

ANNUAL

INSECT  
MIGRATION  
STUDIES

1965 VOLUME 100

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NOTE: THIS IS A REPORT TO MEMBERS OF THE IMA. INFORMATION CONTAINED IN THIS REPORT MUST NOT BE USED FOR SCIENTIFIC PUBLICATIONS.

TO OUR ASSOCIATES

FROM

NORAH AND FRED URQUHART

Now that spring is underway we, members of the IMA, look forward to a summer, not only to carry on our studies of the biology of the Monarch butterfly, a truly remarkable little insect, but also to enjoy the out-of-doors. As we pursue our investigations we become aware of the wonders of and the delight in living with the natural world. As we wander leisurely across green fields, examining milkweed plants for Monarch eggs and watching the females depositing eggs on the underside of leaves, pausing every now and then at some nearby flower to obtain a fresh supply of sweet nectar, we are not thinking of war, pollution, inflation and unemployment. Our minds are on more joyful subjects: the different kinds of plants; different species of birds; multitudes of insects crawling over the ground at our feet or feeding upon the foliage of various kinds of plants; at times we pause to watch a predacious bug looking for a likely prey. Are we not most fortunate to be involved in such a happy occupation?

The study of the habits of any species of animal is a long term project. Man has been studying his own species for countless generations and still has numerous unsolved problems with which to deal. We never reach the end. Each new discovery adds a new dimension and new problems to be examined. For over forty years we have been studying this amazing little butterfly and yet, at times, we feel we know so little about it. How does the Monarch butterfly find its way over hundreds of miles to the overwintering site in Mexico? Why does it choose mountains where the climate is so intemperate? What started this bird-like migration - which question has never been answered for birds by the ornithologists? Did it start during the last Ice Age? Or did it have its beginning millions of years ago, long before the advent of the Rocky Mountains, when a great inland sea divided the continent, when species of milkweed were confined to the eastern sections as proposed by the great authority on milkweed, Dr. Robert E. Woodson. It has recently been shown that the body of the Monarch butterfly contains magnetite, as do migrating birds. If so, is the magnetite located in the antennae? Do the Monarch butterflies thus follow magnetic lines of force to the overwintering site? Because of the activity of the members of the IMA over the past many years, I believe we will have a very plausible answer to the latter question. Then we ask further, why do some Monarch

butterflies migrate and others do not? Do the females return to the exact location where they lived as larvae? Or do they return to different areas? Why do Monarch butterflies that have developed reproductive organs migrate in the fall along with those that are in reproductive dormancy? To all these questions on behaviour we then add much more concerning the amazing changes in cellular structure that takes place when the Monarch changes from a worm-like creature to a most beautiful butterfly. What great mysteries lie in the body of this small creature. Indeed the questions are endless and, in the years that lie ahead, some spectacular results will be obtained. And the important part to we members of the IMA is that we are part of it.

In this volume we have suggested a few observations you may make and a few experiments that you might wish to carry out. Once again we would ask you to make careful observations on the possible relation between birds and the Monarch butterfly. The question being: do birds attempt to eat the Monarch butterfly in nature? Is the Batesian Mimicry hypothesis worthy of the term "hypothesis" or is it an anthropomorphic interpretation of what we think takes place in nature but in truth does not?

We enjoy so very much receiving your letters. There are times under the pressure of various activities that we are unable to answer your letters as promptly as we would like but we do eventually get around to it. As we have stated in previous volumes of our report to you, this research is unique in that it is a "family affair" and we like to treat members as such.

We are pleased to include a copy of one of our scientific papers that was published in the Reports of the National Geographic Society given to us for distribution to members and colleagues. You might consult the list of other papers that are still available to you which are listed in this volume. It is necessary for us to ask for a small payment for such papers, owing to the cost of printing on the part of scientific journals, that are having a difficult time under the present period of inflation.

In closing, a note from one of our long time associates, Mrs. Lorraine Houck who sent us the following, taken from her church magazine:

"Commented E. Paul Jacobson, Iowa farmer, on weeding his soybean and corn fields: 'I like to keep the milkweed. That's where the monarch butterflies lay their eggs. Not that you need 'em to grow corn or soybeans, but who wants a world without monarch butterflies?'".

REPRINTS OF PUBLISHED PAPERS AVAILABLE  
TO ASSOCIATES AT COST (\$2.00 each)

- \_\_\_\_\_ 1. Mechanism of cremaster withdrawal and attachment.
- \_\_\_\_\_ 2. A continuous breeding population of monarch butterflies.
- \_\_\_\_\_ 3. Vernal migration from the overwintering site in Mexico.
- \_\_\_\_\_ 4. Reprint from News of the Lepidopterists Society - an autobiographical account of monarch migration studies.
- \_\_\_\_\_ 5. Aberrant Migration.
- \_\_\_\_\_ 6. Breeding areas and overnight roosting sites in Ontario.
- \_\_\_\_\_ 7. Overwintering site of the eastern population.

Name: \_\_\_\_\_

Address: \_\_\_\_\_

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\_\_\_\_\_

Date requested: \_\_\_\_\_

No. of papers requested: \_\_\_\_\_

Amount of money enclosed: \_\_\_\_\_

Note: The above are available only as long as the present supply lasts. Cost for each paper: \$2.00.

PUBLICATION OF RESEARCH DATA BY ASSOCIATES

Please note that associates who help to collect data for research on the migration of the monarch butterfly are not permitted to use such data for publication in scientific journals since the data belong exclusively to the Insect Migration Association, Scarborough College, University of Toronto, Toronto, Canada.

### MONARCH CONSERVATION

Before discussing this topic, we would like to introduce you to a relatively new term, namely "LOCUS" plural "LOCI". The Monarch butterflies overwinter in two areas in North America, namely California and Mexico. These two areas are accurately referred to as SITES. Thus there is the overwintering Site in California and the overwintering Site in Mexico. In each of these Sites, extending over many miles, there are different, somewhat isolated, groups which are referred to as LOCI or locations. In California there are at least nine Loci; in Mexico we know of at least 11 Loci. Some of these Loci may number several thousands of specimens while others may have only a few hundred.

When we first disclosed one of these Loci in an article in the National Geographic Magazine, we did not know that there was more than the one group and hence was referred to as a "Site". A biologist arriving at this same Locus later and wishing to claim it as a personal discovery on his part termed it the "alpha site", alpha referring to first. Thus confusing the terminology.

Now about the Subject of Monarch Conservation:

We have received letters from our associates expressing grave concern for the survival of the Monarch butterflies in the overwintering Site in Mexico, with particular reference to one of the Loci, as a result of a television program which depicted a biologist lamenting the fact that trees were being removed thus destroying the monarch population; at the same time, for colour effect, was added a "butterfly dancer". May we emphasize to you that the logging operation is not the danger to the Monarch survival - we know of Loci where trees had been completely removed and as a result the overwintering monarchs moved to another group of trees in the same area. Lumbering operations are not carried out on trees when there are overwintering monarchs because the Mexicans are only too well aware of the importance of this phenomenon as a unique Mexican attraction. The only great danger is FIRE. This occurred on one occasion while we were visiting one of the Loci when a group of biologists started a large fire in order to cause the monarchs to fall to the ground from an overhanging branch that was laden with Monarch butterflies, the purpose being to obtain photographs for a popular publication which later appeared in an issue of Natural History, published by the American Museum in New York city.

We are in close contact with Mexican authorities with respect to the conservation of the Monarch butterflies in one Locus of the Mexican Site where there is a large concentration. Although up to the present time adequate protection has not been secured, I have been recently assured that such protection will be given in the immediate future.

It is reassuring that even if one of the Loci should be destroyed, mostly as a result of fire from a careless camp fire or a smouldering cigarette, there are many other Loci of which one is very large.

Now the question arises: IS THE MONARCH BUTTERFLY, LIKE SO MANY OF ITS RELATIVES, AN ENDANGERED SPECIES?

To this question we must answer in the affirmative. Yes, the Monarch butterfly is, along with many species of animals, an endangered species. Our lakes are dying because of acid rain killing not only fish but a host of aquatic life. Our roadways are polluted with herbicides killing countless thousands of acres of milkweed plants. Tons of insecticides are sprayed on crops killing not only the agricultural pests but also other insects that are either harmless or beneficial. It has been many years since we have seen numbers of white and sulfur butterflies flying over our meadows and farmlands. How long is it since you have seen numbers of swallowtails visiting your garden of carrots and parsley?

We wonder about the effect of insecticides on the honey bee populations. We have no data on this and we would be most grateful to you if you have any information that we might put in our next volume as to whether or not the bee keepers are having a problem in this regard. We can not believe that insecticides are only killing agricultural pests.

One of our Associates, Alice Hopf, stating that the Monarch butterflies "like to follow roads" added the comment, "I wonder how they stand the traffic and fumes?" As to the fumes, one can only conclude that these apparently frail little butterflies are much stronger than we tend to attribute to them. We have watched hundreds of Monarchs flying through sulphureous fumes billowing from manufacturing plants; we have photographed Monarchs flying through such dense smog that motor cars had to put on their car lights. We believe Monarchs will survive fumes and industrial waste much better than we humans, at least we do not believe that Monarch butterflies are prone to cancer, clogged arteries and heart attacks. However, as far as traffic is concerned the great destroyer is the motor car. We have counts of over a hundred dead Monarch butterflies collected along .4 km of one of our highways. If you take this figure across the United States and Canada from breeding grounds to the overwintering Site in Mexico, one can only imagine the resulting tremendous reduction in the migrating population.

Yes, the Monarch butterfly is in danger of extermination in some of the Loci of the overwintering Site in Mexico. But the great source of danger to its extermination is not in Mexico but right here in the United States and Canada where the Monarchs breed. It is here where real protection is necessary. The Mexicans may take precautionary measures to protect them in their country but if we do not protect them in our country there will not be any for the Mexicans to protect in the overwintering Site.

How can we prevent such destruction? This is a most difficult question. As new roadways are built and new housing developments, and the indiscriminate use of herbicides and pesticides there will be a great loss in the Monarch population. But one can not stop the development of roads and housing as our human population continues to grow. We can try to stop the use of

herbicides along roadways and in fields not devoted to agriculture. Indeed, the use of herbicides along roadways is, in many cases, a useless waste of such material because when the grasses and sedges are thus destroyed they dry up in the summer sun thus causing a greater danger of fire than if the green vegetation had been left. In addition such thousands of gallons of herbicides eventually end up in our lakes through streams, creeks and underground water drainage, killing aquatic plants and the animals that feed upon them producing a sterile lake.

We realize that the agriculturist must use many kinds of insecticides in order to obtain a marketable crop; one can only hope that the indiscriminate use of such chemicals can be limited.

Many species of butterflies have become extinct. We can only hope that the Monarch butterfly may never be one of them; it has become a National heritage a memory of green fields and flowering plants engendered in our youth. We were so elated one day, while we were collecting and tagging Monarchs along the north shore of Florida, to have a group of teenagers stop their car and shout at us: "Leave the butterflies alone".

So with your assistance over the past many years we have done much to protect this magnificent little creature.

#### TAGGING REARED VS. WILD SPECIMENS

It would appear that in some manner, as yet not clearly understood, the larvae of the Monarch are influenced by lowering temperatures and decreasing amount of daylight causing a cessation of the development of the reproductive organs. The adult butterflies from such affected larvae become the "true migrants", which are those individuals that have undeveloped reproductive organs and exhibit "reproductive dormancy" which is broken after they have journeyed to the overwintering site and spent weeks under moist, cool conditions in the mountains of Mexico.

However, there are members of the fall migrants that do not have reproductive dormancy but nevertheless migrate southward the females depositing their eggs and mating with males that likewise have developed reproductive organs along their migratory route. This accounts for the appearance in the fall of mated pairs of Monarchs and the presence of larvae on the milkweed plants, which have been absent during the summer months, in southern States such as Georgia, Mississippi, Texas, etc. Such larvae and sexually mature adults may occur in these southern States as late as December. One of our Associates, Dorothy Yeager of Pearsall, Texas, reported finding larvae and eggs on milkweed plants in December even though a frost had destroyed many of the



milkweed plants; Dorothy reared some of the larv on milkweed plants growing near her home that had escaped t<sup>h</sup> sharp, killing frost.

If you rear Monarchs out of doors so that the larvae are subjected to natural lowering of temperatures and lessening light periods, the resulting adults will be true migrants. If however your rearing is carried out indoors where there are continuous high temperatures and exposure to artificial light during the day and part of the night, whether continuously or at odd moments, then sexually mature individuals will result. These sexually mature individuals may move southward, at least for part of the migratory journey, but will die after laying the full complement of eggs and hence will never reach the overwintering site. Occasionally, a female may reach the overwintering site with eggs still located in the oviducts. We have never found this among the overwintering Loci in Mexico but approximately one percent have been obtained in the California Site. This is correlated with the distances travelled, a shorter distance from the breeding grounds to the overwintering site in California as compared to the very long distances travelled by the Eastern Population to Mexico, the latter allowing for the deposit of the full complement of eggs.

If you wish to experience the recapture of tagged Monarchs over a long distance, and even to the overwintering site in Mexico, you should do all rearing out of doors.

If you wish to keep live Monarch butterflies during the winter months the following will be of interest to you:

It is important to use only those with reproductive dormancy, namely those collected in the field in late August, September, October or November. To be certain of having such physiological specimens, obtain them from an overnight roosting tree because, from our records of the examination of hundreds of such specimens, all were in reproductive dormancy.

You may allow these butterflies to fly freely in a room, as has been done successfully by one of our associates, the butterflies being caught once per day and fed a solution of honey and water. It is most important to have water and food available, particularly water. In the overwintering site in Mexico, only water is available, the Monarchs using the fat stored up within their bodies laid down during the larval stage.

In our laboratory at the University we kept specimens during the winter months in the following manner: Specimens were placed in plastic envelopes, one to an envelope, containing a small piece of cotton wool moistened with water so as to give a humid atmosphere. These envelopes were placed in a cardboard box and held in a "cool room" at a temperature of 7°C. Once a day the specimens were removed from the

envelopes and the body temperatures raised to that of the room thus causing them to become active at which time they could be fed a solution of honey water.

If you are keeping the Monarchs in a flight cage be sure to keep the material composing the cage moist at all times and suspend a rag soaked in honey solution in the cage.

Since Monarchs will not fly at night, a simple method of keeping them overwinter is to place the cage in a dark room. Thus the Monarchs will remain inactive until taken into the lighted room at which time they can be fed. Again, keep the material of the cage moist at all times.

The above are of particular interest to teachers since they can have live specimens at times when the students are at school. It also adds to the interest in the study of insects to have live specimens available.

If you wish to attempt breeding Monarchs during the winter months, collect the specimens in June or July when breeding is carried out in the fields. Place such specimens in the flight cages with milkweed so as to obtain eggs. Keep the resulting larvae indoors in a room that will be lighted most of the time. When such larvae reach maturity they will give rise to butterflies with developed reproductive organs. You can then obtain another supply of eggs; and so on. To do this you must have potted milkweed plants upon which the females will lay their eggs and a goodly supply of frozen milkweed leaves - the latter gathered in early summer from small plants and placed immediately in a deep freeze refrigerator, the leaves placed in bundles, like a deck of cards, and contained in plastic envelopes of the type used for freezing vegetables and the like.

If you do attempt any of the above we would appreciate hearing from you as to your success or failure which we will report in our next copy of Insect Migration Studies.

#### RELEASING OF TAGGED MONARCHS IN POPULATED AREAS

We would like to urge you strongly to release your tagged specimens away from populated areas as the release of tagged specimens in areas of dense population means that the chance of recapture in the same area are greatly increased. This defeats the purpose of tagging in two ways. It results in many tagged specimens being recaptured before they have had a chance to make a significant flight and the recapture may result in the destruction of those monarchs which have been properly tagged and are the most active flyers.

RECAPTURE RECORDS FOR 1981

Every year we examine with great interest and anticipation the data that we have received in connection with the recapture of tagged monarch butterflies. The data this year are very satisfying and we are happy to report below the record of recaptured butterflies that we thought would be of most interest to you. Of the 6951 butterflies which were tagged this year, 32 were either reported or returned to us. Space does not permit us to publish all of those recaptured. All of those associates whose tagged butterflies were reported to us have already been notified.

Note: Dates are listed as day/month/year.

ASSOCIATE	TAGGED AT	TAGGED ON	RECAPTURED AT	RECAPTURED ON
C. Allgrove*	Madison, Connecticut	13/9/81	Brigantine, New Jersey	19/9/81
E. Kendrick	Sault Ste. Marie, Ontario	3/8/81	Leland, Michigan	12/8/81
R. Lachelt	Arlington, Minnesota	7/9/80	Overwintering site, Mexico	-/2/81
J. Moss**	Roanoke, Louisiana	11/3/81	Breaux Bridge, Louisiana	23/3/81
F. Sutherland	Boise, Idaho	17/8/81	Mountain Home, Idaho	7/9/81
E. Sutton***	Richland Center, Wisconsin	9/9/81	Corpus Christi, Texas	5/11/81

\*This tagged butterfly generated a great deal of interest. We received 3 separate communications concerning this butterfly which was observed at Brigantine Wildlife Sanctuary, N.J. This incident demonstrates the distinct advantage of reporting the tag number and releasing the tagged specimen so that it can continue the migration.

\*\*This butterfly flew 83.2 km due east of the point of tagging. This record is especially valuable because the recapture of a tagged monarch during the spring migration is very rare.

\*\*\*This is a unique record. The first tagged monarch ever recorded by us that left the midwestern U.S. to be recaptured on the Gulf Coast of Texas at a point very close to the Mexican-U.S. border.

RETURN OF SPRING MIGRANTS

Every spring there is a feeling of suspense and eager anticipation as we await the return of the spring migrants.

The sight of the first monarch butterfly of the season is a source of excitement and real pleasure. Many of our associates have made note of the date of their welcome arrival.

In order to give you some idea of the advance of the northward migration, we have listed the dates of the spring arrivals in various parts of the country. It is interesting to note that the monarchs arrive earlier in the midwestern U.S. than they do in the eastern part of the continent due to the shorter distance involved in the return flight from the overwintering site in Mexico.

Joseph Moss	Roanoke, Louisiana	March 12, 1981
Larry Totton	Granger, Indiana	April 26, 1981
Peggy Garner	Le Claire, Iowa	April 27, 1981
Mabel Huber	Fernley, Nevada	April 27, 1981
Jim Gilbert	Waconia, Minnesota	May 14, 1981
Mary Lu Sinclair	Falls Village, Connecticut	May 19, 1981
Sister Laura Banet	New Ulm, Minnesota	May 22, 1981
Virgil Inman	South Bend, Indiana	May 23, 1981
Margaret Elliott	Muskegon, Michigan	May 24, 1981
Roberta McLaughlin	Bloomfield, Connecticut	May 27, 1981
Kirk Larsen	Ann Arbor, Michigan	May 28, 1981
Wendy Hatch	Port Carling, Ontario	June 1, 1981
Debbie Knutson	Iron Mountain, Michigan	June 1, 1981
Edna Sutton	Richland Center, Wisconsin	June 2, 1981
Danny Johnson	Bemidji, Minnesota	June 3, 1981
Ann Irwin, Joan Holden	Bloomfield Hills, Michigan	June 12, 1981
Gina Jordan	Battle Creek, Michigan	June 12, 1981
Frances Buchanan	New Paltz, New York	June 13, 1981
Marjorie Mathes	Blissfield, Michigan	June 13, 1976
Ruth Kough	Dysart, Pennsylvania	June 15, 1981

### TAGGING NEWLY EMERGED MONARCHS

In a previous report we suggested that one wait for at least four to six days after the Monarch has hatched from the pupa before attaching an alar tag. In the case of Monarchs hatched indoors with a high humidity, such as in cellars or in moist buildings, you may have to wait as long as six days before you can safely apply the tag without fear of its falling from the wing later on. The following is the reason for such precautions:

When the Monarch hatches from the pupa the wings are small and the membranes folded like the segments of an accordion. The wings become enlarged by body fluid being pumped into the space between the upper and lower membranes of the wing, the two thin layers being held together by chitinous ridges thus preventing the wings from blowing up like a balloon. When the wings have reached their full size they hang limply because the membranes are still moist and there is still a goodly supply of body fluid still between the two layers of membrane. Gradually the excess body fluid is pumped back into the body cavity of the Monarch butterfly as well as a great deal leaving by evaporation. This process takes time depending upon the rate of evaporation - exposed to the sun with warm incident radiation the wings dry much more rapidly than when kept indoors without incident radiation. Thus, two daylight periods in sunshine will suffice but as long as six days under adverse conditions. If you attempt to remove the scales from the wing in preparation for applying the tag by rubbing the wing between your thumb and forefinger while the wing is still slightly moist a blister will form which may be quite large or small and inconspicuous. Now, if you apply the tag it will not remain on the wing any more than if you applied such a tag to a wet surface. One method of assuring the complete dryness of the wing is to bend the wing slightly and see if it snaps back like that of a dry leaf - be careful not to bend it too far or it will fracture.

We realize that the butterfly may damage its wings if confined in a small container with solid walls. We advocate keeping the butterflies in a fairly large cage the frame of which is covered with cheesecloth or a similar soft fabric so that the wings will not be damaged. Some of our associates allow the butterflies to fly freely in a warm room of low humidity such as one with a southerly exposure and one where sunlight can penetrate through a window. Remember to have a cloth soaked in honey as food during this short waiting period.

Of course, most Monarchs collected in nature will have completely dry wings; the occasional specimen you may capture, however, may have recently emerged and hence have moist wings, so one has to be careful when applying an alar tag to be certain the wing is dry.

The tag will remain attached only to a completely dry wing.

### MILKWEED

We have received enquiries concerning the growing of milkweed. The following may be of some assistance to you:

The Family of Milkweeds, the Asclepiadaceae, is fairly large consisting of over 2000 world species in over 200 Genera. In North America the common genus is Asclepias of which there are approximately 100 species.

As in other families of plants, the various species grow in a wide diversity of ecological conditions, from hot desert sands to cool deciduous or coniferous forest humus. In the Monarch Butterfly book a list of species to be found in each State of the United States is given east of the Mississippi drainage which encompasses the largest areas of breeding grounds.

If you wish to grow milkweed plants in your home garden or in neighbouring fields from seed, or from roots, you should first ascertain the kind of soil and climatic conditions most suitable. Thus species that grow in forested areas will not survive on sand dunes, and vice versa. Some species cover a wide range of ecological conditions, such as Asclepias syriaca, and may be grown in most home gardens. This also applies to the ubiquitous A. curassavica.

In the past we have supplied many of our associates with seeds of A. syriaca and they have been grown with considerable success in most home gardens. If you want seeds of A. syriaca, please let us know.

Place the seeds in a flower pot, scattering the seeds over the surface of the soil thinly and covering with about 6 cm. of soil, preferably sandy soil or potting soil. Keep the soil slightly moist - too wet will cause the seeds to rot. Place a sheet of glass, or plastic, over the pot so as to retain the correct moisture content.

When the small plants have two sets of leaves, transfer them to larger pots. When the plants are about 10 cm. in height they can then be transferred to your garden. Place the plants in a sunny situation.

If you find a few plants growing wild, dig up the "roots"; you will notice vegetative centers along the length of the root which gives rise to the future plants. Thus, the root system of A. syriaca resembles that of a potato. This is the quickest and surest way to obtain good, rapidly growing plants.

THE MORE MILKWEED PLANTS AVAILABLE THE MORE MONARCH BUTTERFLIES WILL OVERWINTER IN MEXICO.

### FROM EGG TO ADULT

In response to a letter received from Garry Williams, the following brief description of the development of the Monarch butterfly may be of interest to others of our associates who might not be familiar with insects that possess a complete metamorphosis.

All species of Lepidoptera (butterflies and moths) pass through four stages in their development - egg to larvae (caterpillar) to pupa (chrysalid) to adults. Many species of butterflies deposit their eggs singly upon the leaves of the larval food plant, the milkweed in the case of the Monarch. The female exercises a considerable degree of selection when depositing her eggs, usually upon small seedling milkweed plants which have small, tender leaves; however, when such small seedling leaves are not available, the female will deposit eggs upon the older and tougher leaves or upon the small leaves surrounding the flowers of the flower heads. However, if you are searching for eggs you should concentrate on the small plants looking at the undersides of the leaves. If you observe a female flying close to the ground across a grassy field in which there are a number of small milkweed plants pausing every now and then to alight upon them, you will be able to collect a great many eggs. If you wish to obtain a number of eggs for rearing purposes you should capture such an ovipositing female and place her in a large flight cage with a goodly supply of fresh milkweed plants. Don't forget to hang a rag soaked in a weak honey solution in the cage - adult Monarch butterflies die within a short time if deprived of moisture and food.

We have found it advisable to remove the eggs from the leaf by cutting out a small section of the latter containing the egg by means of a pair of fine scissors. These eggs should then be placed on a flat container, such as a saucer, well separated from each other because when the larva emerges from its egg it usually devours the empty egg shell and if an unhatched egg is close by it will also devour it. When the minute larvae hatch from the eggs they may be transferred to your rearing jars or cages; use a finely pointed artist's paint brush to pick up the larvae the tip of the brush slightly moistened; in this manner the small, delicate larvae will not be injured.

The larva passes through five stages in its development each stage marked by the shedding of the skin to allow for further growth. This process of shedding the skin is referred to as an "ecdysis" and the cast-off skin is termed an "exuvium" (pl. exuvia).

The final stage in development is the pupa. The rearing cage should be large enough to allow for the larva to move about in its selecting of a suitable place to enter the pupa stage. We use a large screen cage open at the top and bottom so that we can easily remove old milkweed plants and the larval droppings that have accumulated on a piece of paper placed under the cage,

and at the same time by placing a stiff piece of cardboard on the top of the cage the cardboard containing the suspended pupae can be removed and suspended in a suitable place to observe the emergence of the adult. You can place the cardboard on four pedestals, such as fruit jars.

Depending on temperature - the higher the temperature the more rapid the development - the eggs hatch in three to four days; larvae reach maturity in two to three weeks; pupae reach full development in approximately two weeks.

There is much, much more to the development of the Monarch butterfly and we would refer you to the book, THE MONARCH BUTTERFLY published by the University of Toronto Press (1960) which may be available to you at your local library of a University library.

#### DISEASE, PARASITES AND PREDATORS

We have, from time to time, discussed the various parasites, diseases and predators of the Monarch butterfly. However, because of recent enquiries we present the following:

DISEASE: Like all living organisms, the Monarch butterfly suffers from a multitude of disease organisms. There are over fifty strains of bacteria that have been isolated from the larvae. We were able to show that an epidemic that drastically reduces the population in certain years, is due to a nuclear polyhedrosis virus. Usually, this epidemic starts in the mid-west and spreads eastward, according to our records over the past many years, for reasons still unknown. When at its peak Monarchs become rare and this has led to the conclusion that promiscuous spraying of insecticides was responsible. For the past number of years, however, there has not been such a continent wide epidemic. At one time we had considered that it occurred every seven or eleven years, but this has been found to have been a false conclusion.

PARASITES: There are four species of flies that parasitize the Monarch. These belong to the Family Tachinidae. In appearance they resemble large, hairy house flies. They deposit their eggs upon the surface of the body of the larva. The eggs are about 1 mm in length, oval in shape and white in colour. When the larva, or maggot, hatches from the egg it burrows through the Monarch larva integument thus entering the body cavity. Here it feeds upon various body tissues, with the exception of the nervous system. As a result of the latter discrimination the Monarch larva continues to feed and grow even though thus infested. When the fly maggot reaches full development it then feeds upon the nerve tissue of its host causing the infected larva to become lethargic, finally becoming stationary, at times spinning a mat of silk and fastening its legs to it. Thus anchored in one place, the fly maggot burrows through the larval integument to the outside. The maggot then secretes a string-like mucous that assists in lowering the maggot to the ground. It then



burrows below the surface of the soil. It enters the puparium stage - the puparium consisting of the pupa surrounded by the last larval skin of the maggot. The puparium is a dark reddish brown in colour and approximately one centimeter in length - the smallest species has a slightly smaller puparium, approximately 8 mm in length.

If the fly maggot does not reach full maturity during the Monarch larval stage, it will remain in the body of its host through to the pupa stage. Because of the length of time taken for the development of the pupa, the fly maggots do not occur in the adult butterfly body, the maggot having completed its life cycle before the final stages in the Monarch development.

There are two species of parasitic wasps that occasionally attack the Monarch larvae. One of these belongs to the Family, Ichneumonidae. This parasite is about 7 mm in length; the body is laterally flattened; reddish brown in colour; and a long, thread-like organ, the ovipositor, protrudes from the apex of its abdomen. By means of the ovipositor, the female Ichneumon burrows through the Monarch larva integument and deposits an egg in the larval body cavity. A number of eggs may thus be deposited in the Monarch larva.

The other species of parasitic wasp belongs to the Family Braconidae. This minute parasite, not more than three or four millimeters in length, deposit an egg within the Monarch larva. This single egg, by multiple division, produces a number of individuals all from the one egg and all of the same sex. When these small wasps reach maturity they burrow through the larval integument and, unlike the other parasites that leave the host body to enter the pupa stage, they spin small cocoons on the surface of the body of the Monarch larva. There may be as many as twenty or thirty of these small cocoons. In many species of braconids there are no males - all larvae are produced from unfertilized eggs and all adults are female. Other species of braconids complete the life cycle within the body of the Monarch larva, issuing as minute wasps, often of a metallic green in colour.

**PREDATORS:** Like most species of butterflies, the Monarch is fairly free of vertebrate predators, such as birds. However, the Black-billed Cuckoo feeds its young on the larva of the Monarch. If a larva falls to the ground it may be attacked by shrews or mice. Perhaps frogs and toads will eat larvae although we have no definitive proof of this: Perhaps you might try to run a little experiment to see if frogs and toads will eat them and if you do we would be most pleased if you would send us the results of your experiment.

The most active predators are species of "true bugs" belonging to the Order Hemiptera. The predaceous bugs, by inserting their sucking proboscis into the body of the larva, suck out the body fluid. Most of these species are rather flat, oval in shape, and light to dark brown in colour; immature stages, referred to as nymphs, may have brighter colours, such

as markings of red, orange and green. The praying mantis will devour Monarch larvae; spiders, especially the large garden spider with its large orb web, captures the occasional adult Monarch.

We have received reports from many of our associates stating that ants will attack the larvae of the Monarch. As a result of plants being infested with aphids, ants will swarm over such plants in order to obtain the sweet secretions given off by these insects. In our part of the country, and particularly in our milkweed patch, we have never observed ants attacking Monarch larvae. However, there are many species of ants and perhaps in some parts of the Continent some of them do so; the attack on insect life by army ants is well known and perhaps there are many others. We would appreciate any accurate observations on this subject that you may make.

#### MONARCH MATING HABITS

Before leaving the overwintering site and during the entire breeding season, the male Monarch mates with the female in a rather interesting fashion: The male, as in the case of species of birds, stakes out a certain area, usually where there is an abundance of wild flowers, as his particular domain. He assiduously patrols this area, flying leisurely over the field, chasing any stray butterflies, leaves blown in the wind, and even small birds, such as chipping sparrows - it is interesting to note that the Monarch butterfly chases birds rather than the reverse as believed by some biologists involved in the study of the hypothesis of Batesian Mimicry, a fanciful idea based on very little field observations.

When a female Monarch flies over the field which the male is patrolling he will immediately take after her. There then ensues a courtship flight in which the pair circle each other as they fly higher and higher. During this prenuptial flight the male extrudes his anal glands which exude a strong odor resembling that of flowering plants. The male and female eventually come to rest on the foliage of a nearby bush. The male then inserts his sexual organ, the penis, into the bursa of the female at the same time clinging to the tip of the female abdomen by means of his strong, chitinous claspers. Thus joined together they may fly from one bush to another with frequent rest periods. The sperm cells of the male are contained in a thin membranous envelope. The inner surface of the bursa of the female bears a number of sharp chitinous teeth. As the eggs pass down the oviduct the female, by contraction of the bursa, rips open the packet of sperm cells thus fertilizing the eggs.

At the overwintering site in late winter and early spring, at a time when the Monarchs are preparing to return to the breeding grounds, or along their northward migration, mating takes place. This is a remarkable orgy with many males

attempting to copulate with one female or with clusters of males attempting to copulate with each other. Thus females are prepared to deposit fertilized eggs along the migratory route where milkweed plants are available. Since only the very occasional overwintering male returns to the more northern breeding grounds, mating takes place only in the early stages of the migration of the overwintering individuals.

The sexual organs of the male and female Monarch butterflies are quite complex; we refer you to the book, THE MONARCH BUTTERFLY, for further information.

#### ARE THERE MORE MALE MONARCHS THAN FEMALES?

We have received a number of letters expressing the observation that there are more male Monarchs than females. To what can we attribute such discrepancies?

The number of males to females hatching from eggs is always the same, a fifty-fifty ratio. If you take careful note of the number of males to females in your reared specimens obtained from eggs you will find this to be true within limits depending upon the number of eggs involved. Then why the reports of more males than females? And, at times, more females than males? Here are a few possible explanations:

When the overwintering Monarchs return to the breeding grounds in the spring, the females travel much farther than do the males some of the females returning the entire distance to the most northerly parts of their breeding areas. Thus, if you capture Monarchs in the spring and early summer you will find a greater preponderance of females.

In the breeding grounds, the females fly close to the ground and seek out small milkweed plants, for the most part, upon which to deposit their eggs. The males are more active flyers and patrol certain areas where there is an abundance of nectar-producing flowers. Thus, with net in hand, you are most likely to capture more males than females among the flowering plants during the summer months. But, if you confine your activities to where there is an abundance of small milkweed plants, you will capture more females than males.

For reasons which we have as yet no plausible answer, when the Monarchs begin to move southward in the fall the males tend to proceed slightly ahead of the females. Thus, an examination of Monarchs on the overnight roosting sites at the beginning of the fall migration reveals more males than females; later they are about equal in numbers; and still later a few more females than males.

But the above explanation certainly does not answer all the field observations that we have come across in our field studies. For example, while collecting fall migrants along the north shore of the Gulf of Mexico, following a very severe wind

storm, we rarely found a female whereas the males collected had frayed and broken wings. It would appear that the males survived the storm and the females did not.

On the overwintering site in Mexico, after examining many hundreds of specimens, the ratio of males to females was found to be approximately the same. In one sample the ratio was slightly in favour of the number of females.

One can only conclude that there are a number of factors working in nature that can account for the difference in the ratio of males to females in one particular area of the country at one particular time.

Your reports of tagging in which you specify whether or not the specimens were male or female might eventually help in answering this most interesting problem.

#### REPORTS OF TAGGING BUTTERFLIES

In spite of several reports from associates who commented on the scarcity of Monarch butterflies in their area, the amount of tagging done in 1981, namely 6951 specimens is not a great deal less than that of 1980, namely 7576 specimens - a drop of 625.

We would like to thank all of you who sent in reports of tagging along with many details and astute observations all of which are very helpful.

We do try to acknowledge the receipt of all tagging reports but unfortunately, are not able to do so in some cases because of the pressure of dealing with data and with the large volume of correspondence which is generated by this research.

If you have not yet sent in your tagging report for 1981 we would still like to have it as all of your data go on permanent file for use in future reports and books.

BE SURE TO KEEP CARBON COPIES OF YOUR REPORTS AS OCCASIONALLY SOME ARE LOST IN THE MAILS.

#### INCORRECT PRINTING OF TAG NUMBERS

When you receive your tags for tagging the Monarch butterfly, you will notice that the numbers on the right end of the tape are the smallest and the numbers on the left end of the tape are the largest.

This is due to the fact that the printers reversed the conventional order of the numbers and since it is so difficult to get these tags printed at all we were forced to accept this anomaly.

The difficulty of getting the tags printed is due to the fact that each tag must have an individual number on it and most printing firms are not prepared to do such a special job. We have a printer who ordered a special device which is attached to the printing press and thus produces individually numbered tags. Remember to read the numbers from right to left in order to be able to record them in serial order.

#### CAGE FOR REARING MONARCH BUTTERFLIES

Carl Allgrove has sent us detailed plans and drawings for use in constructing a cage for rearing Monarch butterflies. If you would like a copy of Carl's plans, please let us know and we shall send you a copy.

#### PUBLICITY

It is reassuring to learn that despite the many problems of the world, the press still have the interest and concern to publish articles about the wonders of the Monarch butterfly and its migration.

We are especially grateful to those who took the time to send us press clippings many of which are beautifully illustrated.

The following associates sent clippings to us from the publications listed below. Bob Allen, Dick Buegler, Barbara Hagenson, Lorraine and Harvey Houck, Mabel Jenkins, Evelyn Kendrick, Patricia Kester, Ellen Roush, Faye Sutherland, Edna Sutton, Dorothy Yeager.

Excerpts from:

Clinton, Iowa Herald, The Idaho Statesman, Wisconsin State Journal, Gateway Outlook for N.Y. and N.J., Staten Island Advance, The Richland Observer, St. Petersburg Times, Chicago Tribune, County Citizen, (Bethel Maine), Ranger Rick, Ford Times, The Lewiston Maine Daily Sun, The Advertiser Democrat, The Globe-Times (Bethlehem, Pa.), Weekly Reader, Farm and Garden, The Sault Star, The Post-Crescent, 4 newspapers from San Luis Obispo county, California.

#### SPECIAL ACTIVITIES OF OUR ASSOCIATES

Bob Allen conducted nature walks concerned with the Monarch butterfly migration at Pismo, Morro Bay and Los Osos overwintering colonies in California.

Margaret Elliott mentioned the Monarch research in four of her outdoor articles for the "Muskegon Chronicle" and gave a total of 8 talks re Monarch butterflies to schools, garden clubs, nature groups and a Civic Women's group. She gave illustrated

addresses about "Butterfly Gardens" to attract butterflies of all species.

Audrey Wilson presented a lecture which she illustrated with live Monarch butterflies at the Pickering, Ontario Field Naturalists.

#### AWARDS

The 9 year old granddaughter of Evelyn Kendrick used pictures she and Evelyn Kendrick had taken to illustrate an essay on the Monarch butterfly which won first place at her school as well as the Bronze Medal in the County of Strathcona (Alberta) Science Fair.

Another associate of Evelyn's won first place with his Monarch project in the Junior section of the Dryden, Ontario Science Fair and the Bronze Medal for grades 3-11 in Live Science.

Danny Johnson won a state trip and the county Entomology award for his 4-H project about the Monarch butterfly.

#### SPECIAL DONORS

We would like to thank all of our members who have made donations to our research fund dealing with the biology of the Monarch butterfly and especially those who made donations in excess of what is specified as required to carry out this research. These special donors were as follows:

Bob Allen, Timothy Anderson, Betsy Briggs, Kenneth Brooks, Erma De Witt, Margaret Elliott, James Gilbert, J. Glynn, Barbara Hagenson, M. Holliday, Mabel Huber, Mrs. Franklin Hupp, Mabel Jenkins, Danny Johnson, Niel and Sheila Karrow, Norwood Keeney, Donna Kessler, Ron Lachelt, Van Luxenberg, Harold Mahan, Mrs. George Martz, Roland Matson, Ruth Anne McKee, Naturalists' Club of Broome County, Steve Powers, Elizabeth Radens, Walter Regula, Dale Reichert, Beatrice Ridgeway, Millicent Scott, Russell Siegel, George & Marion Smith, Sally Spooner, Edna Sutton, Maryanne West, Gary Williams, Roger Wilson, Alice Woodcock, Dorothy Yeager.

#### VAN LUXENBERG - IN MEMORIAM

It is with deep regret that we report the passing of Van Luxenberg of Castle Rock, Colorado.

Van was one of our long time associates who was very dedicated to the Monarch butterfly research. Her interest was of a very deep and scientific nature - she was devoted to eliciting new information about Monarch butterflies and through her many contacts in the scientific community and her own efforts was able to provide us with much valuable information.

Van's experience with Monarchs was far ranging. She reared them in the desert of Arizona, observed them in Colorado and studied them intensively on Maui where she first reported to us the finding of Monarch eggs and larvae on the giant tree-sized milkweed plants of that island.

Van was also a very faithful correspondent who wrote to us many detailed reports of her findings. Through her efforts we learned many new and fascinating aspects of the Monarchs in many different habitats.

We extend our deepest sympathy to Van's husband, Dr. Lester Luxenberg, who was of great help and encouragement in Van's studies.

#### NEW JERSEY LEPIDOPTERISTS' SOCIETY

Norah and I wish to express our deep gratitude to the New Jersey Lepidopterists' Society for the honour of appointing us Honorary Members of the newly organized Society.

For further information concerning the Society please write to Moly Monica.

RESEARCH ASSOCIATES 1981-1982

Those listed below are research associates actively involved in the study of the ecology and migrations of the Monarch butterfly for the period 1981-82.

Note: If your name does not appear on this list it is because you joined our group after this issue was submitted for publication.

A.

Allen, Bob L. San Luis Obispo, California.  
Allgrove, Carl G. Windsor, Connecticut.  
Anderson, Carolyn. Madison, Wisconsin.  
Anderson, Timothy P. Richfield, Minnesota.  
Armstrong, Fred. Red Bank, New Jersey.

B.

Banet, Sister Laura. New Ulm, Minnesota.  
Bartlett, Bobbye. Mountain Home, Idaho.  
Belknap, Ralph. Ann Arbor, Michigan.  
Bower, Douglas. Morenci, Michigan.  
Bracher, Ray W. South Bend, Indiana.  
Bradley, Catherine M. Plainview, New York.  
Breen, Jean. Brookfield, Connecticut.  
Briggs, Betsy. Marshfield, Massachusetts.  
Britten, Michael W. Manassas, Virginia.  
Brooks, Kenneth A. Conowingo, Maryland.  
Brown, Gabriel, Ralph & Elaine. Baltimore, Maryland.  
Buchanan, Frances B. New Paltz, New York.  
Buegler, Richard P. Staten Island, New York.

C.

Cameron, Tyke. Orange, Texas.  
Carpenter, Fairbank. Far Hills, New Jersey.  
Carter, Gray. Winston-Salem, North Carolina.  
Cheevers, Anthony P. Boston, Massachusetts.  
Clements, Marta. West Paris, Maine.  
Coleman, Wm. J. Ventura, California.  
Costantinos, Gus. North Olmsted, Ohio.  
Courville, Donnie. Beaumont, Texas.  
Crow, Mrs. Bentonville, Arkansas.

D.

De Montes, Sra. Barbara M. Can Cun, Quintana Roo, Mexico.  
Detweiler, M. Carl. Battle Creek, Michigan.  
De Witt, Erma R. New Paltz, New York.



E.

Elliott, Margaret Drake. Muskegon, Michigan.  
Emery, Calvin. Nevada, Missouri. ✓

G.

✓ Garner, Peggy. Le Claire, Iowa.  
Gilbert, James R. Waconia, Minnesota. —  
✓ Glen Carbon School. Glen Carbon, Illinois.  
Glovas, G.S. Bethlehem, Pennsylvania.  
Glynn, J. Limehouse, Ontario.  
Grew, Janet M. Maplewood, Minnesota. —  
Golden, Frank. Miles, Texas.

H.

✓ Hagenson, Barbara. Clinton, Iowa.  
Hansen, R.E. Staten Island, New York.  
Hatch, Wendy. Port Carling, Ontario.  
Henshall, Mary S. Nampa, Idaho.  
Hill, John A. Lyndhurst, New Jersey.  
Hillman, Carol B. Harrison, New York.  
Holck, Bert. Landenberg, Pennsylvania.  
Holden, Joann. Birmingham, Michigan.  
Holliday, M. Reno, Nevada.  
Hopf, Alice. Upper Black Eddy, Pennsylvania.  
Horr, Alta L. Gretna, Nebraska.  
Horstman, Eric. Weaverville, California.  
Hoskins, Dorothy M. Weston, Massachusetts.  
✓ Houck, Harvey & Lorraine. Decorah, Iowa.  
Huber, Mabel L. Fernley, Nevada.  
Hupp, Mrs. Franklin. Hinton, Virginia.

I.

Independent School District 191. Burnsville, Minnesota.  
Inman, Virgil. South Bend, Indiana.  
Ingram, Pamela. Dallas, Texas.  
Irwin, Ann D. Bloomfield Hills, Michigan.  
Island Natural Science School. Toronto, Ontario.

J.

Jenkins, Mabel S. Canton, New York.  
Johnson, Danny K. Bemidji, Minnesota. —  
Jordan, Gina. Battle Creek, Michigan.

K.

Karrow, Niel & Sheila. Waterloo, Ontario.  
Keeney, Norwood H. Hudson, New Hampshire.  
Kendrick, E. Sault Ste. Marie, Ontario.  
Kessler, Donna. Audubon, Iowa.  
✓ Kester, Patricia A. Appleton, Wisconsin.  
Klukas, Andy. Atwater, Minnesota. —  
Knutson, Debbie. Iron Mountain, Michigan.  
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L.

Lachelt, Ron. Minneapolis, Minnesota. —  
Lankford, Lynne. Baytown, Texas.  
Larsen, Kirk L. Ann Arbor, Michigan.  
Larson, Donald W. Minnetonka, Minnesota. —  
Lombard, Matt. Guilford, Connecticut.  
—Lopina, Marion T. Wauwatosa, Wisconsin.  
Lorimer, John & Family. West Bloomfield, Michigan.  
Luxenberg, Van. Castle Rock, Colorado.

M.

Mahan, Dr. Harold D. Cleveland, Ohio. —  
—Malick, Patricia. Stevens Point, Wisconsin.  
Mallery, C. Vestal, New York.  
Martz, George E. Naples, Florida.  
Mathes, G. Eldred & Marjorie. Pontiac, Michigan.  
Matson, R.R. Minneapolis, Minnesota. —  
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McLaughlin, Roberta D. Bloomfield, Connecticut.  
Mellow, Owen. Bracebridge, Ontario.  
Merrill, Kristy. Berlin, Pennsylvania.  
Meyer, Norman & Babs. Monterrey, NL, Mexico.  
Milani, Ruth. Meaford, Ontario.  
Miller, Donna. Ottawa, Ontario.  
Millet, Carol. Jacksonville, Vermont.  
Monica, Molly. Berkeley Heights, New Jersey.  
Moss, Joseph. Roanoke, Louisiana.

N.

Naturalist Club of Broome County. Vestal, New York.

O.

Ortt, Marilyn & Jennifer. Marietta, Ohio. X  
Osborn, Patricia A. Merced, California.

P.

Pendleton, Emily V. Montevallo, Alabama.  
Powers, Steve. Philadelphia, Pennsylvania.  
Preston, Vicki L. Whiteford, Maryland.

Q.

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R.

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Radens, Elizabeth. Tenants Harbor, Maine.  
Reese, Randy. Newark Valley, New York.  
Regula, Walter F. Hamilton, Ontario.  
Reichert, Dale. Hanover, Pennsylvania.  
Ridgeway, Beatrice M.B. North Eastham, Massachusetts.

R. (Continued)

Roush, Ellen. Lynchburg, Ohio. \  
Rutherford, Kathleen M. St. Catharines, Ontario.

S.

Salazar, Aaron John. San Jose, California.  
Schaefer, Christine. Muncy, Pennsylvania.  
Schmitz, T.J. Avon Lake, Ohio. \  
Scott, Millicent. Casper, Wyoming.  
Senghas, Joan. Mount Clemens, Michigan.  
Severson, Lu. Middleton, Wisconsin.  
Shienvold, Susan. Harrisburg, Pennsylvania.  
Siegel, Russell. Danbury, Connecticut.  
Sieker, W.E. Madison, Wisconsin.  
Sinclair, Mary Lu. Falls Village, Connecticut.  
Smith, Leslie V. Citrus Heights, California.  
Smith, Marion E. & George M. Lyndonville, New York.  
Smith, Trudy. Mumford Cove, Connecticut.  
Spoonner, Sally. Lakeville, Massachusetts.  
Stifel, Doris N. Toledo, Ohio. \  
Stull, Jean H. Waterford, Pennsylvania.  
Sutherland, Faye. Boise, Idaho.  
Sutton, Edna M. Richland Centre, Wisconsin.  
Swanson, Elaine. Pickett, Wisconsin.

T.

Teed, L.B. Wichita, Kansas.  
Terry, Willie G. Baytown, Texas.  
Totton, Larry W. Granger, Iowa.  
Tribo, Matthew D. Ponca City, Oklahoma.

W.

Watson, Dorothy M. Cambridge, Idaho.  
West, Maryanne. Gibson Landing, British Columbia.  
White, Margaret. Oakland, Iowa.  
Williams, Gary. Glen Ellyn, Illinois.  
Wilson, Audrey. Cobourg, Ontario.  
Wilson, Roger L. Merville, Iowa.  
Winkler, Amy. Bluebell, Utah.  
Wiser, Gloria. Rifton, New York.  
Woodcock, Alice P. Upper Montclair, New Jersey.

Y.

Yeager, Dorothy. Pearsall, Texas.

Z.

Zewe, Cyril. North Huntingdon, Pennsylvania.  
Zimmerman, Helen. Vineland Station, Ontario.