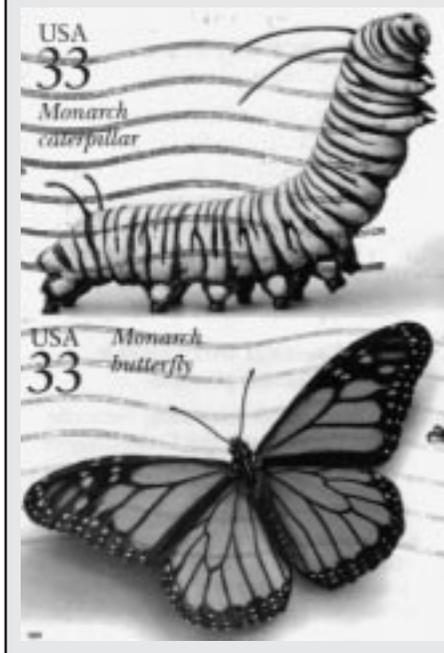
"I know how it feels not to have enough supplies because it has happened to me."

"We're all kids."

As we delivered supplies to the schools in the Monarch reserves, I spoke with teachers and principals. We share the same concerns for our students. I sat with children, laughed with them, listened to them read to me - the same things I do in my own classroom. I watched as one teacher insisted that Chip conduct the lesson (which he did - in Spanish), as Dana and Cathy spoke with children in the classrooms and on the playgrounds, and as children crowded around Jim to see their pictures on the digital camera. I brought back stories of our experiences with Mexican students to the students in my classroom. It was like coming full circle. We both gave and received. We connected. It is when we make these connections that we know Adopt-A-Classroom has been a success.

MONARCH POSTAGE

The United States Post Office kicked off National Stamp Collecting Month with the issuance of their Insects & Spiders series on October 1, 1999. Twenty designs graced the newest 33-cent stamp and not one but TWO of them were illustrations of Monarchs. Cool!



EPIC JOURNEYS IMAX FILM

"Enter a golden blizzard as tens of millions of Monarch butterflies fill the sky in the hidden highlands of Mexico." states the promotional flyer for "Epic Journeys: the Great Migrations" an IMAX film produced by Paul Novros and directed by George Casey of Graphic Films. This IMAX production is distributed by the Houston Museum of Natural Science. Thanks to an invitation from Dr. Nancy Greig, director of the Cockrell Butterfly Center at the Museum, I was able to attend the premiere of this production at the Museum last November. The film features the migrations of six species, but that of the Monarch, filmed mostly at El Rosario with the assistance of Dr. David Marriott, of the Monarch Program, is truly spectacular. Can you imagine the huge clusters of Monarchs at El Rosario featured on an IMAX screen or tens of thousands of Monarchs streaming across such a screen? The word "awesome" comes to mind. It was almost as good as being there.



Photo by O.R. Taylor.

This was a black tie affair - not exactly my day-to-day wardrobe. I tried to look cool and at ease while downing the fine food and drink offered by moving (migrating) hostesses dressed up as the various migrating animals featured in the film. One hostess that caught my eye was dressed up as a Monarch (see photo). My role at the event was to give lectures about Monarchs to museum members prior to the showing of the film. Perhaps the best part was the opportunity to take pictures and enjoy the butterflies in the Cockrell Butterfly Center. The center is one of the premier facilities at which the public can view living butterflies, and I highly recommend it for those of you visiting Houston. --Chip Taylor

PAPER MODEL BUTTERFLIES

Flight Tests with Paper Model Butterflies

By Dr. David Gibo

The following experiments are fun and demonstrate mechanisms that produce stability in flight and some of the characteristics of gliding flight. Stability and flight characteristics of Models I-A and II-A (pp 64-65) are roughly similar to those of Monarch butterflies.

Stability

A flying animal or aircraft has positive stability if it tends to remain in straight and level flight and will automatically return to this state following a disturbance. Positive stability is designed into most aircraft to reduce the workload on pilots. Flying animals also exhibit various degrees of positive stability, particularly when gliding.

Roll, Pitch, and Yaw:

Movement Around Three Axes

Butterflies in flight move around three axes that are perpendicular to each other and pass through the center of gravity. The three axes are the longitudinal axis, the lateral axis, and the vertical axis. The three can be easily demonstrated. Assuming that you're in a room, point at the wall in front of you with the index finger of your right hand. At the same time point to the ceiling with your thumb and point to the wall to your left with your middle finger (if you are using your left hand then point to the wall to your right with your middle finger). Your index finger is the longitudinal axis, your middle finger is the lateral axis, and your thumb is the vertical axis. Movement or rotation around the longitudinal axis is roll, movement around the lateral axis is pitch, and movement around the vertical axis is yaw. Gliding butterflies have features that result in positive dynamic stability in roll, pitch, and yaw.

Constructing the Paper Models and Jig

Make photocopies of the models and use these for the experiments. Start with the Monarch-like models (I-A and

II-A). Cut out the butterflies and fold as indicated - along line **a** (Fig. 1) for model I-A and along lines **a**, **b**, and **c** (Fig. 5) for model II-A. The transverse lines should be on the bottom of the wings. Make sure that each wing is flat. Then angle the wings upward about 10 degrees above the horizontal as shown (Fig. 4). This angle is called the dihedral. Attach a small (no more than 1 - 1.25 inches long) metal paperclip to the front of the "body" as shown in Fig. 3 for model I-A and Fig. 2 for model II-A.

The jig is used to determine the location of the center of gravity of the models. Fold a 3x5 inch index card (or any other similar piece of stiff paper) to make a jig as shown (Figs. 6-8). It is easier to balance the models if the two balance points are trimmed so that they are slightly rounded. The jig may have to be braced when balancing the larger, tailed models. Simply place an eraser, a few coins, or any other conveniently available object on the base. Use the transverse lines on the underside of the models as reference lines to assist in marking the balance points for the models.

Mechanisms of Positive Stability Built into the Models

Model II-A is more stable than I-A and should be used for your initial experiments. Model II-A achieves positive stability in the longitudinal axis (roll) because of dihedral and the pendulum effect (caused by the center of gravity being located below the wings). The model achieves positive stability in the vertical axis (yaw) from the gentle sweep back of the wings and the keel-like shape of the body. Because the model has no tail, it achieves positive stability in the lateral axis (pitch) only when the center of gravity is within a specific range.

First Set of Experiments - Stability Characteristics of Model Butterflies

****CAUTION:** Read Rules for flight tests (Appendix I, p. 63) before performing any flight tests**

Experiment I:

Flight Tests to Determine Range of Positions of the Center of Gravity that Produce Stable Flight

Place a paperclip in the full aft (tailward) position of Model II-A. Use a pencil to put a mark on the side of the body (Fig. 2) to indicate the position of the paperclip. Inspect the model to make sure that the wings are properly aligned and then carefully balance it in a level flight position on the jig. Put a pencil mark on the bottom of each wing at the balance point (Fig. 2). The balance point is the center of gravity of the model for the current position of the paperclip. Make sure that the wings are still properly aligned and then grip the model like any other folded-paper aircraft and gently loft it forward and slightly down. The model may fly the first time but it is most likely to pitch up sharply, start rotating around the lateral axis, and flutter to the floor.

The model stalls and auto rotates to the floor because it is tail heavy. The center of gravity is located behind the center of pressure. Move the paperclip no more than 1/8 inch forward and mark the new location. Re-balance the model on the jig to determine the new location for the center of gravity and mark the new balance position on the bottom of each wing. Check the wings for alignment and attempt to fly the model again. If the model crashes again, repeat the routine of moving the paperclip forward, marking the new position, etc. Continue until you find a location for the center of gravity that results in stable flights. At this point, be sure to put small checks next to the marks that indicate the position of the paperclip and the position of the center of gravity. Then continue the routine of advancing the paperclip forward in steps. You will probably find that flights become smoother when the paperclip is moved forward a few more intervals. As you continue to move the center of gravity ahead of the center of pressure, the model butterfly should fly noticeably faster until the

point that you exceed the forward limit for stable flight. At this point, the model is too nose-heavy and will dive toward the floor shortly after launch. Shift the paperclip back one step and perform more flight tests to confirm this hypothesis. Alternatively, you may find that you run out of 'body' to hold the paperclip in place before you exceed the forward limit for the center of gravity.

The series of checked pencil marks on the bottom surface of the wings of your model indicate the range of balance points associated with positive stability in the lateral axis. The front and back marks are the fore and aft limits for the center of gravity. Remember that the measurements are valid only for the specific paper model and the particular paperclip that you used. However, you will find for most models that the aft limit for the center of gravity is close to the position of maximum wingspan, or approximately 1/3 behind the leading edge of the forewing, and the forward limit falls roughly half way between the aft limit and the leading edge of the wing.

Because Monarch butterflies have most of their mass suspended below their wing bases, their stability characteristics are more like those of model II-A than I-A. The butterflies also have similar fore and aft range of locations for their center of gravity. Monarchs that have only small amounts of stored lipids in their abdomen will be nose heavy while those with large amounts of stored lipids will be tail heavy. Nose heavy Monarchs move their center of gravity aft by taking on water ballast. The ballast is stored in a bag-like structure (crop) in their abdomens. Tail heavy Monarchs contain relatively less water. They apparently compensate by sliding their front wings back over their hind wings to shift their center of pressure behind their center of gravity.

You can find an expanded version of this text including more experiments on the Monarch Watch Web site (www.MonarchWatch.org). The additional experiments on the Web site are: II. Flight Tests to Measure the Stabilizing Effect of Dihedral and the Pendulum Effect, III. Flight Tests to

Measure Glide Ratios, IV. Flight Tests to Measure Sink Rate, V. Flight Tests to Calculate Airspeed, and VI. Flight Tests to Show Effectiveness of Roll Versus Yaw in Turning.

Appendix I

Flight tests require that the models be thrown. The models carry a paperclip on the front, fly fast, and are a potential hazard to eyes. Paper cuts to the eyes are also a possible risk. We strongly recommend that you follow these rules to minimize your risk of injury.

Rules for Flight Tests

1. All flights are launched from behind a line (launch line) that is clearly indicated and directed across the line. Spectators are to remain behind the line. 2. Models are thrown gently to minimize airspeed. 3. Models are never thrown upward.

Appendix II Tips for Flight Tests

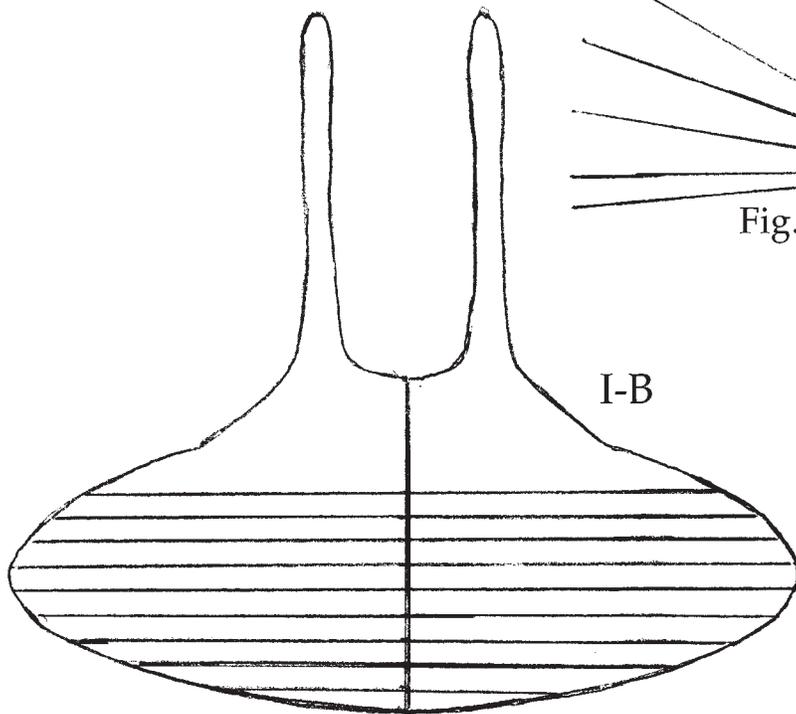
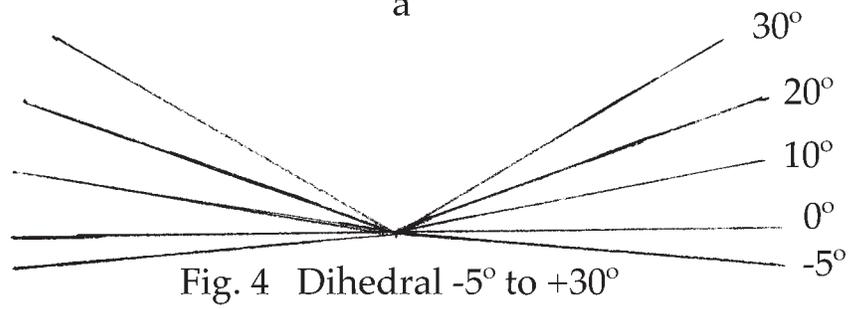
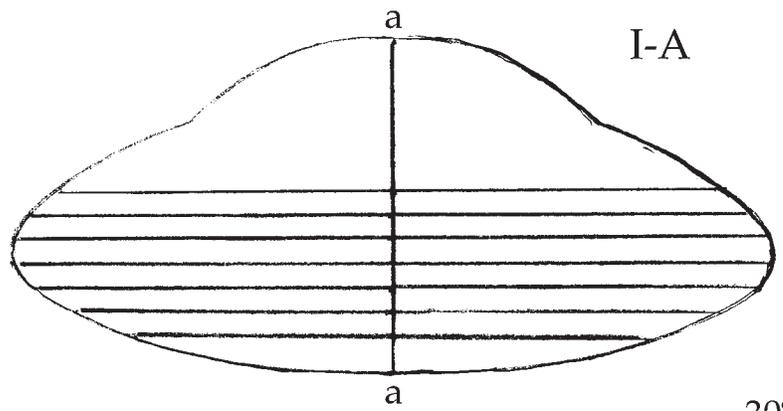
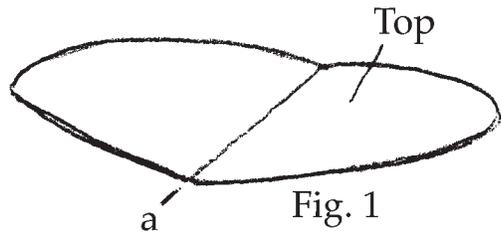
General Tips

1. Gentle launches are better than vigorous launches. 2. Before each flight check that the wings are flat, have the same angle of attack, the same dihedral (positive or negative) and that the paperclip is in the right position. 3. A small paperclip is best for most models. The fore and aft range for the center of gravity is larger for a small paperclip. Small movements in the position of the paperclip are not as likely to produce drastic changes in flight characteristics. The model flies slower and is easier to observe. 4. Photocopy paper and paperclips are not uniform. Different brands of photocopy paper have different weights, stiffness, and surface properties. Different brands of similar size paperclips have different weights. Flight characteristics of the models will vary depending upon specific materials used in their construction. Accordingly, all instructions and tips should be considered only guidelines. Experiment to see what works best with your materials.

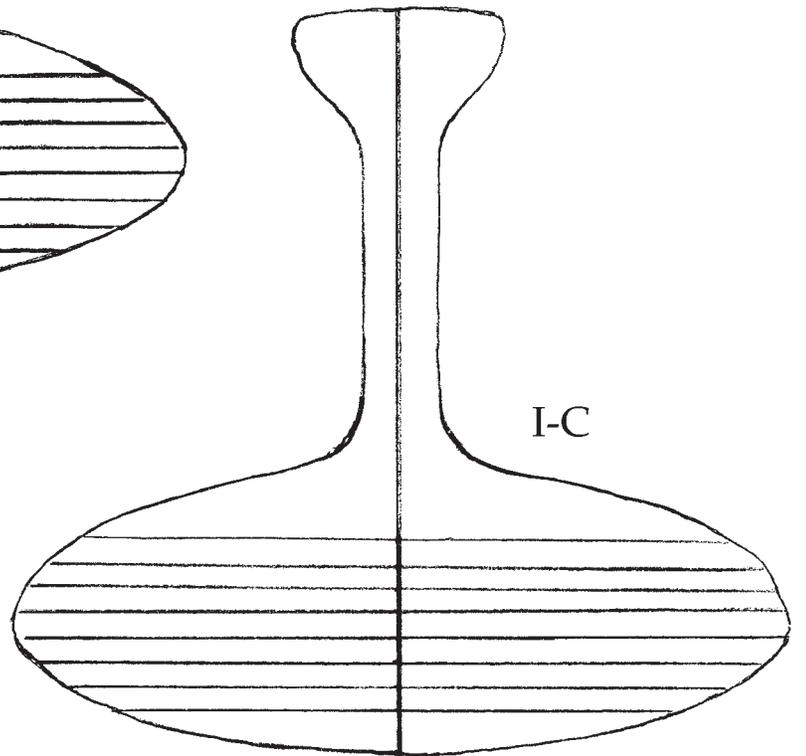
Specific Tips

When launched: 1. *model noses up and then settles to the ground.* Make sure each wing is flat. Center of gravity may be too far back. Try moving the

paperclip forward a step at a time. If this is not possible start over with a larger paperclip. 2. *model noses up, then dives out of control.* Same as above for tailless models. If flying single tailed model make sure that the horizontal tail is not set in a negative angle of attack (angled down). 3. *model climbs steeply, stalls, dives, and then levels out.* Same as for (2). In addition, model was launched upward and/or too fast. Center of gravity may be also near aft limit. First try a slower launch. Then try moving the paperclip forward a step at a time. 4. *model dives toward ground then levels out.* Launch is too slow. Center of gravity may also be near forward limit. Try a faster launch. Then try moving paperclip back a step. 5. *model dives to ground.* Center of gravity may be too far forward. If flying single tailed model, tail may be set in positive angle of attack (angled upward). Check tail. Then try moving paperclip back or start over with a smaller paperclip. 6. *model consistently turns to one side despite proper launch.* Model is not in trim. Check both wings to make sure that they are flat. Then check that they have the same angle of attack, the same dihedral, and are both the same size. If flying a two-tailed model then make sure that both tails are aligned with the body and of the same size. If flying a single tailed model then check the horizontal tail to make sure it isn't twisted, that the two sides are flat, properly aligned, and the same size. 7. *model consistently turns but direction of turn is unpredictable.* Model is unstable in roll or yaw or both in current configuration. Try increasing the dihedral. If this doesn't work, try decreasing the dihedral, or even try negative dihedral. My model II-B worked well with negative dihedral. Also try moving the paperclip forward a step at a time. If neither helps, then try adding a tail. Often the reasons for instability are obscure. Experiment. 8. *wings visibly bow upward during flight and the model has a high sink rate.* Model is too heavy for the wings (wing loading is too high). Start over with a smaller paperclip. Brace the wings by adding struts or increase their stiffness by adding spars to the bottom surface at about the 1/3 posterior to the leading edge of the forewing.



I-B



I-C

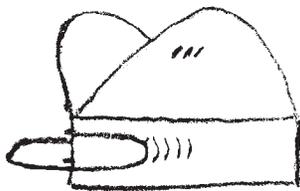


Fig. 2 Side View

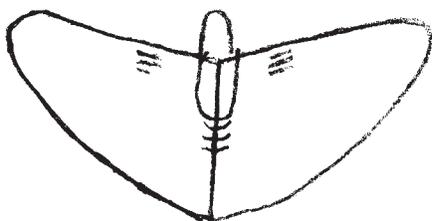


Fig. 3 Bottom View

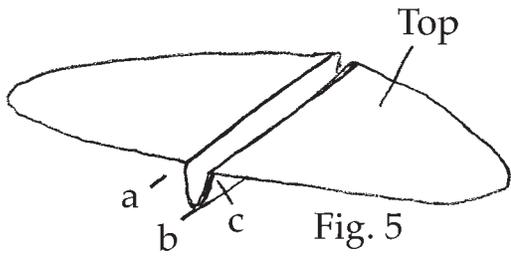
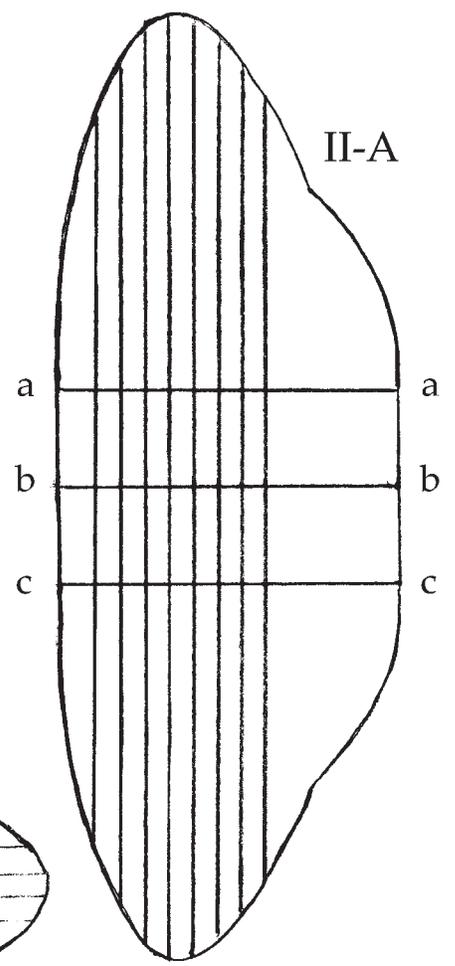
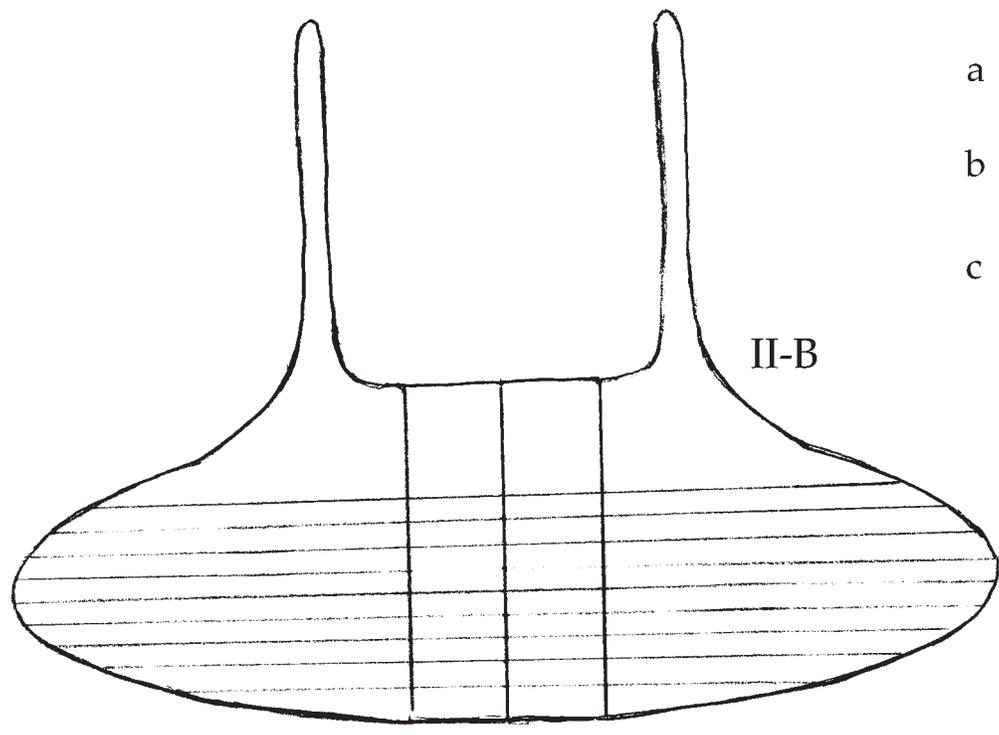


Fig. 5



II-A



II-B

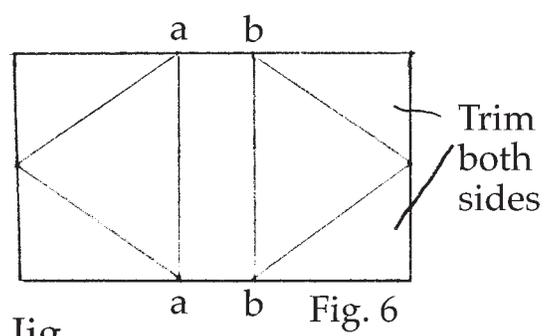


Fig. 6

Jig

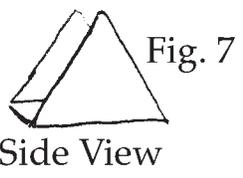


Fig. 7

Side View

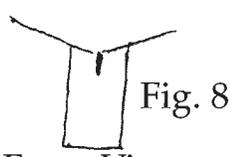
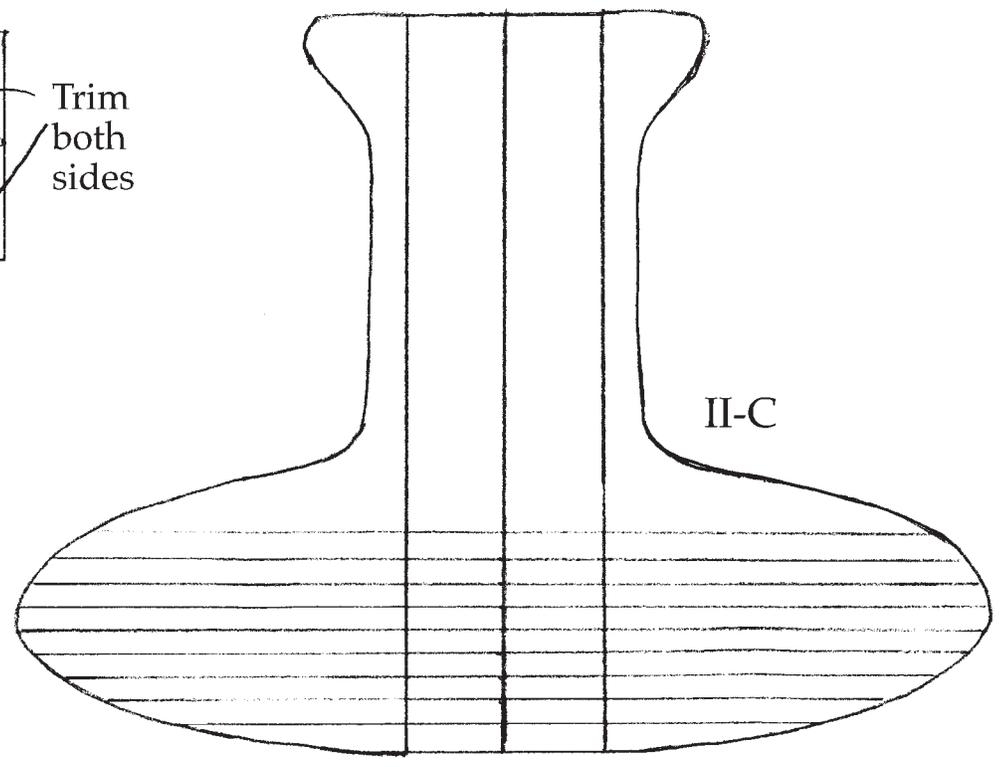


Fig. 8

Front View
(with glider)



II-C

MONARCH BIBLIOGRAPHY UPDATE

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"IF YOU PLANT IT, THEY WILL COME"

The Butterfly Gardeners' Quarterly offers valuable information related to the increasingly popular subject of butterfly gardening. Articles in the Summer 1999 issue include a review of the migration and life cycle of the Monarch ("The Amazing Life of the Monarch") and a discussion of milkweed toxicity and growing tips ("Milkweed: Native Nectar Plant; Food for Royalty"). This publication offers not only the basics of butterfly gardening, but also information on current events and resource lists. By sending just \$2.50 to the Butterfly Gardeners' Quarterly, anyone can obtain a copy of the Summer 1999 newsletter. Yearly subscriptions are \$10.

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REGIONAL COORDINATORS

Below is a list of Regional Coordinators for Monarch Watch. The role of Monarch Watch Regional Coordinators has changed in the last year. Regional Coordinators will no longer sell or distribute tags or tagging kits. It has proven to be more efficient for us to collect and store the tagging data in a central location. However, we would like the coordinators to continue to be local contacts for our members who have questions or need information about tagging Monarchs. All of the coordinators have experience tagging Monarchs and are, in effect, local Monarch experts. We encourage you to use this resource and contact them with questions about tagging in your area. Thank you to all of the Regional Coordinators for your help in the past with the Monarch Watch tagging program.

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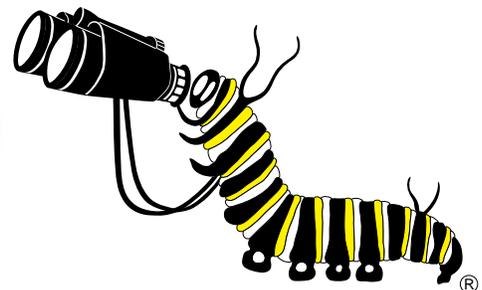
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