THE BIONOMICS OF PLATYNOTA IDAEUSALIS (Lepidoptera: Tortricidae) IN MICHIGAN

Thesis for the Degree of M. S.
MICHIGAN STATE UNIVERSITY
HENRY WILLIAM HOGMIRE, JR.
1976

ABSTRACT

The tufted apple bud moth, *Platynota idaeusalis* (Walker) (Lepidoptera: Tortricidae), has 2 generations per year in southwestern Michigan apple orchards. Most abundant in Berrien Co., populations rapidly diminish as one proceeds northward. The appearance of percentages of the adult male population is predicted based on day-degree accumulations. Variation between orchard locations occurs, with more day-degrees being accumulated at corresponding population percentages as one moves inland (east) from Lake Michigan. The adult male is active throughout the night with peak flight occurring between 12 p.m.-4 a.m. An insignificant number of larvae are parasitized by the braconid parasitoid, *Microgaster pantographae* Muesebeck. 'Windsor' and 'Schmidt' sweet cherry varieties serve as additional hosts.

THE BIONOMICS OF *PLATYNOTA IDAEUSALIS* (Lepidoptera: Tortricidae) IN MICHIGAN

By

Henry William Hogmire, Jr.

A THESIS

Submitted to

Michigan State University

in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE

Department of Entomology

1976

ACKNOWLEDGEMENTS

The author wishes to express sincere appreciation to Dr. Angus J. Howitt for his guidance and support, and for providing the rewarding opportunity to work at the Trevor Nichols Farm. The author thanks the Department of Entomology for providing financial assistance during the course of this study, and to Drs. Frederick W. Stehr, Robert F. Ruppel and James E. Moulton for their services on the guidance committee.

The author is grateful to Dr. J. F. Gates Clarke and Mr. Peter Martinat for their identification of collected material; Mr. Larry Olsen and his field scouts for their aid with the distribution study; Mr. Sam Jennings for his help with the linear regression analysis; Mr. Vic Friday, Mr. George Shane, and Mr. John Page for the use of their orchards during the course of this study; and to Dr. Ray Kriner, Extension Entomologist at Rutgers University, for the use of figures 33 and 36.

A very special thanks is extended to Mr. Alfred Pshea for his assistance in familiarizing the author with fruit pests and orchard practices.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Platynota idaeusalis (Walker) was originally described by Clemens (1860) as *P. sentana* and was redescribed by Robinson (1869) using the scientific name of *Tortrix sentana*.

This tortricid has been labeled as a general feeder. Fernald (1882) lists black haw (*Viburnum prunifolium*) and blood root (*Sanguinaria* sp.) as food plants. Mr. August Busck (Frost, 1923), of the United States National Museum, has unpublished records of larval feeding on blackberry (*Rubus* sp.), osage orange (*Maclura pomifer*), golden rod (*Solidago* sp.) and aspen (*Populus* sp.). Additional reported food plants include apple (*Malus* sp.) (Frost, 1923), *Solanum* and clover (*Trifolium* sp.) (Forbes, 1923) and *Vaccinium* (MacKay, 1962). Bode (1975), by examining plants underneath apple trees, discovered larvae feeding on slender knotweed (*Polygonum aviculare*), dewberry (*Rúbus villósus*), yellow toadflax (*Linaria vulgaris*), Pennsylvania smartweed (*Polygonum pennsylvanicum*), common dandelion (*Taráxacum officinále*), horsenettle (*Solánum carolinénse*), alfalfa (*Medicágo sativa*), nimblewill (*Muhlenbergia schreberi*), bindweed (*Convólvulus* sp.), smooth crabgrass (*Digitaria ischaemum*), birdsfoot trefoil (*Lótus corniculátus*), white clover (*Trifólium rêpens*), green foxtail (*Setária viridis*), wild strawberry (*Fragaria virginiana*) and Virginia creeper (*Psédera* sp.).

P. idaeusalis is found along the atlantic coast from

Nova Scotia to Florida, west to Manitoba and Texas, and in Washington and British Columbia. Distribution probably occurs throughout the northern United States and Canada (Fernald 1882, U.S.D.A. 1959, MacKay 1962).

This insect was first reported as an economic problem in Pennsylvania apple orchards by Frost (1921a, 1921b). Larvae were reported feeding in orchards during late May and early June, and again in the fall. Considerable injury was reported from Erie, Blair and Adams counties, Pennsylvania (Frost 1942, 1951).

The insect museum at Michigan State University has specimens and Michigan records from the counties of Charlevoix, Otsego, Montmorency, Oscoda, Midland, St. Clair, Oakland, Livingston, Washtenaw, Wayne, and Berrien (starred counties in Figure 1). The presence of significant populations of *P. idaeusalis* in Michigan apple orchards was first realized in 1973 with the use of a pheromone (synthetic chemical attractant) produced by the Zoecon Corporation. Field scouts working for the Michigan Cooperative Pilot Apple Pest Management Program found *P. idaeusalis* present in 143 orchards throughout the fruitbelt of Michigan from Berrien to Benzie counties (Figure 1). The species was identified by Dr. J. F. Gates Clarke* from 30 adult male specimens obtained by pheromone trapping.

---

*Dr. J. F. Gates Clarke is a Research Associate in Lepidoptera at the Smithsonian Institution, Washington, D. C.

As a result of this insect's reported economic importance in Pennsylvania, and its wide distribution throughout Michigan's fruitbelt, a study was conducted to determine the biology and pest status of *P. idaeusalis* in Michigan.

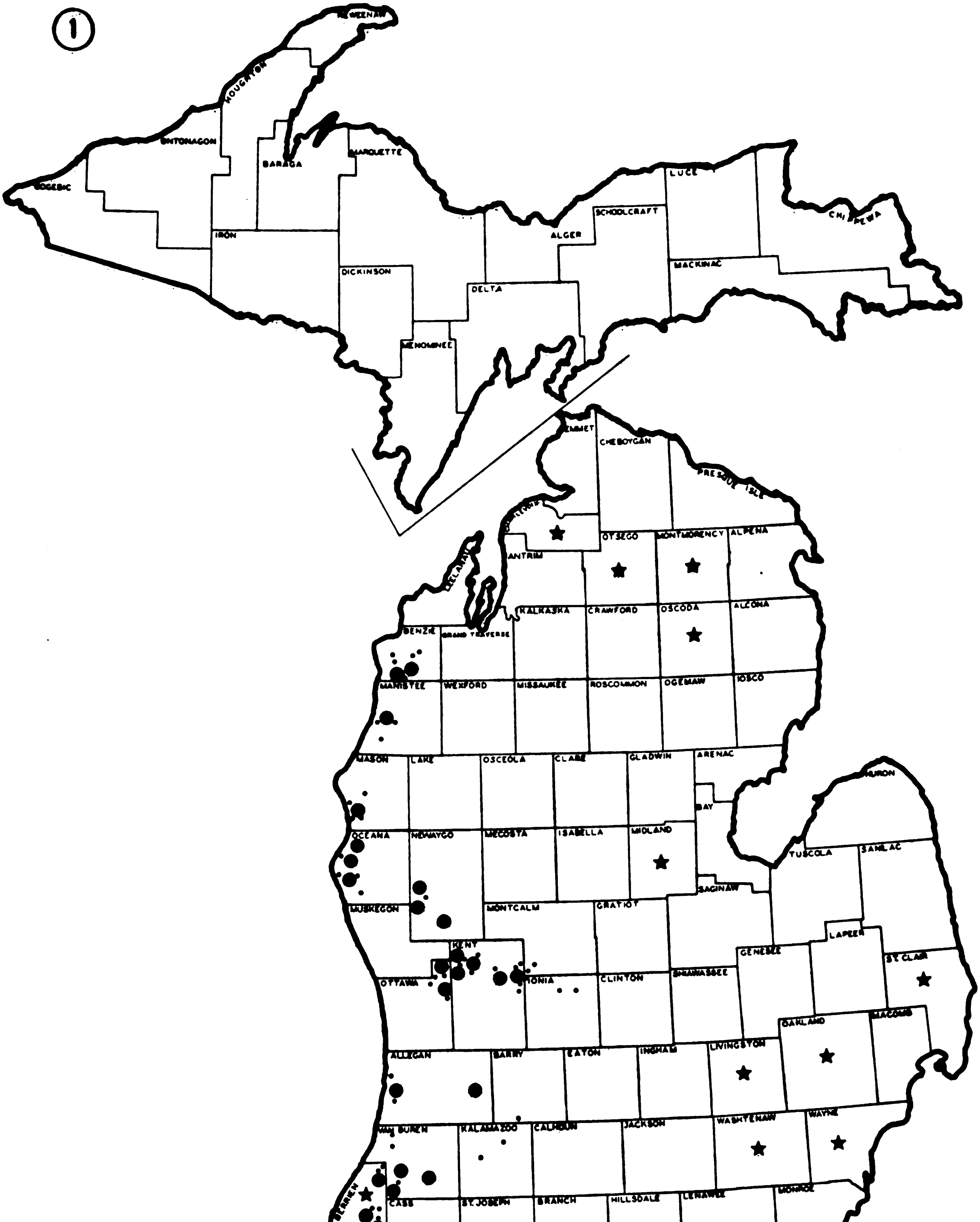
Figure 1. - Collecting sites of *Platynota idaeusalis* in Michigan, 1974-1975.

●= 3 or more locations.

•= 1 location.

★= insect museum records.

1


KEWEENAW
HOUGHTON
ONTONAGON
GOGEBIC
BARAGA
MARQUETTE
IRON
DICKINSON
MENOMINEE
DELTA
ALGER
SCHOOLCRAFT
LUCE
CHIPPEWA
MACKINAC
EMMET
CHEBOYGAN
PRESQUE ISLE
OTSEGO
MONTMORENCY
ALPENA
ANTRIM
LEELANAU
BENZIE
GRAND TRAVERSE
KALKASKA
CRAWFORD
OSCODA
ALCONA
MANISTEE
WEXFORD
MISSAUKEE
ROSCOMMON
OGEMAW
IOSCO
MASON
LAKE
OSCEOLA
CLARE
GLADWIN
ARENAC
HURON
BAY
OCEANA
NEWAYGO
MECOSTA
ISABELLA
MIDLAND
TUSCOLA
SANILAC
SAGINAW
MUSKEGON
MONTCALM
GRATIOT
KENT
LAPEER
OTTAWA
IONIA
CLINTON
SHIAWASSEE
GENESEE
ST. CLAIR
OAKLAND
MACOMB
ALLEGAN
BARRY
EATON
INGHAM
LIVINGSTON
VAN BUREN
KALAMAZOO
CALHOUN
JACKSON
WASHTENAW
WAYNE
BERRIEN
CASS
ST. JOSEPH
BRANCH
HILLSDALE
LENAWEE
MONROE

Description of Stages

Egg

The eggs (Figure 28) are laid in patches of 100 or slightly more overlapping eggs which are covered with a milky-white translucent envelope. Initially apple green in color, these masses change to a copper color, and finally to a black head capsule stage prior to hatching (Frost, 1923). The incubation period ranged from 10-14 days for both spring (June, July) and summer (August, September) generations in 1974.

Larva

First instar larvae are 1.5-2.0 mm long, have a head capsule width of .20 mm, and are yellowish in color with a dark brown to black head and prothoracic shield. Larvae mature through 5 instars, with the last instar having a length of 13-18 mm and an average head capsule width of 1.21 mm. Mature larvae (Figure 29) are brown, rarely olive, in color with a chestnut brown head and prothoracic shield. The prothoracic shield is lighter colored anteriorly with some darker brown overlay on the posterior margin. Each body segment has 4 dorsal, silver-colored pinacula which are raised, thus giving the body a warty appearance (Frost, 1923). MacKay (1962) reports that the body may also bear vague, pale, longitudinal stripes (Figure 30). The last segment possesses a 6-9 pronged anal comb (Figure 31) which according to Frost (1919) is used to propel frass pellets away from the larva's body.

Pupa

The pupa (Figure 32) is reddish-brown, about 13-15 mm long; the adult emerges in 9-11 days (Frost, 1923).

Adult

The adult (Figure 33) is small, usually less than 12 mm in length, and is inconspicuously patterned with various shades of gray and brown scales. Forbes (1923) describes the adult as ash gray, irregularly shaded with blackish and dull brown with raised black striae. The male tends to have a pale outer wing margin with 2 or 3 fine striae. The female has a pale basal half, slightly broader than the male's, with an oblique black stria across the middle of the wing. The hind wing in both sexes is grayish-brown. The tips of the forewings are ribbed longitudinally and possess 2 or 3 groups of erected scales which give the insect its common name; tufted apple bud moth.

Life History

The winter is passed as immature larvae webbed in dead leaves of the previous season on the orchard floor (Frost, 1923). Early in the spring, about bud swell, these larvae crawl up the trunk and seek out the opening buds of apple where they feed on developing leaves, often burrowing in the petioles or chewing the blossoms. Bode (1975) believes that the overwintering larvae complete their development on ground vegetation. The author's research revealed that either situation may occur depending on the availability of ground vegetation.

Frost (1923) found that 2 flights of adults occurred under Pennsylvania conditions; the first in late May and early June, and the second in August and September. Forbes (1923) believes adults are on the wing from June to August. Bode (1975), via pheromone trapping, found male moths from overwintering larvae to be active from early May to mid-July, with a second flight occurring from mid-July into October. Prentice (1965) found adults to be active from late June to mid-July in Canada. While Frost's and Bode's reports suggest that P. idaeusalis is bivoltine under Pennsylvania conditions, Asquith (Chapman and Lienk, 1971) believes this species to be univoltine in Pennsylvania. Life history studies in Michigan support Frost's and Bode's findings.

Frost (1923) reports that P. idaeusalis is very similar to the eye-spotted bud moth, Spilonota ocellana Denis and Schiffermüller, in its habits and manner of feeding, and that the injuries caused by these 2 species are indistinguishable. Forbes (1923) reports that the larvae of P. idaeusalis are frequently found webbed within a folded leaf or between 2 leaves. The larvae chew part way through the petiole of a leaf and then feed on this hanging leaf webbed within a lengthwise fold (Figure 34). Feeding continues even though the leaf becomes dried and withered from the petiole damage. Asquith (Chapman and Lienk, 1971) reports that the most typical feeding site occurs where a larva has cut a leaf and fastened it with webbing to the side of an apple (Figure 35), thus allowing the larva to feed on both in relative seclusion. Damage to the fruit is characterized as shallow, irregular, surface excavations (Figure 36).

Pheromone

Roelofs and Comeau (1971) found trans-11-tetradecenyl alcohol to be an attractant for the male tufted apple bud moth. A pheromone consisting of this compound plus a synergist, trans-11-tetradecenyl acetate, was produced by the Zoecon Corporation in 1973, thus providing a monitoring tool for the adult male population.

Control

Bode (1975) advocates control through the use of properly timed sprays at intervals of 7-9 days during the 2 critical periods of oviposition and egg hatch. He also suggests that a delayed-dormant spray of oil plus insecticide be directed onto the ground beneath the trees in an effort to reduce overwintering larval populations in orchards where *P. idaeusalis* is a problem.

EXPERIMENTAL METHODS AND MATERIALS

A. Pheromone Monitoring.

The adult male population was monitored with the use of a pheromone (synthetic chemical attractant) at 8 southwestern Michigan apple orchard locations (Table 1, Figures 2-15) during 1974-1975.

Table 1. - Pheromone monitoring sites.

Orchard Location	Orchard Status	Apple Varieties
Berrien Co.		
Coloma, Mich.	*Sprayed	Chenango, Jonathan
Watervliet, Mich.	*Sprayed	Jonathan, McIntosh
Van Buren Co.		
Bangor, Mich.	Unsprayed	Jonathan, Red Delicious
Kalamazoo Co.		
Kalamazoo, Mich.	Unsprayed	Jonathan, Northern Spy, Rhode Island Greening, Red Delicious
Richland, Mich.	Unsprayed	McIntosh, Northern Spy, Jonathan, Snow, Wealthy
Allegan Co.		
Fennville, Mich.	Unsprayed	McIntosh, Northern Spy, Jonathan
Douglas, Mich.	Unsprayed	Jonathan, Red Delicious Winesap
Barry Co.		
Hickory Corners, Mich.	Unsprayed	Jonathan, Red Delicious

* Insecticide Application.

Rubber septums containing the pheromone (trans-11-tetradecenyl alcohol plus trans-11-tetradecenyl acetate) were purchased from the Zoecon Corporation. A single septum was placed in a Sectar® commercial tent trap from 3M (Figure 37) which had been purchased pre-coated with a sticky substance. As a result, male moths which were attracted to the pheromone and which entered the trap, were caught. Three traps (1 trap/tree) were hung about 5-6 feet high in each of the orchard locations. Each trap was separated by a minimum of 2 tree spaces. Traps were placed in the orchards during the first week of May and removed during the latter part of October after the moth catch had reached and remained at zero for 2 weeks. Each trap was checked once a week on the same day, with the moths being removed and counted. When high moth catches were obtained, the trap was removed and replaced with a new trap. The rubber septums, which last 6-8 weeks, were replaced every 5 weeks to ensure adequate pheromone concentration and trapping efficiency.

B. Seasonal Appearance Based on Day-Degrees.

Day-degrees were accumulated (equations for calculations provided by Ruppel, 1974) from January 1 until the end of emergence so that the seasonal appearance of percentages of the adult male population could be predicted. Samples were collected by pheromone trapping utilizing the data obtained from the 3 traps described above. Data were obtained from

4 orchard sites in 1974, and the same 4 plus 1 additional site in 1975. Maximum and minimum daily temperatures were collected for both years from the nearest recording weather station.

Orchard Site	Weather Station
Coloma, Mich.	Watervliet, Mich.
Watervliet, Mich.	" "
Bangor, Mich.	Bloomingdale, Mich.
Kalamazoo, Mich.	Kalamazoo State Hospital
Richland, Mich.	Gull Lake Biological Station

A base developmental temperature of 48°F (9°C) and an upper threshold limit of 86°F (30°C) were used. Fahrenheit temperatures were utilized in calculations since weather stations record daily maximum and minimum temperatures in these units. Day-degrees were computed and accumulated daily by using the equation:

$$DD_{48} = \frac{\text{max. temp.} + \text{min. temp.}}{2} - 48.$$

Sine-wave correction tables (Gage and Haynes, 1974) were used to calculate the day-degrees when the minimum temperature fell below the base temperature. The area under the curve represented by each sample was computed with the equation:

$$A = \frac{d(N + N_{-1})}{2};$$

where d is the difference in accumulated day-degrees between the date sampled and the previous date sampled; N is the sample size and N_{-1} is the previous sample size. The sample areas were summed (SA) and the percent of the total area represented by the area for each sample was calculated by the equation:

$$\% = 100\frac{A}{(SA)}$$

The percentages were accumulated for each location for each year, and then transformed (tables used) to logistic units for linear regression analysis. The data for all locations and for both years were pooled for the final regression analysis. The computed sigmoid curves for both spring and summer generations were graphed (Figures 16-25) and the observed data were added as points on the graph.

C. Seasonal Development.

The seasonal development of both generations of *P. idaeusalis* was monitored in a 15 acre mixed block of Chenango and Jonathan apple varieties near Coloma, Mich. in 1974. The adult male population was monitored by pheromone trapping (See Section A above), with data on other life stages obtained by making field observations and through rearing under orchard conditions.

Adult moths were captured on the trunks of apple trees, and both sexes were released into a 3x3x3 wooden and wire screened cage containing apple seedlings. The life history of the progeny from these adults was then studied. Some of the larvae obtained from the orchard were also placed on seedlings so development and feeding behavior could be observed. Apple seedlings were watered every 2 days and replaced as needed. Egg masses and pupae were marked in the orchard with red ribbon so hatch and emergence could be monitored.

D. Alternate Hosts.

A variety of both tree and small fruits were investigated for the presence of P. idaeusalis life stages. The presence of the adult male was investigated by pheromone trapping in a 4 acre block of Montmorency tart cherries near New Era, Mich., 10 acres of Windsor and Schmidt sweet cherry varieties near Coloma, Mich., and a 1.5 acre patch of Jersey blueberries near Grand Junction, Mich. These same locations plus a 3 acre block of Redhaven peaches and a 5 acre field of Midway strawberries near Coloma, Mich. were investigated for the presence of other life stages.

E. Adult Male Flight Activity.

The flight activity of the adult male was monitored using an hourly timing trap (Figure 38). This trap was placed in a 10 acre mixed block of Windsor and Schmidt sweet cherry varieties near Coloma, Mich. where larval feeding had been observed in the spring of 1975. This trap provided a 12-hour sampling period, with each hourly sample being caught in a separate compartment on a revolving cylinder which was coated with Stickem Special®. Moths were attracted to the timing trap by the use of a pheromone capsule suspended above the revolving cylinder. Samples were taken for a 12 day period (August 18-29) from 7 p.m. - 7 a.m., E.D.T. Captured moths were counted and removed every morning with additional

Stickem Special® being added as needed. The hourly temperature and relative humidity were recorded using a hygrothermograph.

F. Natural Enemies.

Folded apple leaves containing parasitoid pupae were placed in 4" diameter petri dishes along with some moistened cotton to prevent desiccation. These petri dishes were placed in an environmental chamber which was maintained at a temperature of 75°F and 80-90% relative humidity. Adult specimens were delivered to Mr. Peter Martinat* for identification.

G. Larval Key.

A last instar larval key was developed to distinguish living specimens of *P. idaeusalis* from 7 other tortricids commonly found in Michigan apple orchards. Morphological observations were made on specimens obtained from the field as well as those reared on apple seedlings under controlled laboratory conditions (temperature 75°F, 80-90% relative humidity).

---

* Mr. Peter Martinat is a graduate student in taxonomy at Michigan State University.

RESULTS AND DISCUSSION

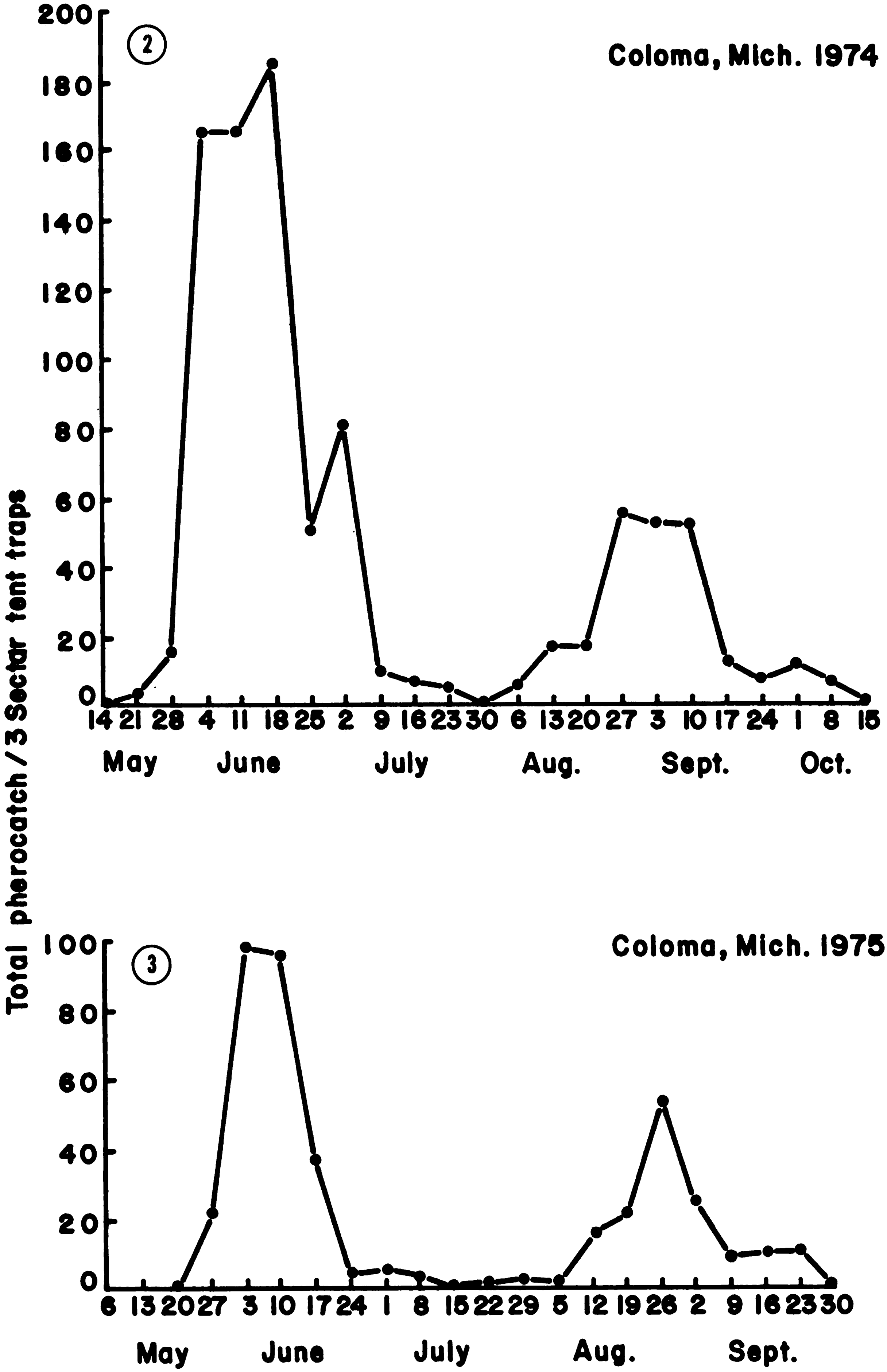
A. Pheromone Monitoring.

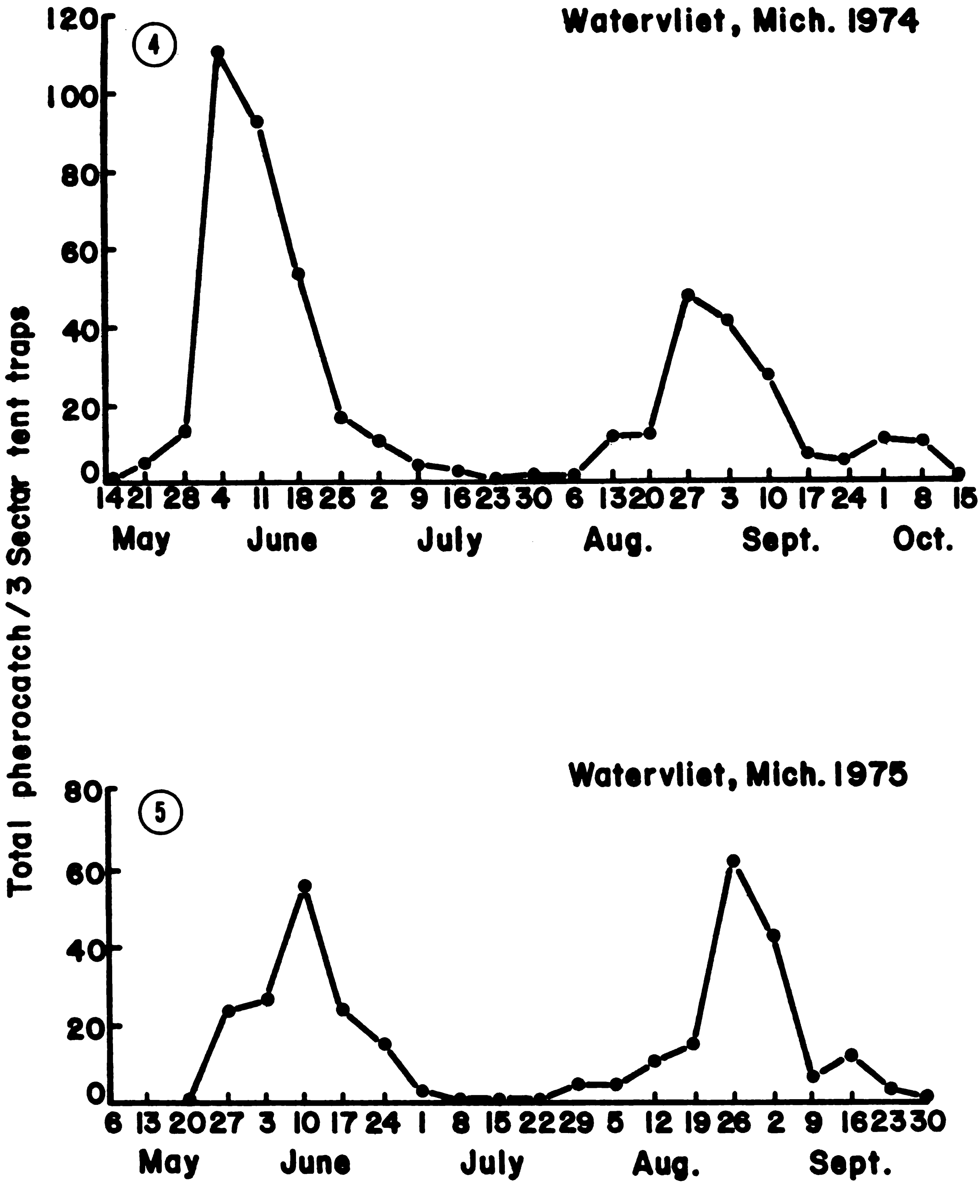
Figures 2-15 show the results of the pheromone monitoring at 8 orchard sites during 1974-1975. Two generations were found to occur in all locations except Douglas, Mich. where only a single generation was discovered. This may be due to the proximity of Lake Michigan (1.5 mi.) to the Douglas orchard which delays seasonal development. However, at the Fennville orchard site which is only 3.5 miles from Lake Michigan, a second generation was found to occur but even here the number of moths caught was quite minimal. *P. idaeusalis* was found to be most abundant in Berrien Co. A significant reduction in numbers of moths caught is observed as one proceeds in a northern and eastern direction from the southwestern corner of the state. At the 6 orchard sites where trapping was conducted both years, the number of adult males caught in 1975 was considerably less than that obtained in 1974 (Table 2). No explanation for the trap catch reduction in 1975 can be given.

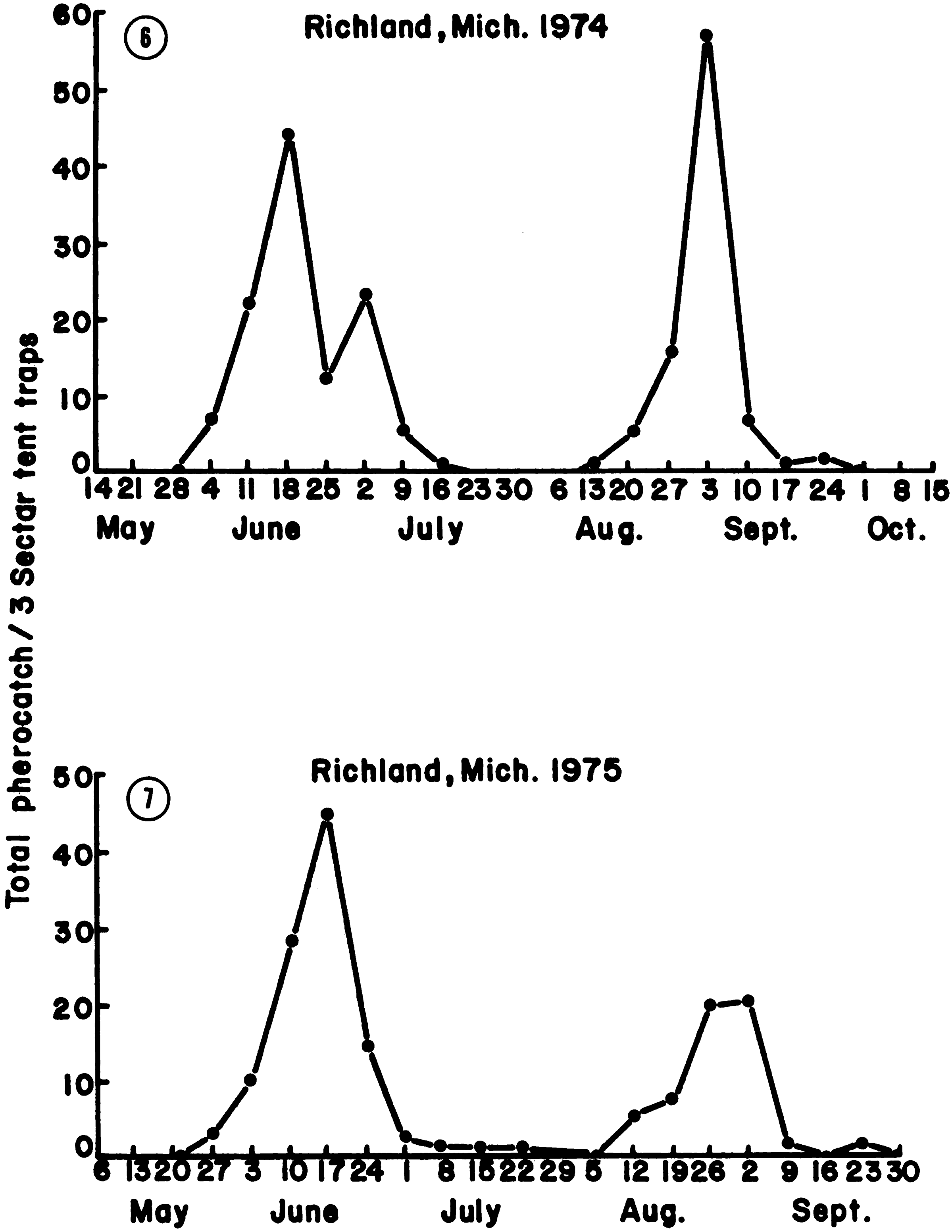
B. Seasonal Appearance Based on Day-Degrees.

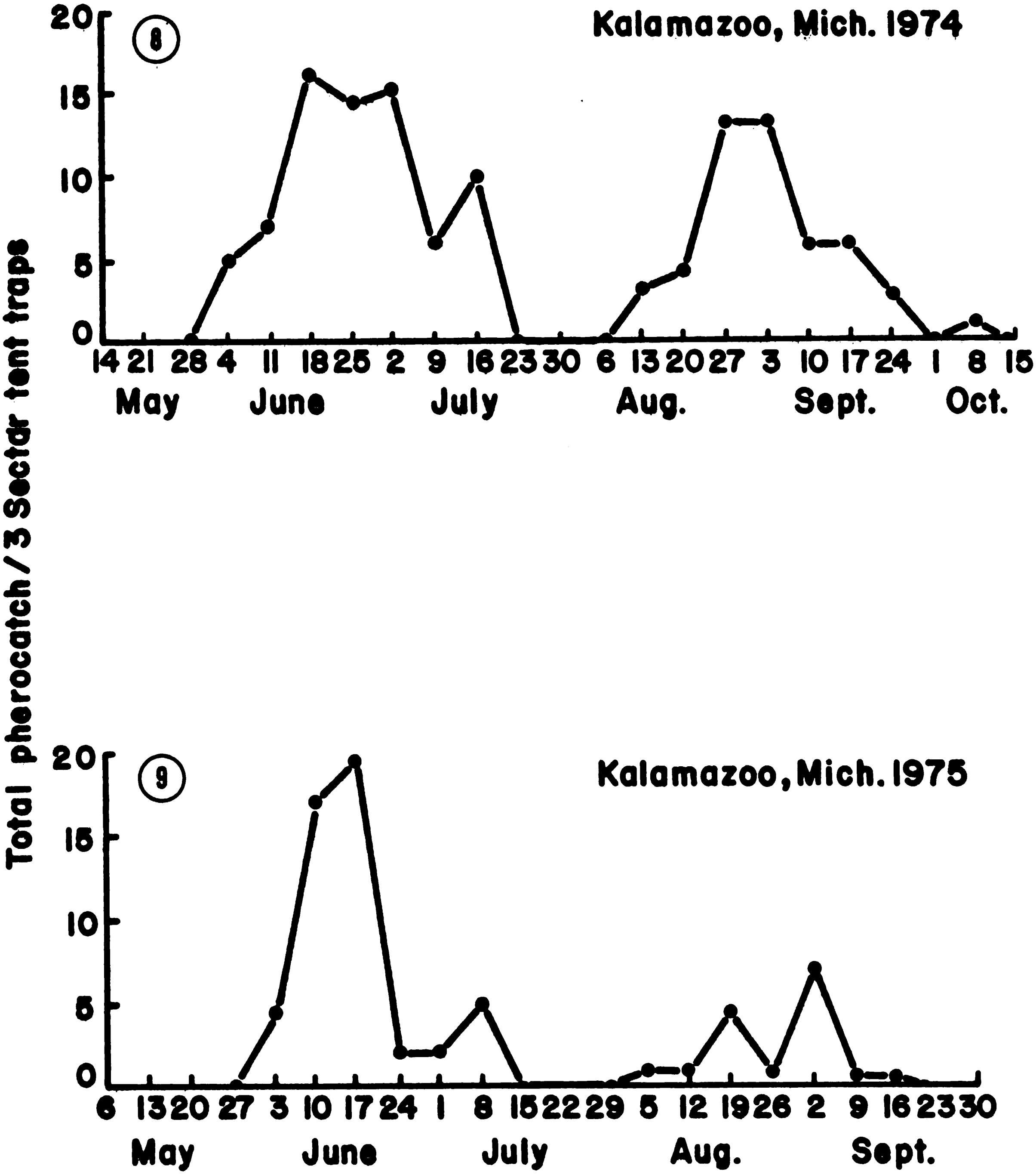
A good correlation (Figures 16-25) was found to exist between the seasonal appearance of percentages of the adult male population and accumulated day-degrees. The coefficient of correlation ranged from .960-.999 for both spring and summer generations. Table 3 reveals that the appearance

Figures 2-15. - Pheromone monitoring of adult male population at 8 southwestern Michigan orchard locations, 1974-1975.

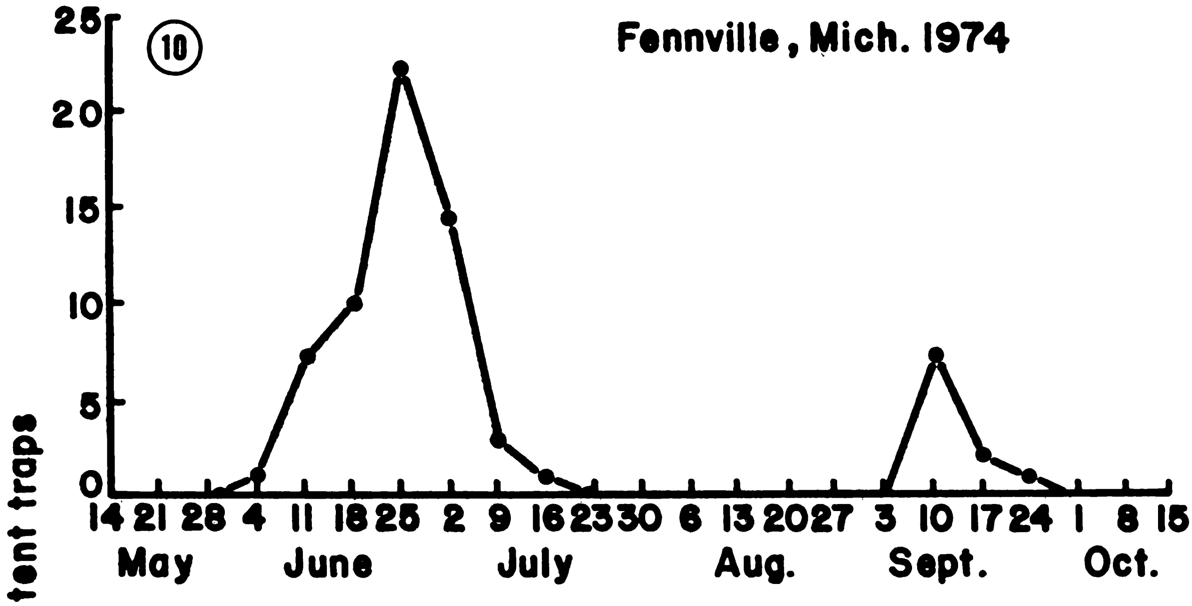

Total pherocatch / 3 Sectar tent traps
2
Coloma, Mich. 1974
0
20
40
60
80
100
120
140
160
180
200
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15
May
June
July
Aug.
Sept.
Oct.
3
Coloma, Mich. 1975
0
20
40
60
80
100
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 30
May
June
July
Aug.
Sept.

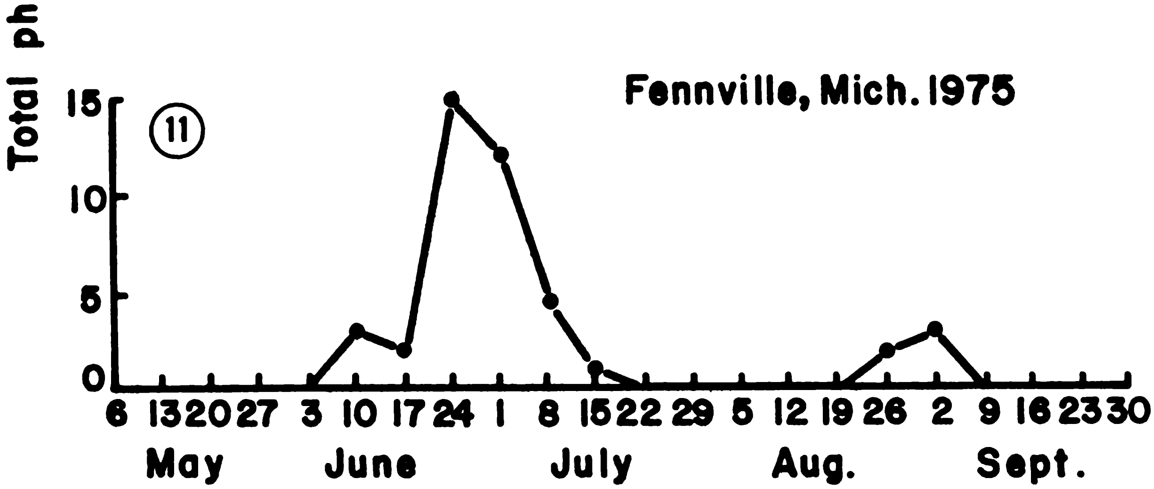

Watervliet, Mich. 1974
4
120
100
80
60
40
20
0
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15
May June July Aug. Sept. Oct.
Total pherocatch / 3 Sectar tent traps
Watervliet, Mich. 1975
5
80
60
40
20
0
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 30
May June July Aug. Sept.

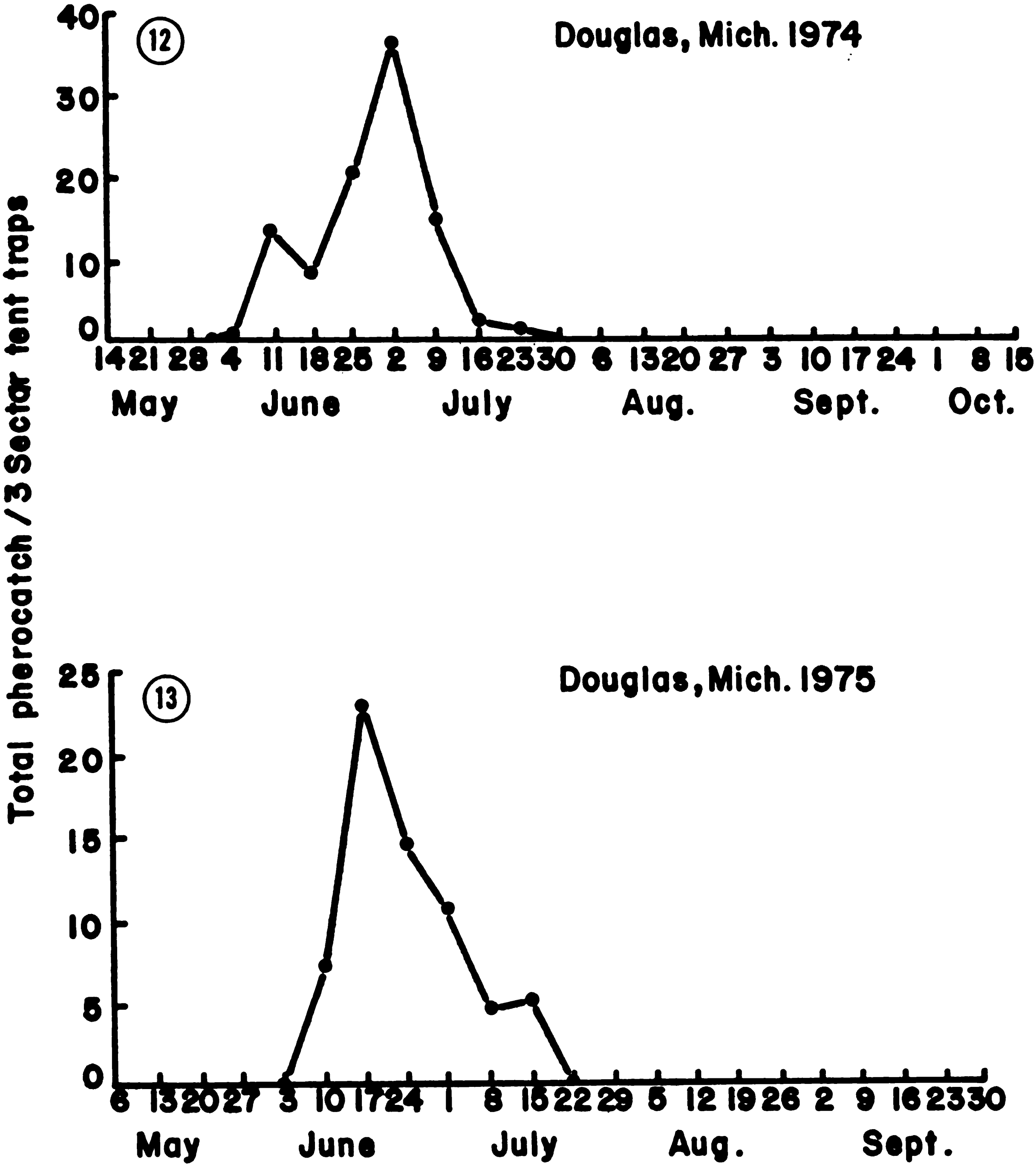

Total pherocatch / 3 Sectar tent traps
⑥
Richland, Mich. 1974
60
50
40
30
20
10
0
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15
May
June
July
Aug.
Sept.
Oct.
⑦
Richland, Mich. 1975
50
40
30
20
10
0
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 30
May
June
July
Aug.
Sept.



Total pherocatch / 3 Sectar tent traps
8
Kalamazoo, Mich. 1974
0
5
10
15
20
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15
May
June
July
Aug.
Sept.
Oct.
9
Kalamazoo, Mich. 1975
0
5
10
15
20
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 30
May
June
July
Aug.
Sept.


10
Fennville, Mich. 1974
25
20
15
10
5
0
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15
May
June
July
Aug.
Sept.
Oct.
Total pherocatch / 3 Sectar tent traps


11
Fennville, Mich. 1975
15
10
5
0
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 30
May
June
July
Aug.
Sept.


Total pherocatch / 3 Sectar tent traps
12
Douglas, Mich. 1974
40
30
20
10
0
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15
May
June
July
Aug.
Sept.
Oct.
13
Douglas, Mich. 1975
25
20
15
10
5
0
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 30
May
June
July
Aug.
Sept.

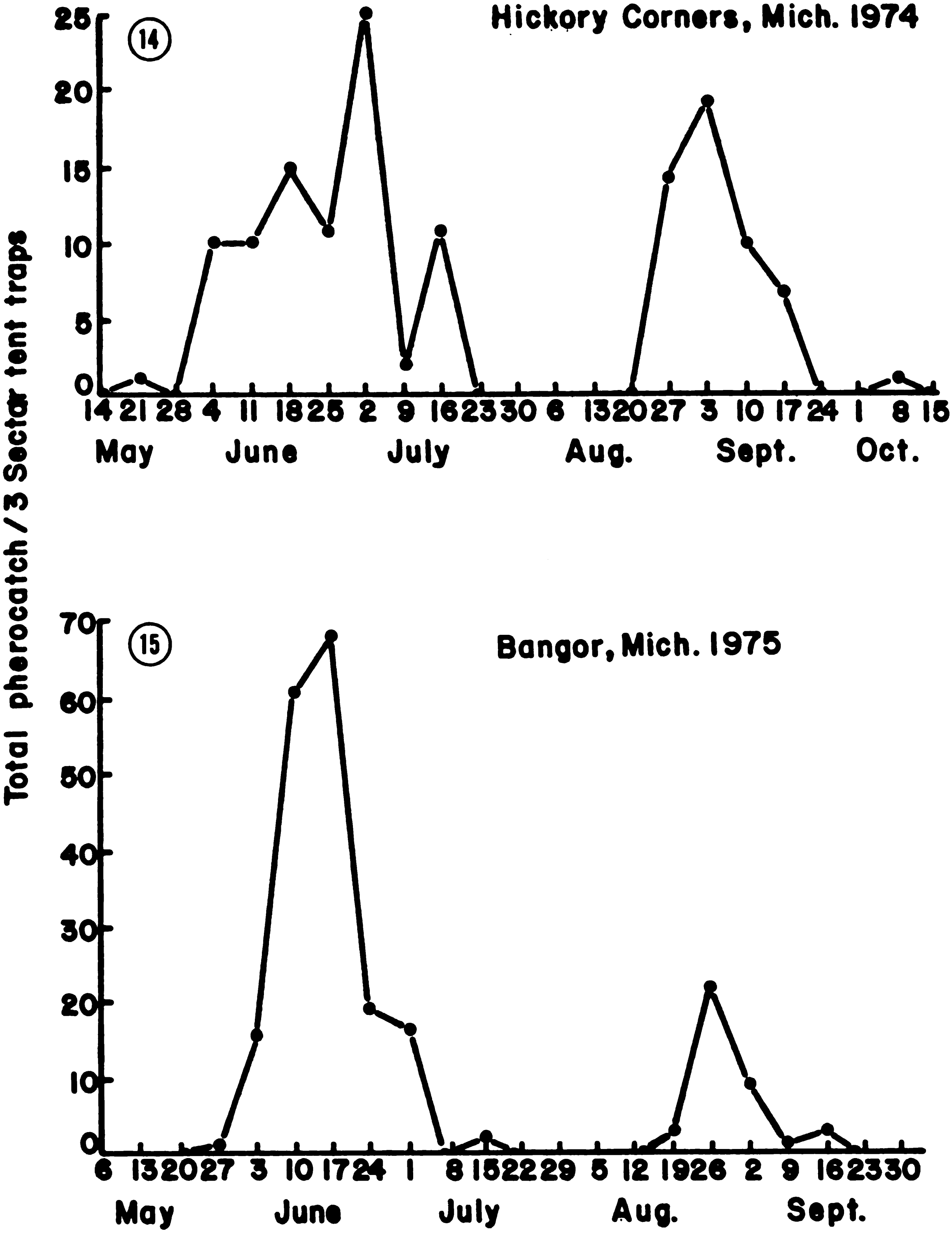
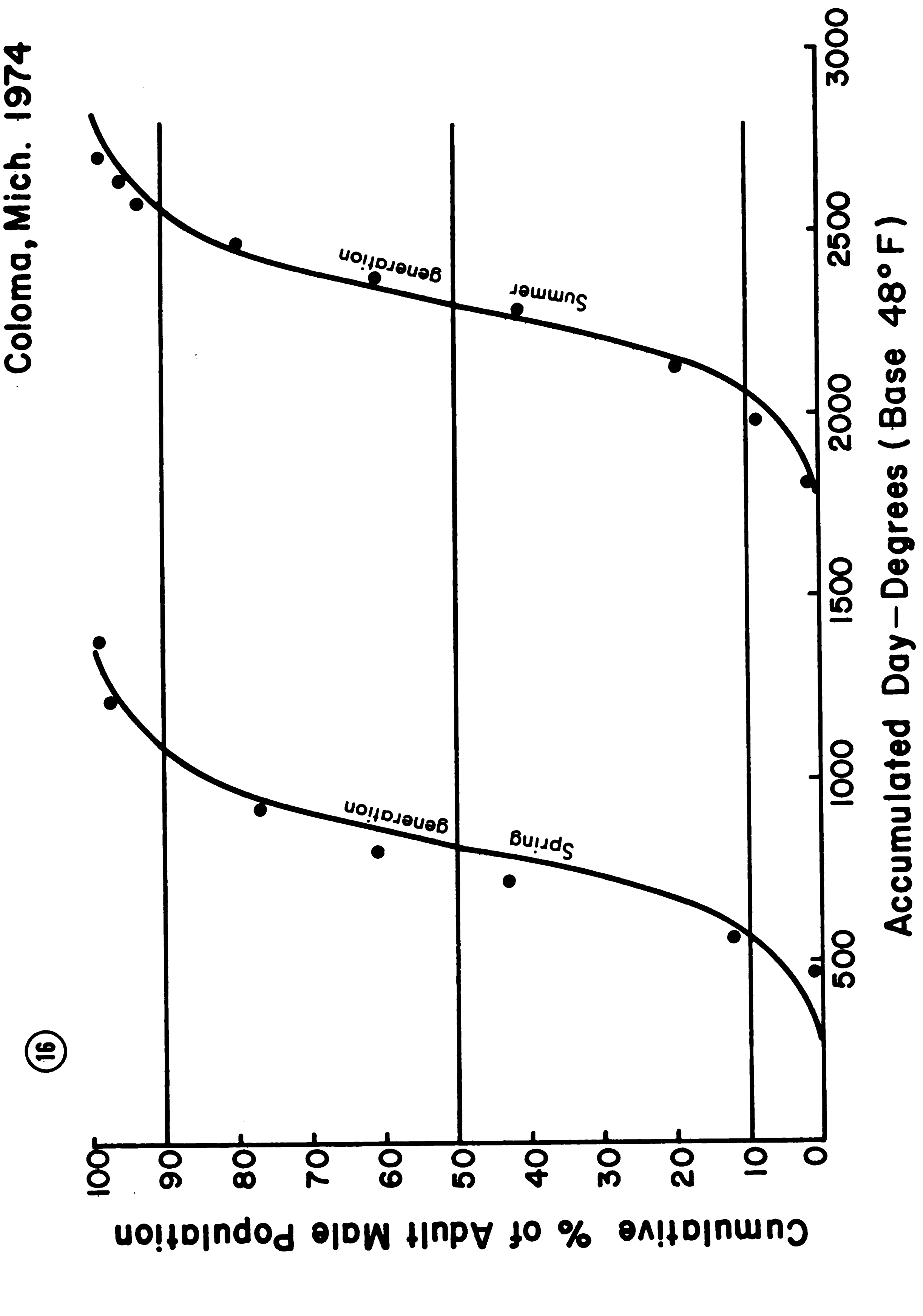

Total pherocatch / 3 Sector tent traps
14
Hickory Corners, Mich. 1974
25
20
15
10
5
0
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15
May
June
July
Aug.
Sept.
Oct.
15
Bangor, Mich. 1975
70
60
50
40
30
20
10
0
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 30
May
June
July
Aug.
Sept.

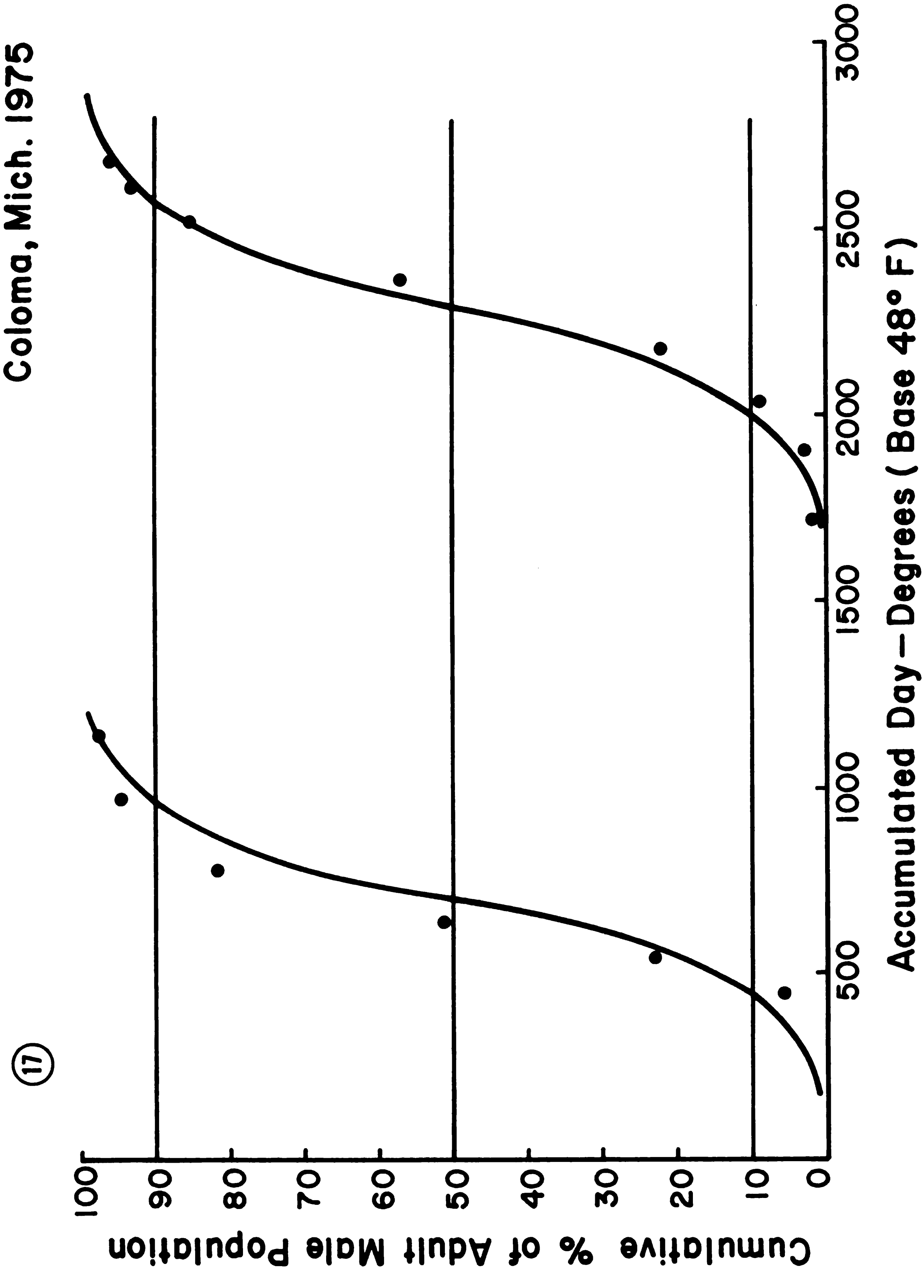
Table 2. - Total adult male pherocatch/3 Sectar tent traps.

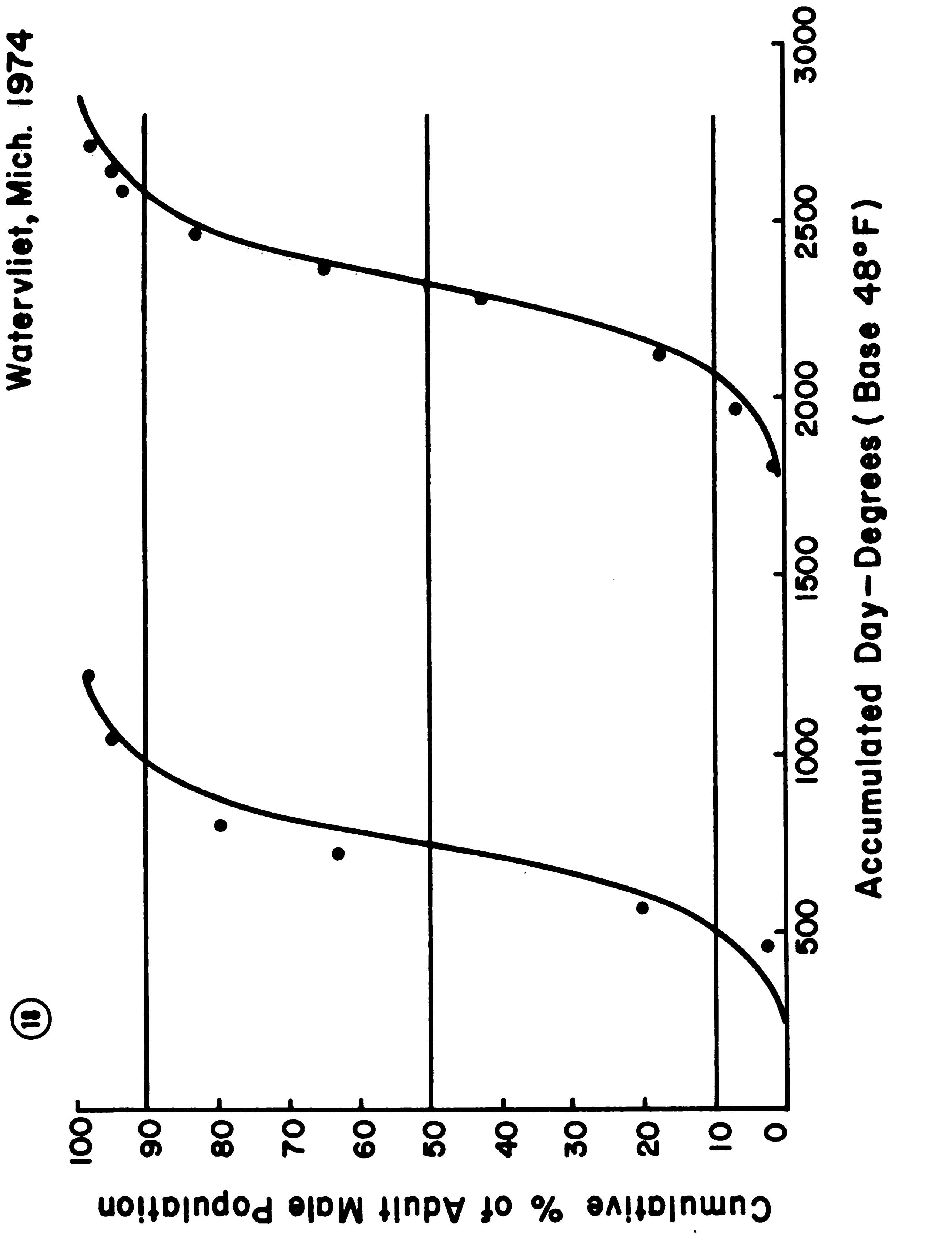
Location	1974	1975	% Reduction in 1975
Coloma, Mich.	918	410	55.3
Watervliet, Mich.	471	294	37.6
Richland, Mich.	205	159	22.4
Kalamazoo, Mich.	122	65	46.7
Fennville, Mich.	68	42	38.2
Douglas, Mich.	95	64	32.6

Figures 16-25. - Seasonal appearance of percentages of the adult male population on day-degrees at 5 southwestern Michigan orchard locations, 1974-1975.

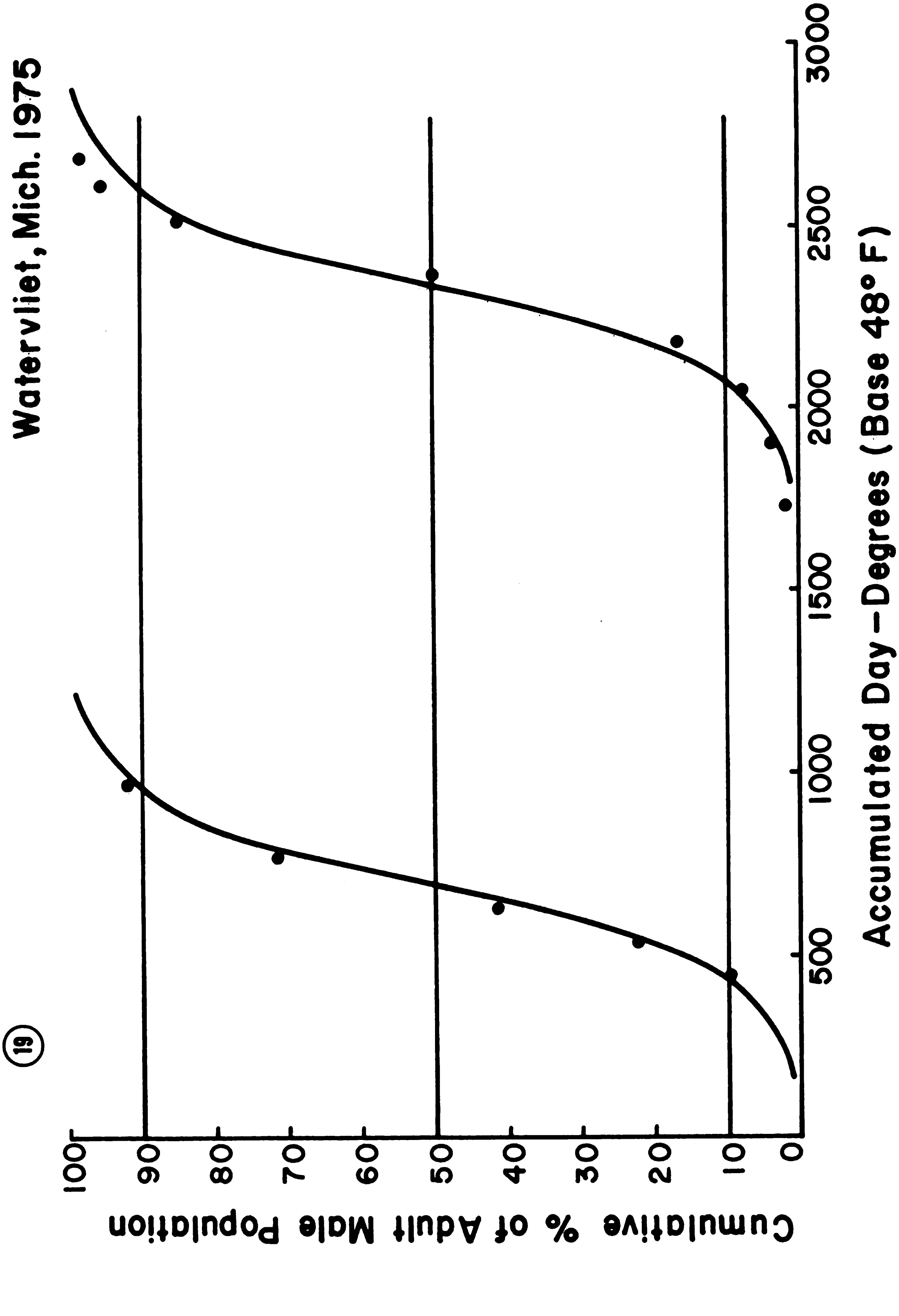


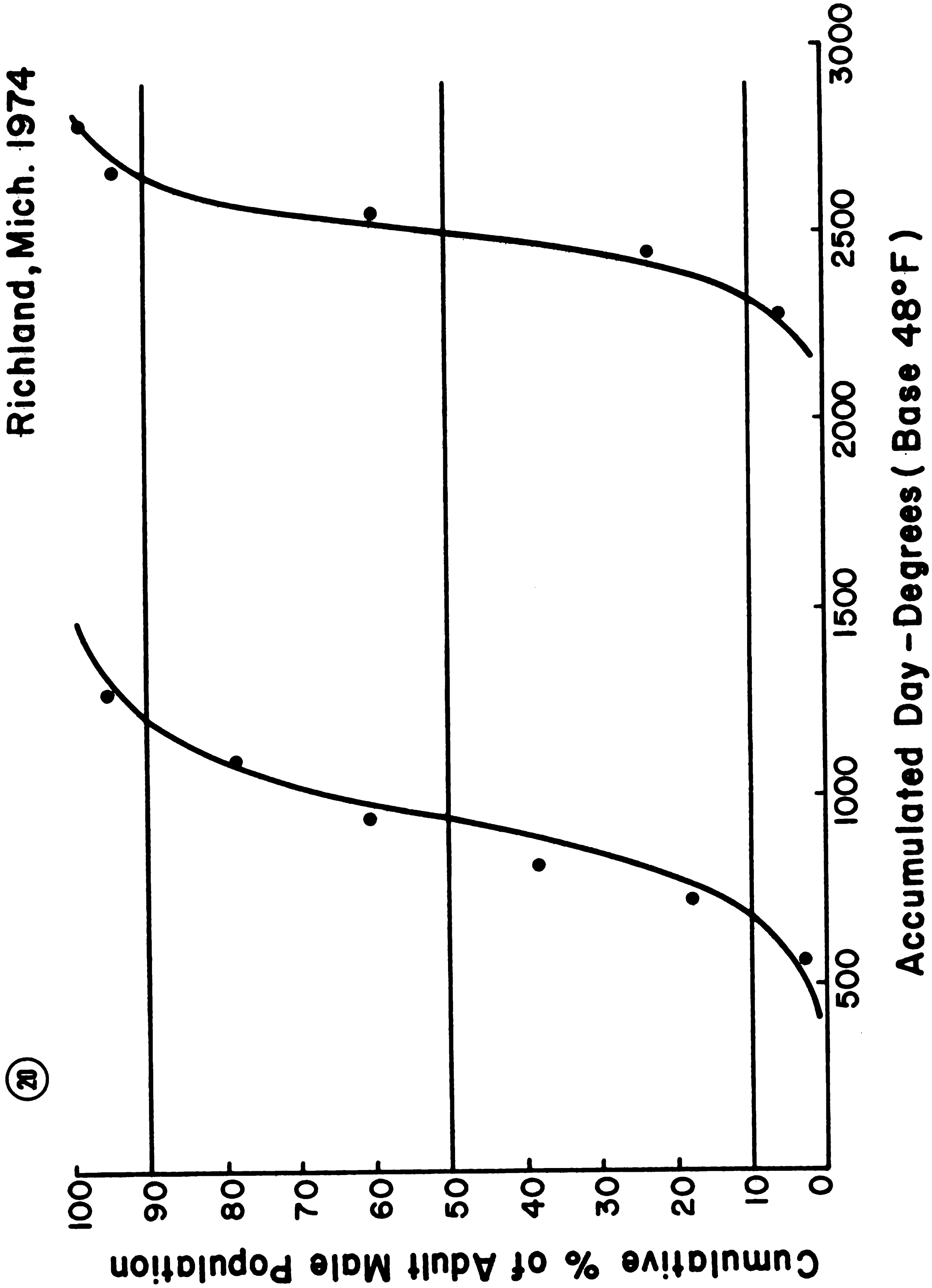
Coloma, Mich. 1974
16
Spring generation
Summer generation
Cumulative % of Adult Male Population
0
10
20
30
40
50
60
70
80
90
100
Accumulated Day-Degrees (Base 48° F)
500
1000
1500
2000
2500
3000

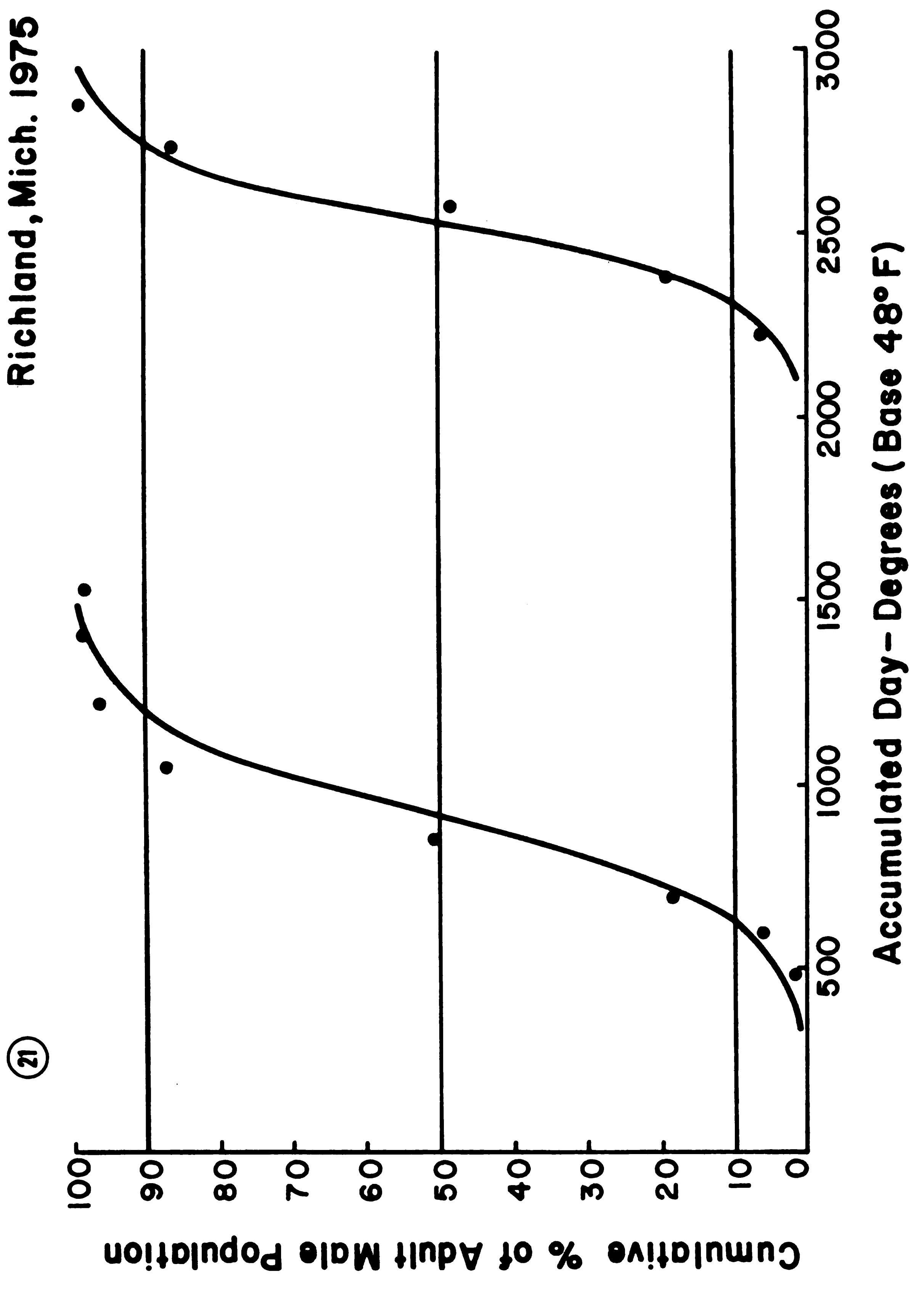

17
Coloma, Mich. 1975
Cumulative % of Adult Male Population
0
10
20
30
40
50
60
70
80
90
100
Accumulated Day—Degrees (Base 48° F)
500
1000
1500
2000
2500
3000



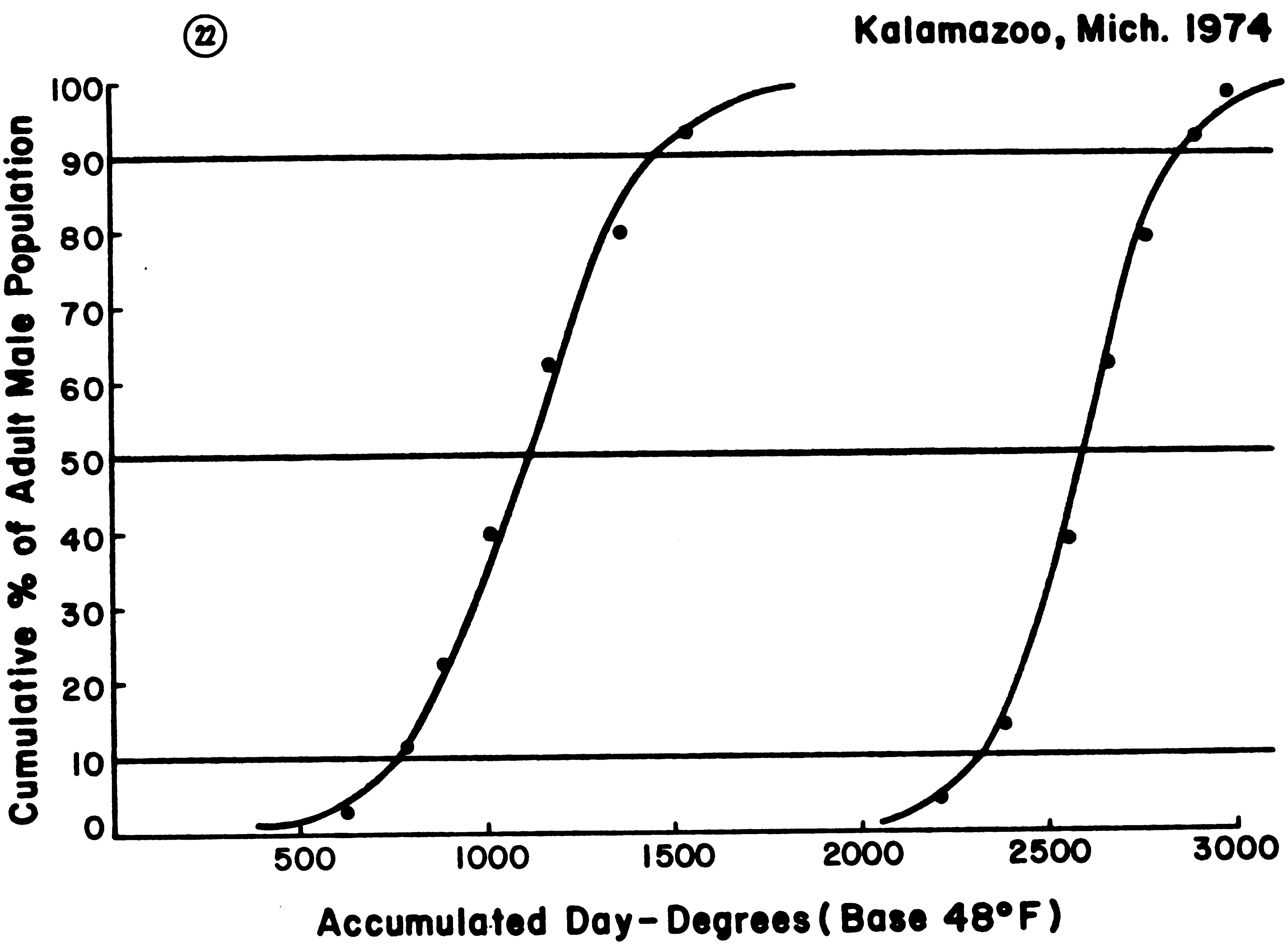
18
Watervliet, Mich. 1974
Cumulative % of Adult Male Population
0
10
20
30
40
50
60
70
80
90
100
500
1000
1500
2000
2500
3000
Accumulated Day-Degrees (Base 48°F)

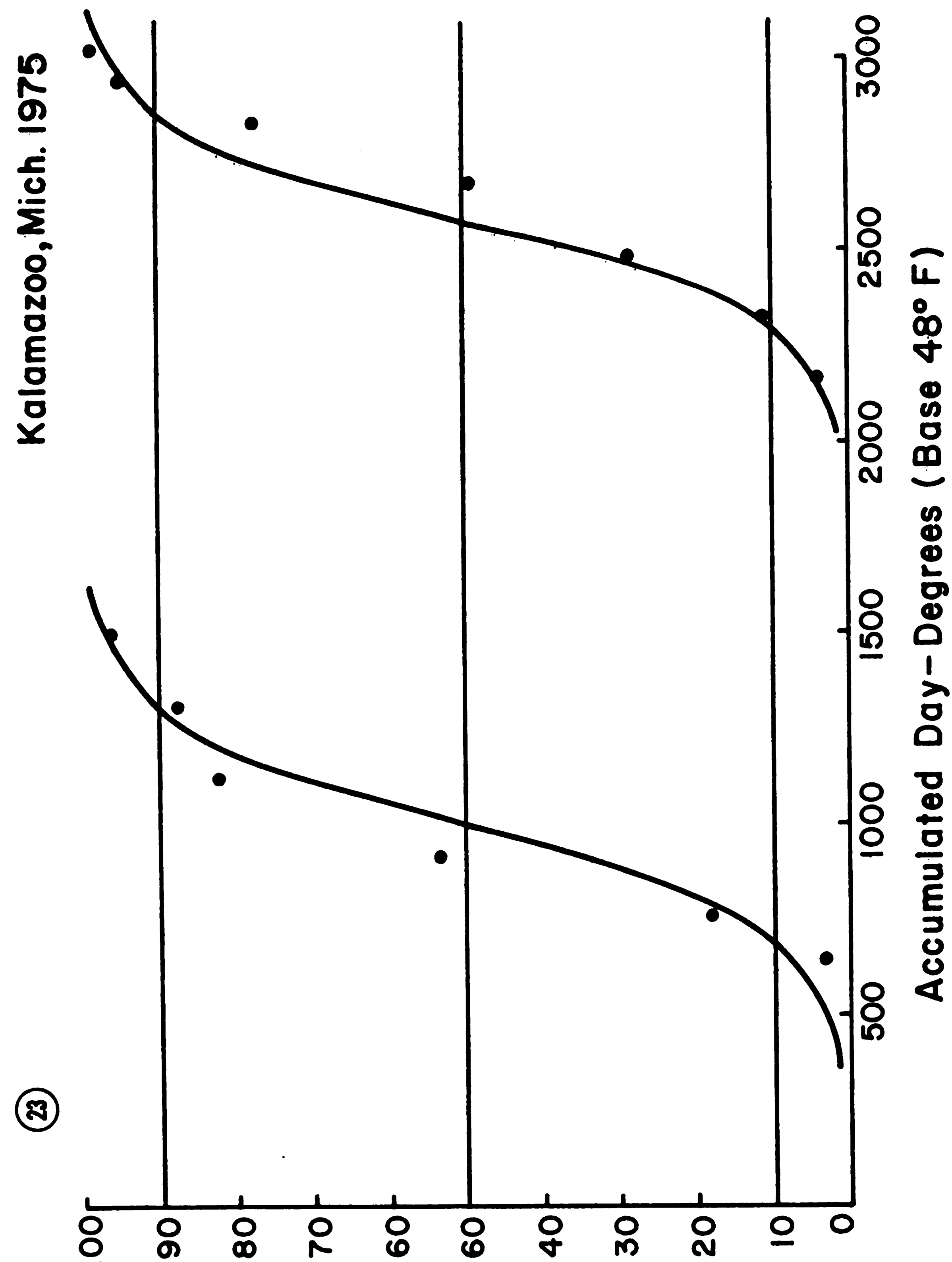

19
Watervliet, Mich. 1975
Cumulative % of Adult Male Population
0
10
20
30
40
50
60
70
80
90
100
500
1000
1500
2000
2500
3000
Accumulated Day-Degrees (Base 48° F)

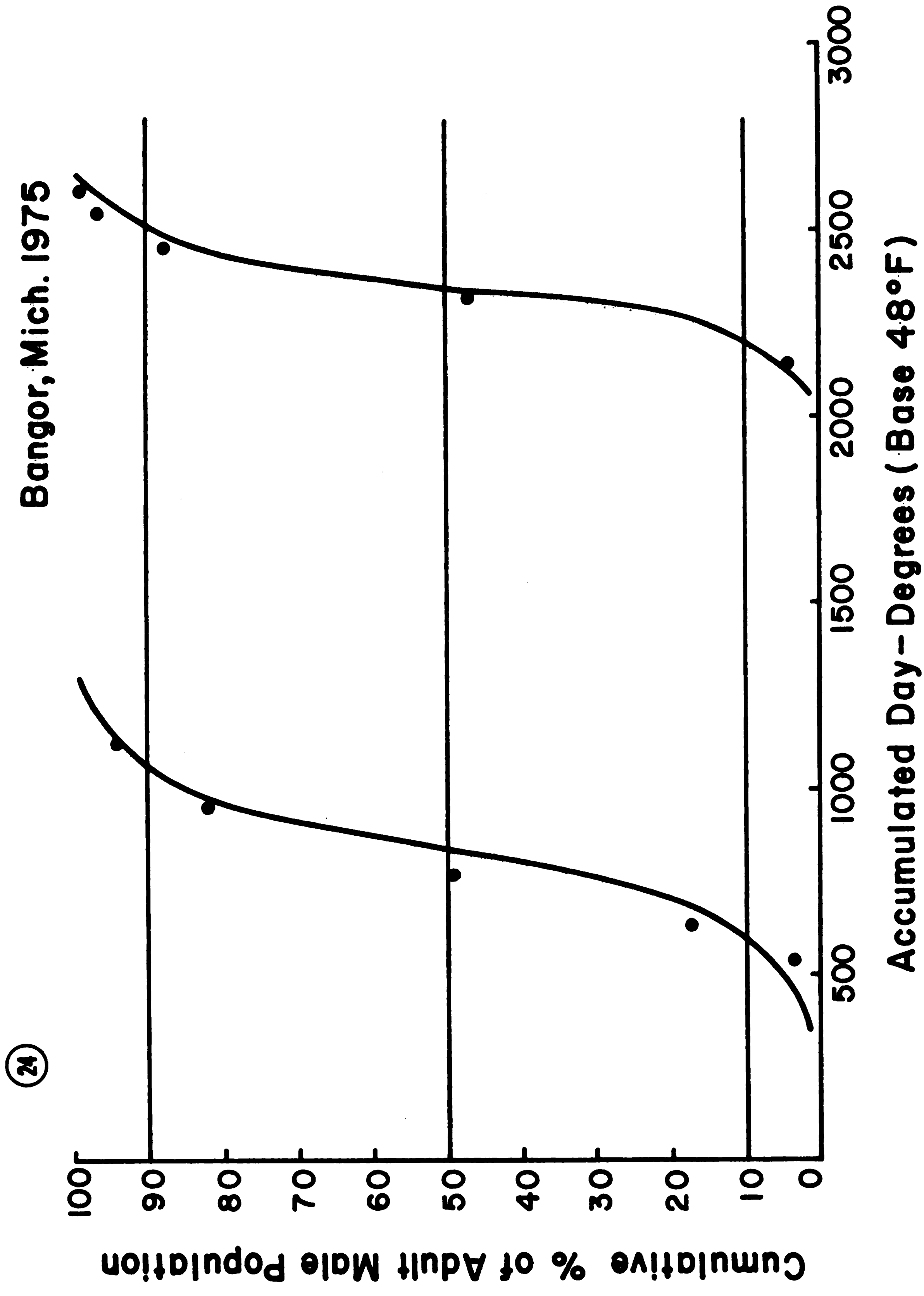

20
Richland, Mich. 1974
Cumulative % of Adult Male Population
0
10
20
30
40
50
60
70
80
90
100
500
1000
1500
2000
2500
3000
Accumulated Day-Degrees (Base 48°F)



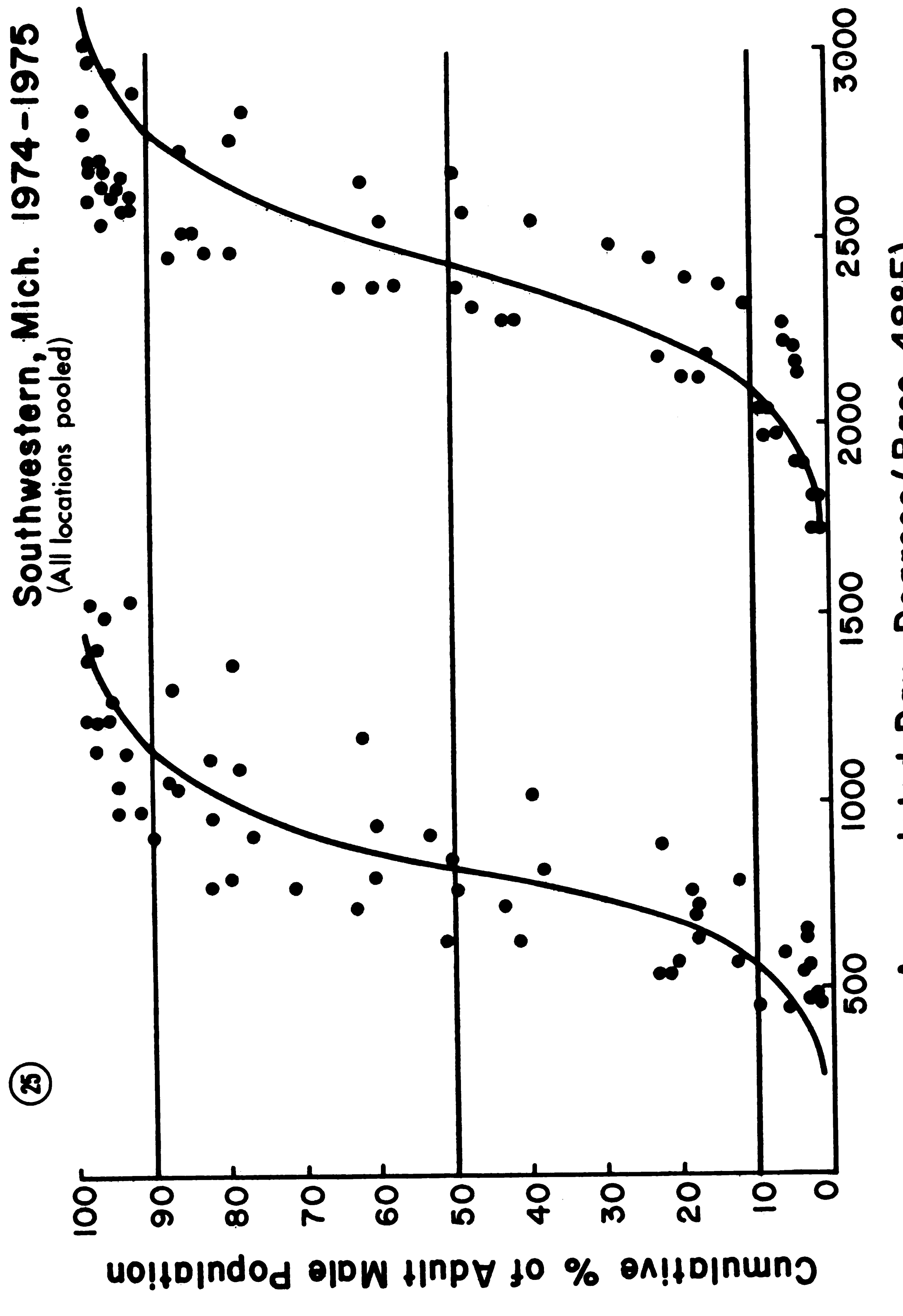
Richland, Mich. 1975
21
Cumulative % of Adult Male Population
100
90
80
70
60
50
40
30
20
10
0
500
1000
1500
2000
2500
3000
Accumulated Day-Degrees (Base 48° F)


22
Kalamazoo, Mich. 1974
Cumulative % of Adult Male Population
100
90
80
70
60
50
40
30
20
10
0
500
1000
1500
2000
2500
3000
Accumulated Day-Degrees (Base 48°F)


23
Kalamazoo, Mich. 1975
Cumulative % of Adult Male Population
100
90
80
70
60
60
40
30
20
10
0
500
1000
1500
2000
2500
3000
Accumulated Day-Degrees (Base 48° F)



24
Bangor, Mich. 1975
Cumulative % of Adult Male Population
0
10
20
30
40
50
60
70
80
90
100
500
1000
1500
2000
2500
3000
Accumulated Day-Degrees (Base 48°F)



25
Southwestern, Mich. 1974-1975
(All locations pooled)
Cumulative % of Adult Male Population
0
10
20
30
40
50
60
70
80
90
100
Accumulated Day-Degrees (Base 48°F)
500
1000
1500
2000
2500
3000

Table 3. - Estimated percentages of the total adult male population at accumulated day-degrees (Base 48°F).

Location	Year	Generation	10%	50%	90%
Berrien Co.					
Coloma, Mich.	1974	Spring	568	818	1068
		Summer	2056	2300	2544
	1975	Spring	441	685	928
		Summer	2009	2280	2551
Watervliet, Mich.	1974	Spring	505	731	957
		Summer	2061	2311	2561
	1975	Spring	437	687	937
		Summer	2076	2332	2589
Van Buren Co.					
Bangor, Mich.	1975	Spring	598	819	1040
		Summer	2206	2346	2485
Kalamazoo Co.					
Kalamazoo, Mich.	1974	Spring	761	1100	1439
		Summer	2322	2578	2835
	1975	Spring	691	988	1284
		Summer	2303	2567	2831
Richland, Mich.	1974	Spring	676	926	1176
		Summer	2332	2485	2639
	1975	Spring	634	906	1177
		Summer	2323	2521	2719
Southwestern, Mich.	1974-1975	Spring	574	853	1132
(All locations pooled)		Summer	2093	2421	2748

of corresponding percentages of the adult male population occurred earliest in Berrien Co., with more day-degrees being accumulated as one proceeds farther inland (Van Buren and Kalamazoo Cos.) from the lakeshore. A difference is also noted between 1974 and 1975 with respect to the day-degrees accumulated at respective population percentages. In almost all instances, the appearance of 10, 50 and 90% of the population occurred at earlier day-degree accumulations in 1975 than in 1974.

Differences encountered between orchard locations and years with respect to day-degrees accumulated at given population percentages cannot be fully explained. Only 1 environmental parameter, air temperature, is utilized as a predictive tool. Other parameters such as soil temperature and rainfall can be very influential factors as regulators of insect development. For example, Miller*, working with Diaparsis sp., has found that the appearance of given population percentages occurs at greater day-degree accumulations when rainfall increases. This ichneumonid parasitoid overwinters in the soil as a prepupa within the cereal leaf beetle cocoon.

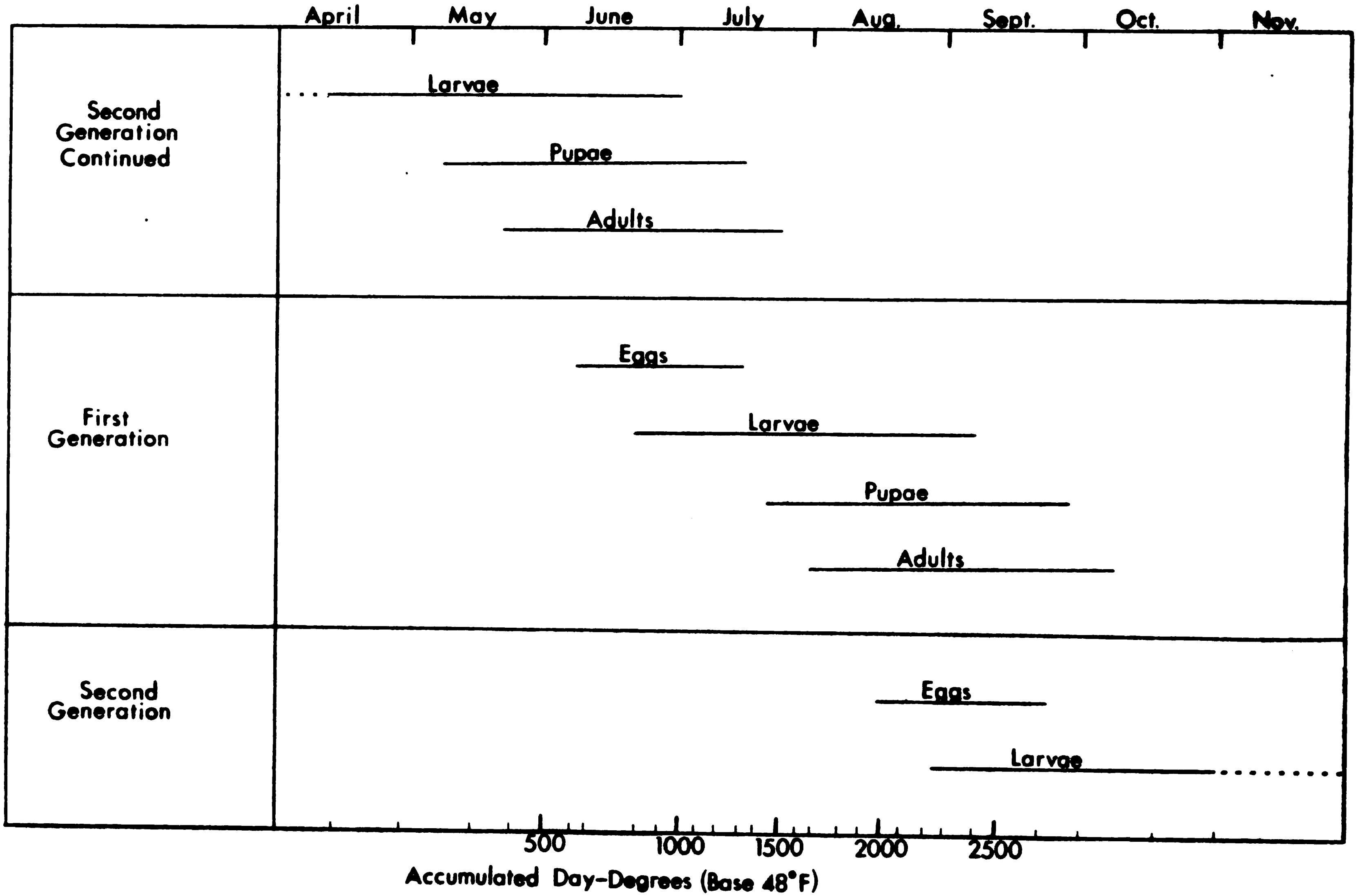
C. Seasonal Development.

Figure 26 shows the seasonal development of the life

---

* Mr. Dave Miller is a graduate student in the Department of Entomology, Michigan State University.

Figure 26. - Seasonal Development of *P. idaeusalis*, Coloma, Mich., 1974.



stages of P. idaeusalis at Coloma, Mich. during 1974. The monthly (upper horizontal axis) occurrence of life stages is plotted, with the corresponding monthly day-degree accumulations appearing on the lower horizontal axis.

Egg masses were found to be deposited on the upper surface of leaves on scaffold limbs near the trunk of the tree. Overwintering larvae were found maturing on ground apple sucker growth early in the spring. Newly hatched larvae disperse and web themselves in with an abundance of silken threads on the undersurface of the leaf. This silken chamber is usually situated along the midrib or other large vein. Larvae were also found webbed between 2 leaves. Later instar larvae were found webbed within a lengthwise fold of a hanging leaf which had been clipped at the petiole. Fruit feeding was quite minimal and consisted of shallow, surface feeding beneath a leaf which had been webbed to the side of the apple. Adults of both sexes were observed during the day resting on the tree trunks near the ground.

D. Alternate Hosts.

Pheromone trapping revealed the presence of the adult male in all areas sampled. However, this does not imply that the particular fruit investigated is utilized as a host but merely that the insect is present in the vicinity or possibly on ground vegetation within the crop investigated. Eggs were found deposited on the upper leaf surface, trunk, and scaffold limbs of the sweet cherry varieties studied near Coloma, Mich. Larval feeding was observed on the foliage of sweet cherry in the tree, as well as on dead and withered leaves on the ground beneath the trees. However, no feeding was observed on tart cherry or on blueberry. A closely related insect, the variegated leafroller, Platynota flavedana Clemens, was discovered feeding on the foliage of Midway strawberries, and on both the foliage and fruit of Redhaven peaches near Coloma, Mich.

E. Adult Male Flight Activity.

Table 4 shows the hourly moth catch along with the hourly temperature and relative humidity. The temperature was not recorded on August 25-26 due to a malfunctioning of the temperature recording needle on the hygrothermograph. Male moths were found to be active throughout the night from 9 p.m. - 7 a.m., E.D.T. the next morning. The peak flight activity occurred between 12 p.m. - 4 a.m. (Figure 27) with 63.5% of the total catch occurring during this time interval. Relatively little activity was observed during the early morning hours of August 19 and 27. In both cases the temperature ranged from 60-62°F. It appears that 62°F may be an activity threshold for the male moth as no other climatic conditions which might explain this inactivity could be found.

F. Natural Enemies.

A total of only 4 parasitized larvae were discovered

Table 4. - Hourly timing trap pherocatch, temperature and relative humidity.

	Time (EDT)											
	p. m.					a. m.						
Date	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7
August 1975												
18-19	0[a]	0	11	23	3	4	0	0	5	1	0	0
	75[b]	71	68	66	63	61	61	60	60	61	61	62
	67[c]	73	75	84	93	97	98	99	100	100	99	98
19-20	0	0	4	10	10	15	11	14	5	4	2	0
	79	74	71	69	67	65	64	63	63	63	63	62
	64	78	85	88	92	93	95	96	96	96	96	97
20-21	0	0	6	16	11	21	22	27	12	23	11	0
	73	73	72	71	71	71	71	70	71	71	72	73
	95	94	95	96	96	95	93	92	94	97	98	98
21-22	0	0	0	1	2	24	22	57	31	5	0	2
	87	82	76	73	71	72	72	71	70	70	71	71
	69	85	95	93	92	97	97	97	98	99	99	100
22-23	0	0	0	5	12	11	26	28	14	2	1	2
	77	74	73	71	71	72	72	73	73	72	72	73
	85	89	90	93	96	97	97	98	96	96	97	98
23-24	0	0	4	6	16	24	46	45	25	9	11	4
	85	83	82	81	80	80	79	79	78	77	77	76
	70	76	77	77	78	78	78	79	87	93	92	92
24-25	0	0	4	8	23	34	36	18	36	18	14	0
	86	84	81	80	80	79	79	78	77	76	76	75
	65	71	77	81	81	79	78	80	82	84	85	90
25-26	0	0	10	11	14	27	26	40	24	22	14	1
	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	74	84	89	91	93	95	97	98	99	99	97	96
26-27	0	0	13	57	47	36	20	3	6	0	0	0
	76	69	67	66	64	63	62	62	62	61	61	61
	64	81	75	77	90	89	91	96	97	97	98	98
27-28	0	0	0	0	9	11	3	7	20	9	3	0
	78	74	70	67	66	65	65	64	64	65	65	66
	66	78	87	92	94	95	96	97	97	97	93	90
28-29	0	0	4	1	5	13	3	15	29	7	3	0
	82	79	78	77	73	71	72	71	70	70	71	71
	72	79	80	82	93	97	99	100	100	100	100	100

a trap catch
b temperature (°F)
c % relative humidity
NR not recorded

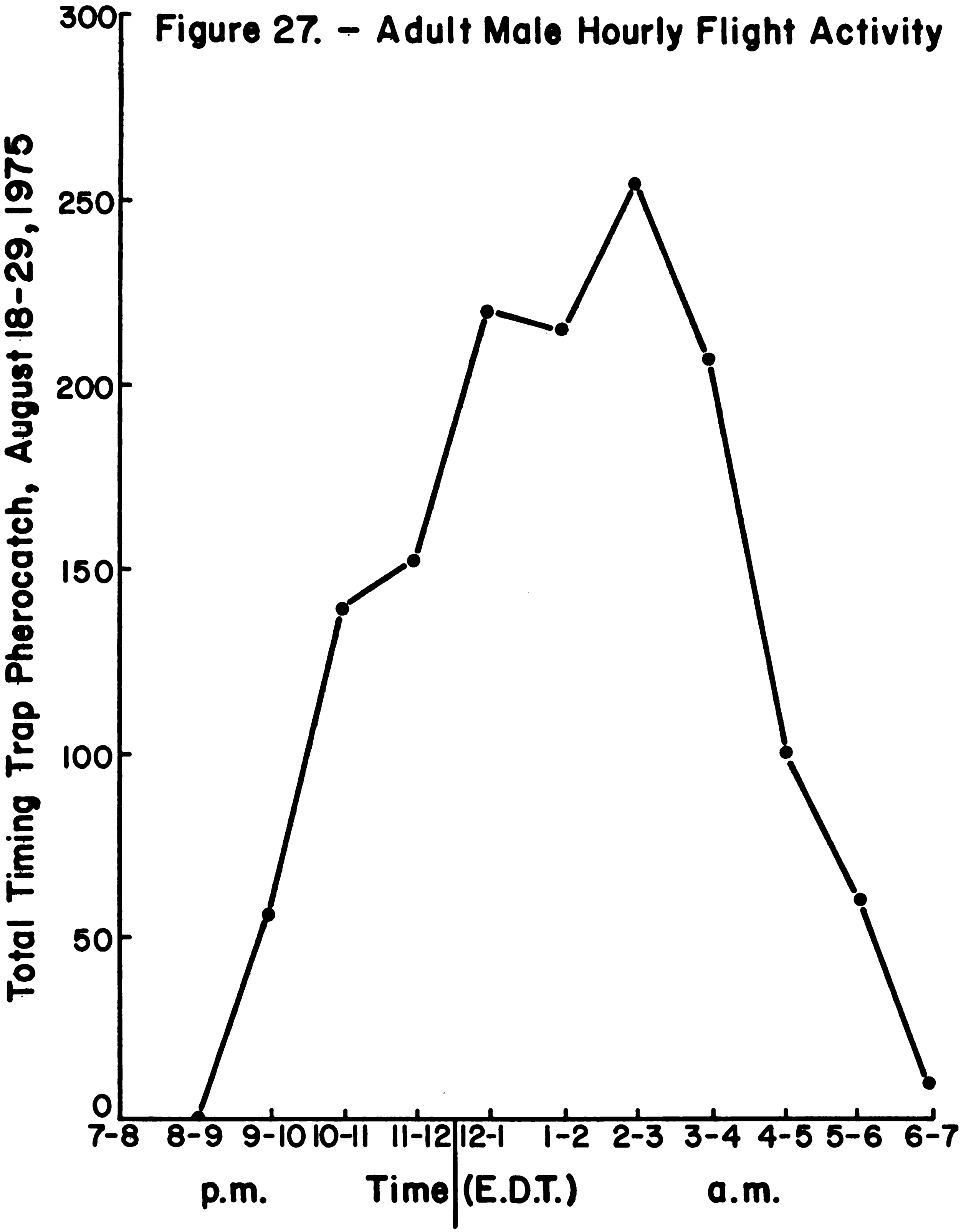


Figure 27. – Adult Male Hourly Flight Activity
Total Timing Trap Pherocatch, August 18-29, 1975
300
250
200
150
100
50
0
7-8
8-9
9-10
10-11
11-12
12-1
1-2
2-3
3-4
4-5
5-6
6-7
p.m.
Time (E.D.T.)
a.m.

during the course of this 2-year study. Two were found on apple and the other 2 were discovered feeding on the foliage of sweet cherry. The larval parasitoid was a braconid, Microgaster pantographae Muesebeck (Figure 39). It pupated as the larval host reached maturity. Both the braconid cocoon and the remaining larval head capsule were discovered in a folded leaf. It doesn't appear that the braconid parasitoid exerts much of a regulatory effect on P. idaeusalis populations.

G. Larval Key.

The last larval stage of P. idaeusalis is distinguished from the other 7 Michigan apple feeding tortricids in the key on page 45. This differentiation is based on the fact that P. idaeusalis is an external fruit feeder and leaf-fruit webber, brown bodied, and has a 6-9 pronged anal comb. Some color variation may be encountered. For example, larvae which are feeding on succulent green growth rather than dried foliage may appear olive in color.

LAST INSTAR LARVAL KEY TO LIVING MICHIGAN APPLE-FEEDING TORTRICIDS

1. Body white to pink; internal fruit feeder - - - - - - - - 2

1a. Body not as above; external fruit feeder or leaf-fruit webber- 3

2. Anal comb lacking - - - - - - - - - - - - - - -Codling Moth
Laspeyresia pomonella

2a. Anal comb present - - - - - - - - - - - - - -Lesser Appleworm
Grapholitha prunivora

3. Body green to yellow- 4

3a. Body brown, rarely olive- - - - - - - - - - - - - - - - - - 6

4. Head capsule green- - - - - - - - - - Red-banded Leafroller
Argyrotaenia velutinana

4a. Head capsule brown or black - - - - - - - - - - - - - - - - 5

5. *Female head width 1.16-1.48 mm (mean 1.33 mm); length 15-21 mm (mean 17.8 mm). Male head width 1.04-1.32 mm (mean 1.19 mm); length 13-18 mm (mean 15.3 mm)
Variegated leafroller
Platynota flavedana

5a. *Female head width 1.70-1.87 mm (mean 1.78 mm); length 15-24 mm (mean 20.0 mm). Male head width 1.48-1.60 mm (mean 1.59 mm); length 16-21 mm (mean 18.3 mm) (See 5b)
Fruit-tree Leafroller
Archips argyrospilus

5b. *Female head width 1.79-2.04 mm (mean 1.94 mm); length 20-30 mm (mean 24.0 mm). Male head width 1.54-1.87 mm (mean 1.70 mm); length 16-23 mm (mean 20.0 mm)
Oblique-banded Leafroller
Choristoneura rosaceana

6. Anal comb 2-5 pronged - - - - - - - - -Eye-spotted Bud Moth
Spilonota ocellana

6a. Anal comb 6-9 pronged (Figure 31) - Tufted Apple Bud Moth
Platynota ideausalis

---

*Males distinguished from females by the presence of a pair of internal oval organs (pregonads) located dorsally in the fifth abdominal segment (Chapman and Lienk, 1971).

Conclusions and Recommendations

Pheromone trapping during 1974-1975 revealed the presence of significant populations of *P. idaeusalis* throughout southwestern Michigan, especially in Berrien Co. However, damage in Michigan apple orchards caused by this insect was quite minimal during the 2 years of this study. Thus, it does not appear that *P. idaeusalis* is an important pest at the present time in Michigan.

Since this insect feeds and matures on a wide range of hosts, high pheromone trap counts in an orchard cannot necessarily be correlated with damage levels. The pheromone may attract the insect from ground vegetation within the orchard or possibly from hosts outside the orchard, as is the case with red-banded leafroller. As a result, the decision of whether to direct control measures specifically at this insect, should be made based on damage levels observed in the fall rather than on moth presence determined through pheromone trapping. If damage is observed in the fall, the following steps should be taken the next spring. Pheromone trapping should begin early in May to determine moth presence in an orchard vicinity. If present, a search should be made for egg masses and larval injury throughout the season. Since many members of the leafroller complex inflict similar injury on apple, positive identification of *P. idaeusalis* injury based on damaged fruit alone is extremely difficult.

If mature larvae are found, one can utilize the key provided and identify the tortricid pest species. If the pest is identified as P. idaeusalis, and if damage levels warrant control, insecticides should be used. The application of a broad spectrum organophosphate during oviposition and hatch should provide control. It is imperative to apply insecticides before larvae web themselves within a folded leaf which makes them impervious to chemical control measures.

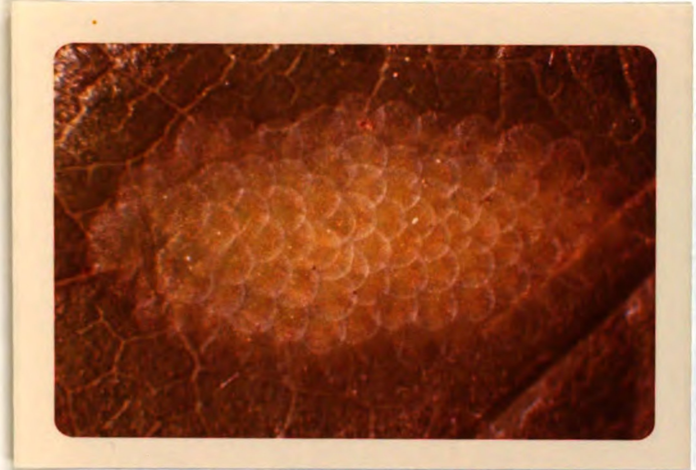


Figure 28. - Egg mass on upper surface of apple leaf.

Figure 29. - Mature larva webbed in folded apple leaf.

Figure 30. - Mature larva. Note longitudinal stripes.

Figure 31. - Last abdominal segment of mature larva showing 6-9 pronged anal comb. Note 6th prong behind 5th (arrow).

Figure 32. - Pupa in folded apple leaf.

Figure 33. - Adult female.

Figure 34. - Foliar damage on apple seedling. Note folded leaves clipped at petiole.

Figure 35. - Clipped leaf webbed to side of apple.

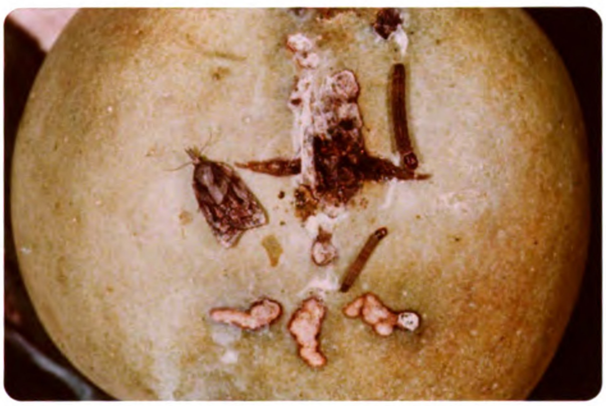


Figure 36. - Shallow, irregular surface feeding on apple.

Figure 37. - 3M Sectar tent trap containing adult male moths.

Figure 38. - Timing trap.

Figure 39. - Braconid parasitoid.

LITERATURE CITED

Anonymous. 1959. Maps. Coop. Econ. Insect Rep. 9:35-6.

Bode, William M. 1975. The Tufted Apple Budmoth in Pennsylvania, 1974. The Pennsylvania Fruit News. 54:57-8.

Chapman, P. J. and S. E. Lienk. 1971. Tortricid Fauna of Apple in New York. Cornell University. New York. 122 pp.

Clemens, Brackenridge. 1860. Contributions to American Lepidopterology.-No. 6. Proceedings of The Philadelphia Academy of Natural Sciences. 12:348.

Fernald, C. H. 1882. A Synonymical Catalogue of the described Tortricidae of North America north of Mexico. Trans. Am. Ent. Soc. 10:23.

Forbes, W. T. M. 1923. The Lepidoptera of New York and neighboring states. (Part 1). Cornell Univ. Agr. Exp. Sta. Memoir 68. 729 pp.

Frost, S. W. 1919. The Function of the Anal Comb of Certain Lepidopterous Larvae. J. Econ. Entomol. 12:446-7.

Frost, S. W. 1921a. Lepidoptera Injurious to the Apple in Pennsylvania. Pa. Agric. Exp. Sta. Bull. No. 169. 16 pp.

Frost, S. W. 1921b. Late Feeding Larvae Injurious to Apple in Pennsylvania Including Several New Injurious Species. J. Econ. Entomol. 14:324-8.

Frost, S. W. 1923. A New Apple Bud-Moth in Pennsylvania. J. Econ. Entomol. 16:304-7.

Frost, S. W. 1942. Common Insect Larvae that Attack the Apple in Pennsylvania. Pa. Agric. Exp. Sta. Bull. No. 420. 30 pp.

Frost, S. W. 1951. Insects That Attack the Apple in Pennsylvania. Pa. Agric. Exp. Sta. Bull. No. 535. 30 pp.

Gage, S. H. and D. L. Haynes. 1974. Degree-day tables for several developmental thresholds. East Lansing, Michigan; Michigan State University (Mimeographed).

MacKay, M. R. 1962. Larvae of the North American Tortricinae (Lepidoptera: Tortricidae). Canadian Entomol. Suppl. 28. 182 pp.

Prentice, R. M. 1965. Forest Lepidoptera of Canada Recorded by the Forest Insect Survey. Microlepidoptera. Canada Dept. Forestry Publ. 1142. 4:545-834.

Robinson, Coleman T. 1869. Notes on American Tortricidae. Trans. Am. Ent. Soc. 2:277-8.

Roelofs, W. L. and A. Comeau. 1971. Sex Attractants in Lepidoptera, p. 91-112. In A. S. Tahori (ed.), Proc. 2nd Int. IUPAC Cong. of Pesticide Chemistry, Tel-Aviv, Vol. 3. Gordon and Breach Scientific Publishers, New York. 227 pp.

Ruppel, Robert F. 1974. Notes on Plotting Seasonal Appearance of Insects (Mimeographed Handout).