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A study was conducted on *Ischnura posita* to gain information on aspects of its seasonal cycle and what types of regulation are imposed upon it in achieving metamorphosis and emergence.

Information was obtained through a program of larval population sampling and field observations throughout one year. It was found that *I. posita* was a univoltine, and possibly bivoltine summer species. Emergence was initiated in early spring, and adults were flying from early spring to late autumn. Emergence extended over most of the flying period. There was evidence of a second generation in the same year (bivoltine). The overwintering population appeared in a number of different sizes, and there was no indication of a diapause.

Temporal variation may have been reduced to some extent in this species, as evidenced by an accumulation of final instar larvae in the winter and early spring just before the initial emergence.

Males and females were found in approximately equal numbers. Courtship was observed prior to mating in several instances. Oviposition occurred over the water as the females perched on a stem or flower of an emergent plant.

A LIFE-HISTORY STUDY OF ISCHNURA POSITA (HAGEN) IN RELATION TO SEASONAL REGULATION (ODONATA: COENAGRIONIDAE)

by

Odessa Robinson Patrick

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Approved by

Paul E. Lutz
Thesis Adviser

This thesis has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro.

Thesis Adviser: Paul E. Lutz

Oral Examination Committee Members:
Henry L Anderson
Hollis J. Rogers
Edward McCrady III

January 14, 1969
Date of Examination

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INTRODUCTION

The Odonata are familiar animals around marshes, ponds, and lakes during the spring and summer since the adult stage is spent in flight. However, little is known about their biology, especially that of the larvae. The scarcity of data on life histories, and information about the group in general, points up the importance of such findings in order to provide a fuller understanding of this taxanomic group.

Recent studies have been directed toward the problem of seasonal regulation in the odonates. Corbet (1956; 1957; 1963) in studies on larval populations of several species has provided most of the information available on seasonal regulation. A study was made by Kormondy (1959) on several species of _Tetragoneuria_ in Michigan in which life histories of larval populations were described by a regular program of population sampling. Only a few such studies have been made on life histories of odonates employing this method of sampling of populations in nature. A similar study was conducted by Lutz and Jenner (1964) in North Carolina on _Tetragoneuria cynosura_. While most of the population in the study by Lutz was univoltine in their life history, some individuals were found to be semivoltine. Seasonal regulation was studied in Pachydiplax longipennis in North Carolina by Eller (1963). He found a semivoltine as well as a univoltine cycle displayed. This is indicative of variations in life histories which may be found within a population of odonates. Kormondy and Gower (1965) reported that among 17 species of Odonata, annual variations in development and emergence existed in each species over a two-year period.

Lutz (1968a) conducted a study on the life history of Lestes eurinus, a univoltine summer species in which he utilized the sampling method. He found a synchronized emergence pattern in this species, which was made more uniform by its response to changes in environmental temperature. The variability in life histories was found to be more prevalent among the species in the above studies. These findings are indicative of the plasticity of response to different environmental conditions which is characteristic of the odonates.

Nothing has been reported about the life history of Ischnura posita in nature. Since a large population was present and conveniently located, I began to sample in a regular, systematic way the population in nature. Such a program provided a knowledge of the life history of this species in this area. Observations were made on other facets of the life history in order to gain information about its emergence, flight and reproductive behavior.

MATERIALS AND METHODS

The study area for the investigation was an impoundment located 4.19 km east of the geographical center of Greensboro, N. C. The impoundment was constructed in 1950 on the North Carolina Agricultural and Technical University experimental farm and was located about 50 m north of Road No. 3000. It had a surface area of approximately 0.86 hectares and a shape approximating an elongated triangle. The pond was situated in a pasture used solely for grazing sheep. Due to a high degree of organic runoff into the pond, there developed a high rate of biological productivity which accounted for the dense vegetation in and around the water.

The submerged vegetation consisted chiefly of the algae Cladophora and Spirogyra, and Anacharis (Elodea). The Anacharis was present in an extensive peripheral zone occupying about 75% of the lake area, and extended from the shoreline to a point where the depth of the water was about 1.5 m. There was a blanket of floating algae composed of the species mentioned above which were in various stages of decomposition at the surface. This blanket covered much of the surface of the pond from the shore to the lakeward margin of growth of the submerged vegetation. Numerous air pockets could be seen over the surface. They had been formed by gases being evolved due to photosynthetic, decomposition and respiratory activity below. The gases were trapped under the algal mat.

Emergent vegetation, including _Typha_, _Potamogeton_, and _Sagittaria_, was present in clumps around the pond. The shoreline was covered with various rushes, sedges, and grasses.

There was an abundance of small animal life in the pond which served as food for odonate larvae. Among the more numerous were small crustaceans, oligochaete worms, and immature stages of a variety of insects in a number of orders. Some other odonates present in large numbers were _Pachydiplax longipennis_, _Erythemis simplicollis_, _Enallagma geminatum_, _Enallagma basidens_, and _Libellula luctosa_.

Twenty-five collections of _Ischnura posita_ were made from June 19, 1967 to July 20, 1968. A Cable-Turtox scoop was used; it was made of 3/8" wire mesh, and had a 1/8" wire mesh lining. Numbers of animals in each collection ranged from 37 to 89. Larvae were found to be most abundant among the submerged vegetation at depths of 0.3 to 1.3 meters.

The larvae were taken from among the vegetation in the scoop and placed into 8 oz collecting jars. In the collections made from April, 1968 until the end of the study, masses of vegetation were scooped up and dumped into white plastic pans in order to facilitate the visual sighting of the smaller animals.

Animals comprising each collection were brought into the laboratory, and measurements of certain characteristics were made within two days after the collection date. Observations were made with a binocular microscope containing a Whipple disc as an ocular micrometer. The micrometer was calibrated against a Bogusch measuring slide which had a scale of 4 cm^2. Each cm^2 was subdivided in millimeter squares. The metric values of the micrometer units were determined for the magnifications of 7X and 15X by converting the micrometer units to millimeters. Measurements were made of:

Total length: From the anterior tip of the rostrum to the posterior tip of the tenth abdominal segment (to 0.1 mm). This excluded abdominal appendages and gills.

Head width: Maximum width at eye level (to 0.1 mm).

Absolute wing-pad length: From the point of lateral origin of the metathoracic wing pads at the juncture of the meso- and metathoracic segments to their posterior tips (to 0.1 mm).

Relative wing-pad length: Extensions of metathoracic wing-pads in relation to the abdominal segments (to 0.1 abdominal segment).

Collections were made weekly from June 19 through September 6, 1967. These larvae were measured for the characters above and then returned to the pond, except for some which were retained in the laboratory and allowed to mature. This was done to verify the larval stages and the appearance of the adult. Larvae in the later instars were brought to the laboratory, measured, and maintained until emergence. They were checked daily for molts and measured after each molt in order to determine the size of the final instar.

Subsequent collections were made at intervals of approximately 3 to 4 weeks from September 16, 1967 to March 10, 1968. Collections from March 26 to June 21, 1968 were made approximately every 10 days. The final collection was made on July 20, 1968.

During the spring and summer of 1968, extensive observations were made on adult behavior of *I. posita*. The pond was visited several times weekly beginning the first week in April. Visits were made at different times of the day in an attempt to determine the time of activity during the daylight hours. Observations were made on the onset and duration of emergence, duration of the flying period, and reproductive behavior.

A number of hours was spent at the water's edge, as well as in the water, wearing waders, while observing emergence, numbers of animals flying, daily activity peaks, and oviposition.

Samples of vegetation, on which _I. posita_ females appeared to be ovipositing, were brought to the laboratory in June, 1968. The samples were examined microscopically for eggs and kept in 8 oz collecting bottles to be examined daily for the appearance of young larvae.

RESULTS

The Larva

The larvae that I collected were found among submerged vegetation and their color approximated that of the plants among which they lived. However, larvae of *I. posita* are described by Walker (1958) as having a dark brown, smoky body. These observations may indicate a chromatic adaptation by individuals of this species to their immediate environment.

I. posita and *Enallagma geminatum* apparently occupied similar ecological niches in the pond. The larvae of the two species were very similar in appearance. Zygoptera possess caudal gills which are accessory respiratory organs. The structure and markings of these gills are characteristic for different species. *I. posita* individuals were definitively recognized by the banding and shape of the caudal gills.

Larval development in *I. posita* was studied by analyses of samples of the population. Relative length-frequency histograms of larval samples are shown in Figure 1. Due to the extended flying and oviposition periods, larvae in a wide range of sizes were present in all the samples collected.

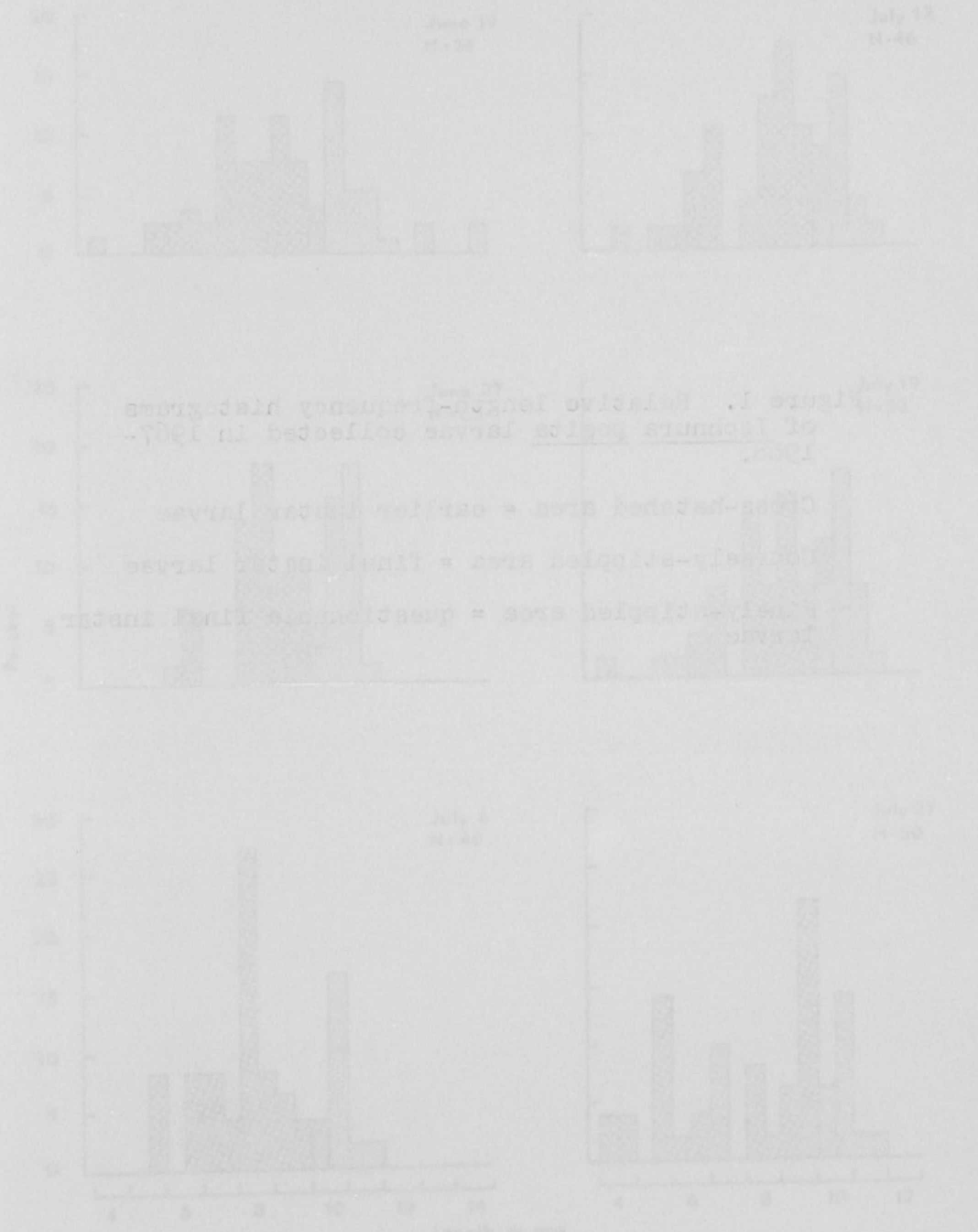
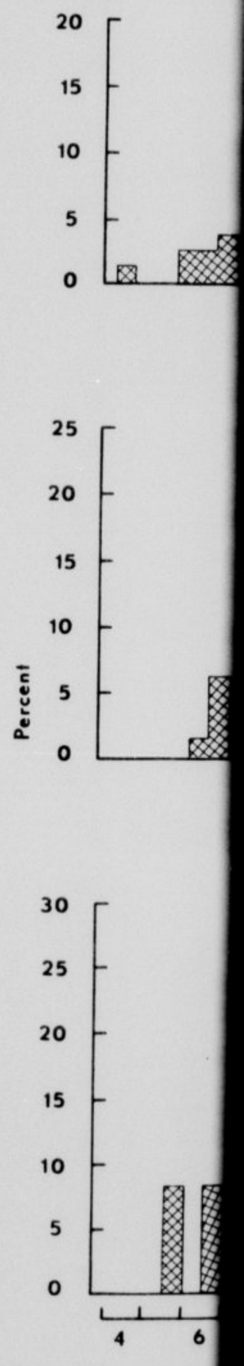


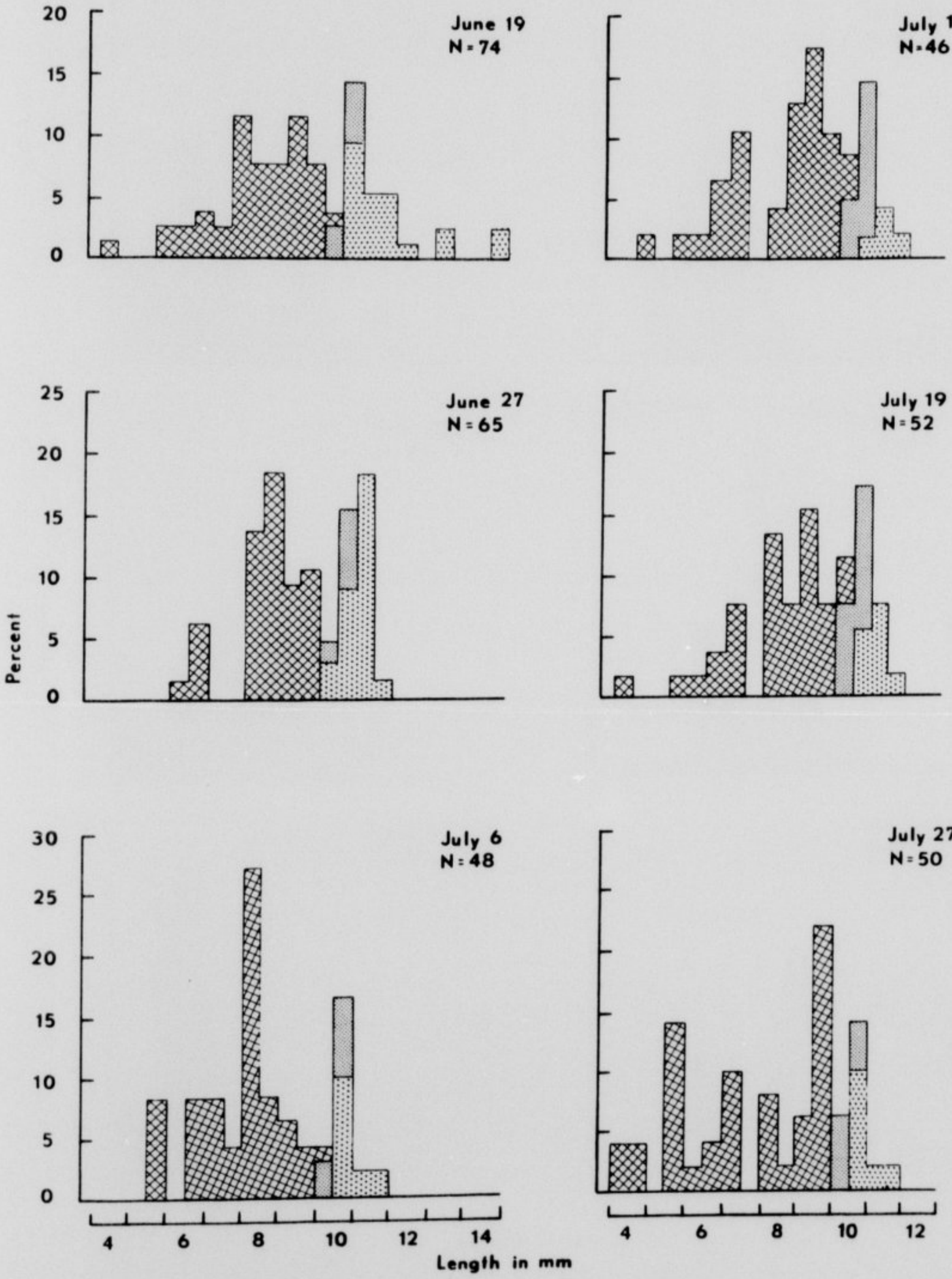
Figure 1. Relative length-frequency histograms of *Ischnura posita* larvae collected in 1967-1968.

Cross-hatched area = earlier instar larvae

Coarsely-stippled area = final instar larvae

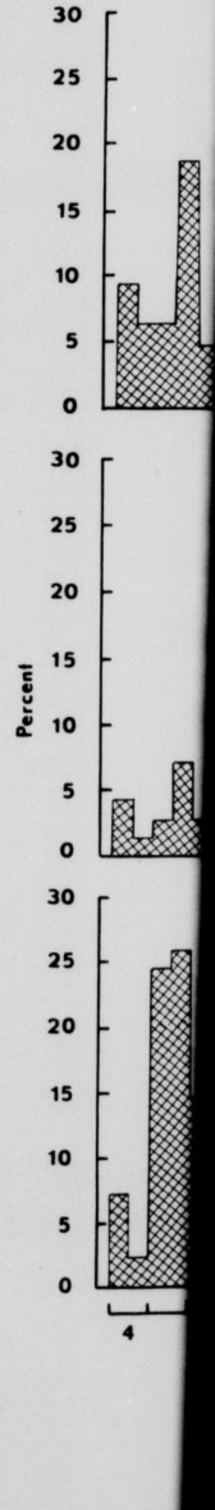
Finely-stippled area = questionable final instar larvae

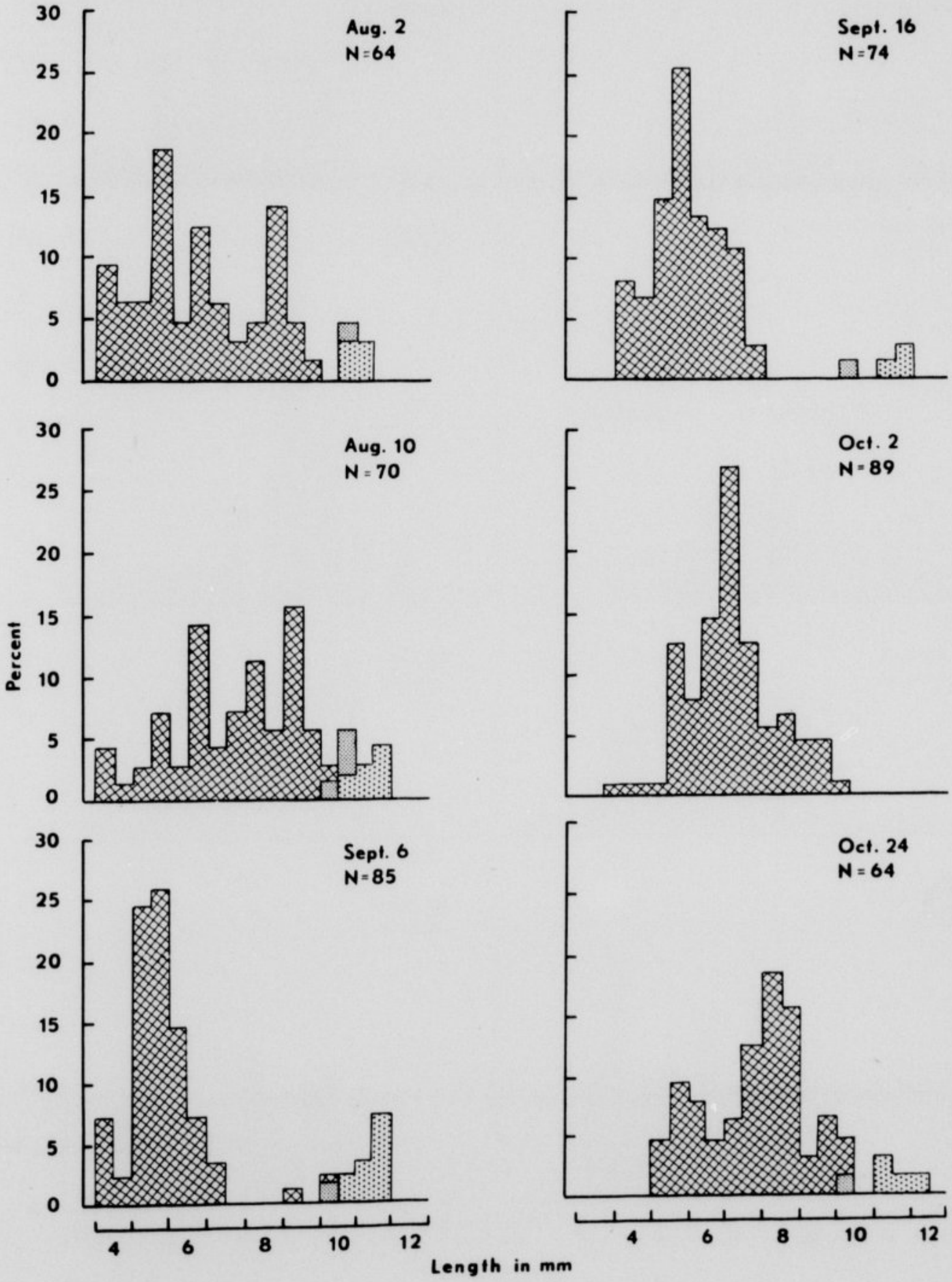




June 19
N=74
July 12
N=46
June 27
N=65
July 19
N=52
July 6
N=48
July 27
N=50
Percent
0
5
10
15
20
25
30
4
6
8
10
12
14
Length in mm

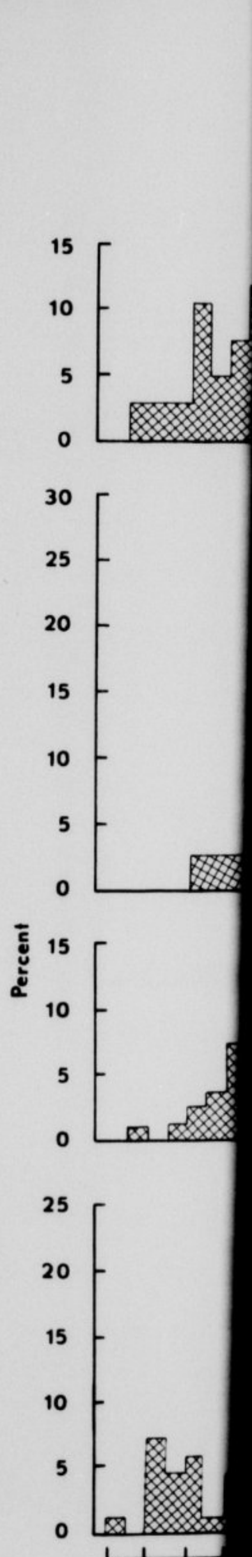
Figure 1. continued

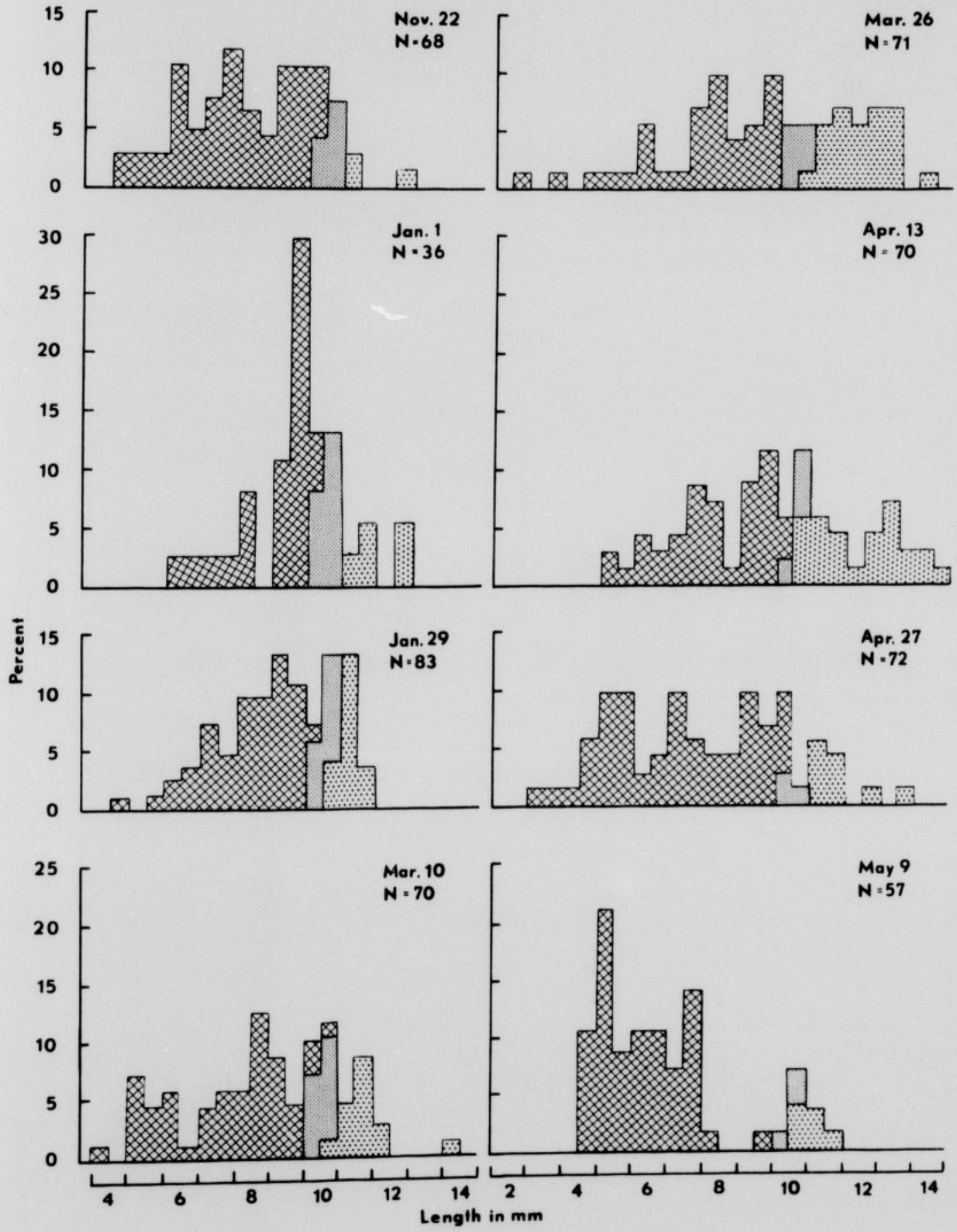




Aug. 2
N=64
Sept. 16
N=74
Aug. 10
N=70
Oct. 2
N=89
Sept. 6
N=85
Oct. 24
N=64
Percent
0
5
10
15
20
25
30
4
6
8
10
12
Length in mm

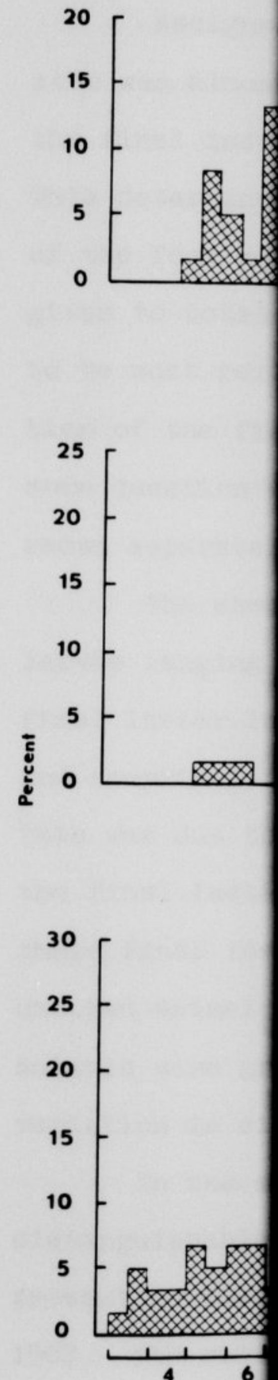
Figure 1. continued

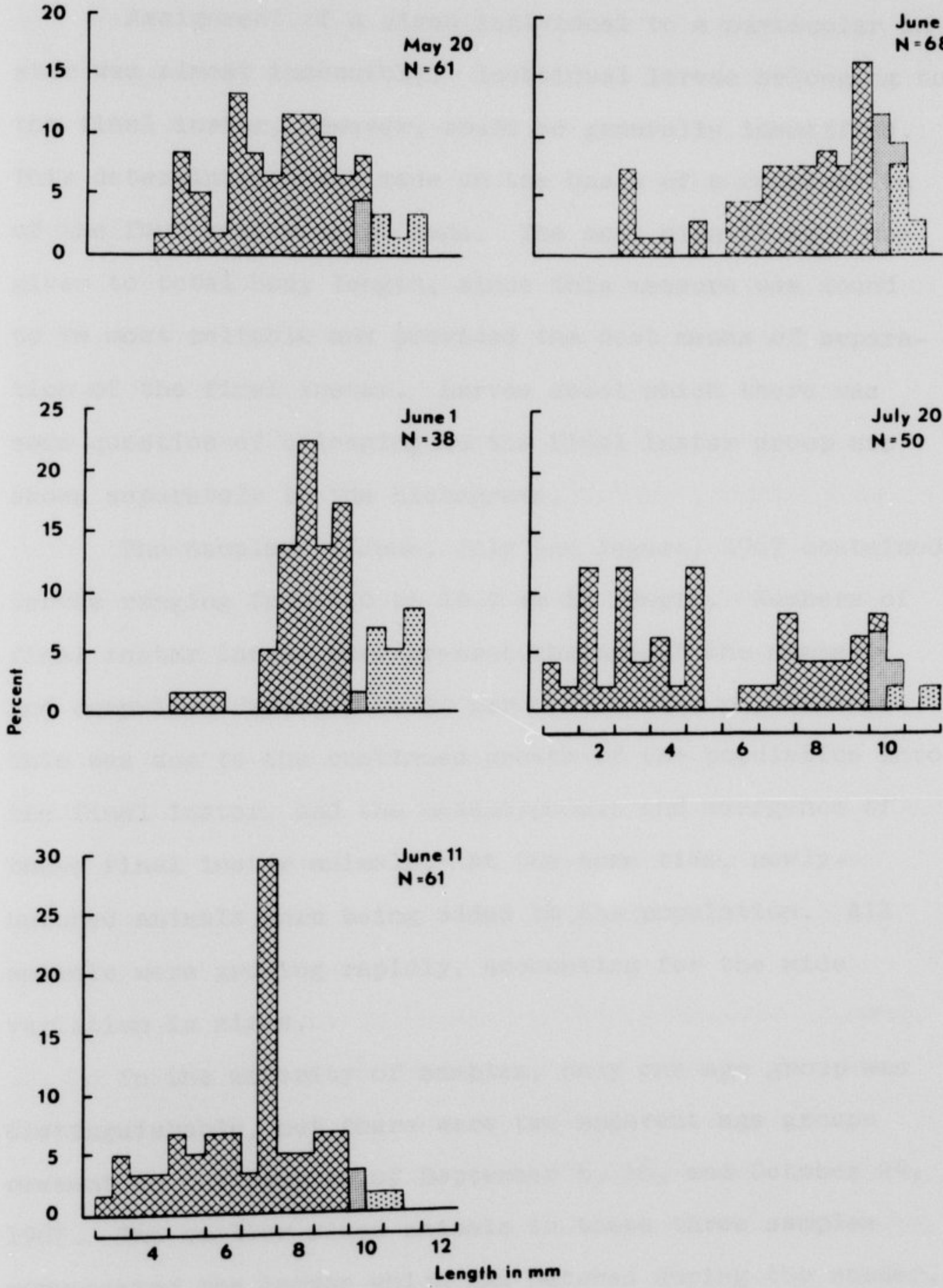




Nov. 22
N=68
Mar. 26
N=71
Jan. 1
N=36
Apr. 13
N=70
Jan. 29
N=83
Apr. 27
N=72
Mar. 10
N=70
May 9
N=57
Percent
Length in mm

Figure 1. continued





May 20
N=61
June 21
N=68
June 1
N=38
July 20
N=50
June 11
N=61
Percent
Length in mm
0
5
10
15
20
25
30
2
4
6
8
10
12

Assignment of a given individual to a particular instar was almost impossible. Individual larvae belonging to the final instar, however, could be generally identified. This determination was made on the basis of a combination of the four measurements made. The most significance was given to total body length, since this measure was found to be most reliable and provided the best means of separation of the final instar. Larvae about which there was some question of belonging to the final instar group are shown separately in the histograms.

The samples of June, July and August, 1967 contained larvae ranging from 4.0 to 14.9 mm in length. Numbers of final instar larvae were present throughout the summer, and comprised from 6.1 to 32 per cent of the population. This was due to the continued growth of the population into the final instar, and the metamorphosis and emergence of these final instar animals. At the same time, newly-hatched animals were being added to the population. All animals were growing rapidly, accounting for the wide variation in sizes.

In the majority of samples, only one age group was distinguishable, but there were two apparent age groups present in the samples of September 6, 16, and October 24, 1967. The smaller-sized animals in these three samples represented the larvae which had hatched during the summer, and the group of final instar individuals was probably the remaining members of the population which had hatched in the late spring or early summer and developed at a fast rate. Growth of the population continued from September through December.

The January, 1968 samples contained an accumulation of final instar larvae. This may have represented an increase in the average size of the individuals in the population due to growth during the winter, or it may have been due to faulty sampling. Paulsen (unpublished data) reported the collection of larvae in the last seven instar classes as part of the overwintering population.

A wide variation was observed in the size of the larvae in the sample of March 26. Very small animals which were part of the overwintering population were found. A white plastic pan was used for the first time to facilitate sighting of the smaller larvae. The small larvae first collected on this date may have been due to change in technique of collecting.

Larger numbers of final instar larvae were observed in the samples of March 10 through April 13, 1968. The first adult of I. posita was seen flying on April 10. Accordingly, there was a decrease in the percentage of final instar larvae present in the samples which were made after April 13 due to emergence.

Continued growth in length of the animals in the population was observed in the samples between May 20 and June 1. There was a high degree of activity among the adults on June 1, indicating that large numbers of larvae had emerged prior to that time.

The 0-year class was first represented in the samples of June 11. Very small larvae had been found in the samples of March 26 and April 27, but they were obviously part of the overwintering population. There were no animals collected on May 9 and June 1 that were as small as those obtained on June 11. In the sample of June 21, 10.4% of the sample represented small animals which were distinct from the 1-year class to comprise the 0-year class. The samples of June 19 and July 19, 1967 did not contain representative individuals of the new population for that year, but the presence of the 0-year class was confirmed by the sample of July 20, 1968.

Emergence and oviposition extended over a long period, and hatching resulted in new animals being added during this time to the population. As the newly-hatched animals were continuously added, they were growing quite rapidly. Growth continued at the same time in individuals of the 1-year class. Since the whole population was growing, distinct size classes were very obscure and differentiation of the samples into size classes was almost impossible.

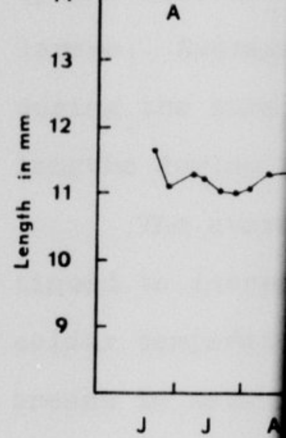
No distinct separation of sizes could be determined, which may have accounted for the overlapping sizes as represented in the histograms.

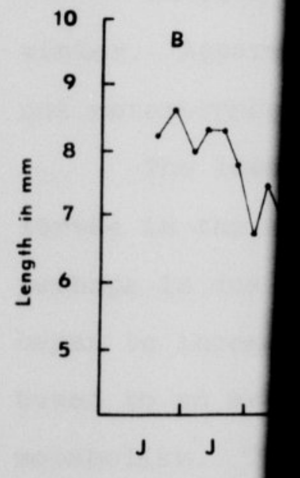
In this study, I have found that I. posita is generally a univoltine species, but there were indications that part of this population may have been bivoltine, or perhaps the entire population may be bivoltine. The larvae of I. posita overwintered in a wide variation of sizes. Emergence began in April and extended until late September or early October, so the overwintering population emerged during the spring and early summer. At the same time, eggs which were laid in May or early June hatched, and those larvae may have completed their larval development, emerged and oviposited before the end of the season (November). The presence of two age groups in the samples of September 6, 16, and October 24, 1967 were indicative of the second generation in the same year.

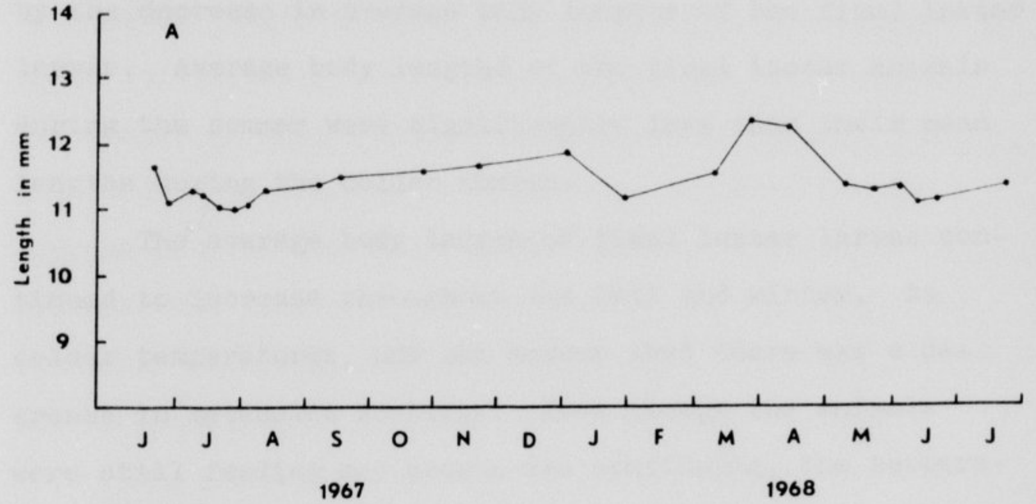
A comparison of average body lengths of final instar larvae from successive samples is shown in Figure 2A. The average body length of the final instar decreased in June, July and August, 1967. At higher water temperatures during the summer, development was proceeding at a rapid rate. The rate of development of the final instar larvae was also accelerated. Because of the short duration of the final instar during the warm season, the animals did not

Figure 2A. Changes in average body length of final instar larvae.

Figure 2B. Changes in average body length of larvae other than final instar.






A
14
13
12
11
10
9
Length in mm
J J A S O N D J F M A M J J
1967
1968

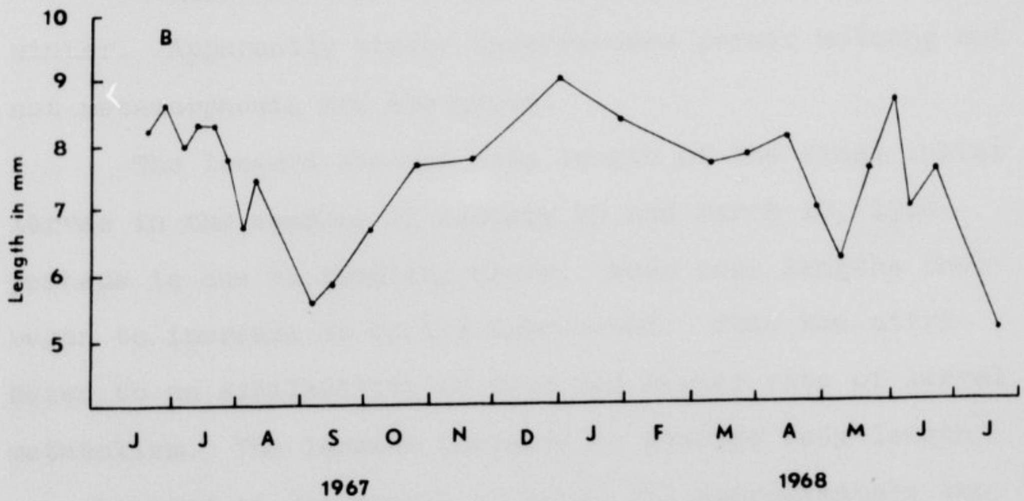

B
10
9
8
7
6
5
Length in mm
J J A S O N D J F M A M J J
1967
1968

exhibit much growth in body length during their final intermolt period. The higher developmental rates are reflected by the decrease in average body lengths of the final instar larvae. Average body lengths of the final instar animals during the summer were significantly less than their mean lengths during the colder months.

The average body length of final instar larvae continued to increase throughout the fall and winter. At colder temperatures, one can assume that there was a decrease in metabolic activity. Even though the animals were still feeding and growth was continuing, the temperature was not high enough to allow metamorphosis to occur, so the final instar larvae increased in body length.

Numbers of final instar animals increased during the winter. Apparently winter temperatures permit molting but not metamorphosis and emergence.

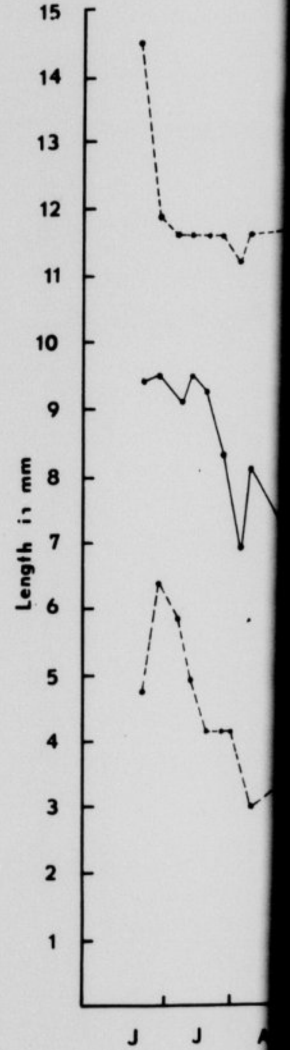
The lowered average body length of the final instar larvae in the samples of January 29 and March 10, 1968 perhaps is due to sampling error. Mean body lengths then began to increase as spring approached. This was attributed to an availability of food and higher rate of larval metabolism. The largest increase in average body length was observed in the sample of March 26, approximately two weeks before the appearance of the first adult, which was seen on April 10. The average body length of the final instar decreased from April 13 to May 20, with a slight increase observed in the sample of June 1. The decrease in average length in April and May was due to emergence of those larvae which had overwintered in the final instar. The sample of June 1 showed an increase in average length, but it did not indicate a significant increase in the average size of the final instar larvae. A decrease in average body length throughout June, July and August was identical with what had been observed in the final instar larvae from samples of June, July and August, 1967.

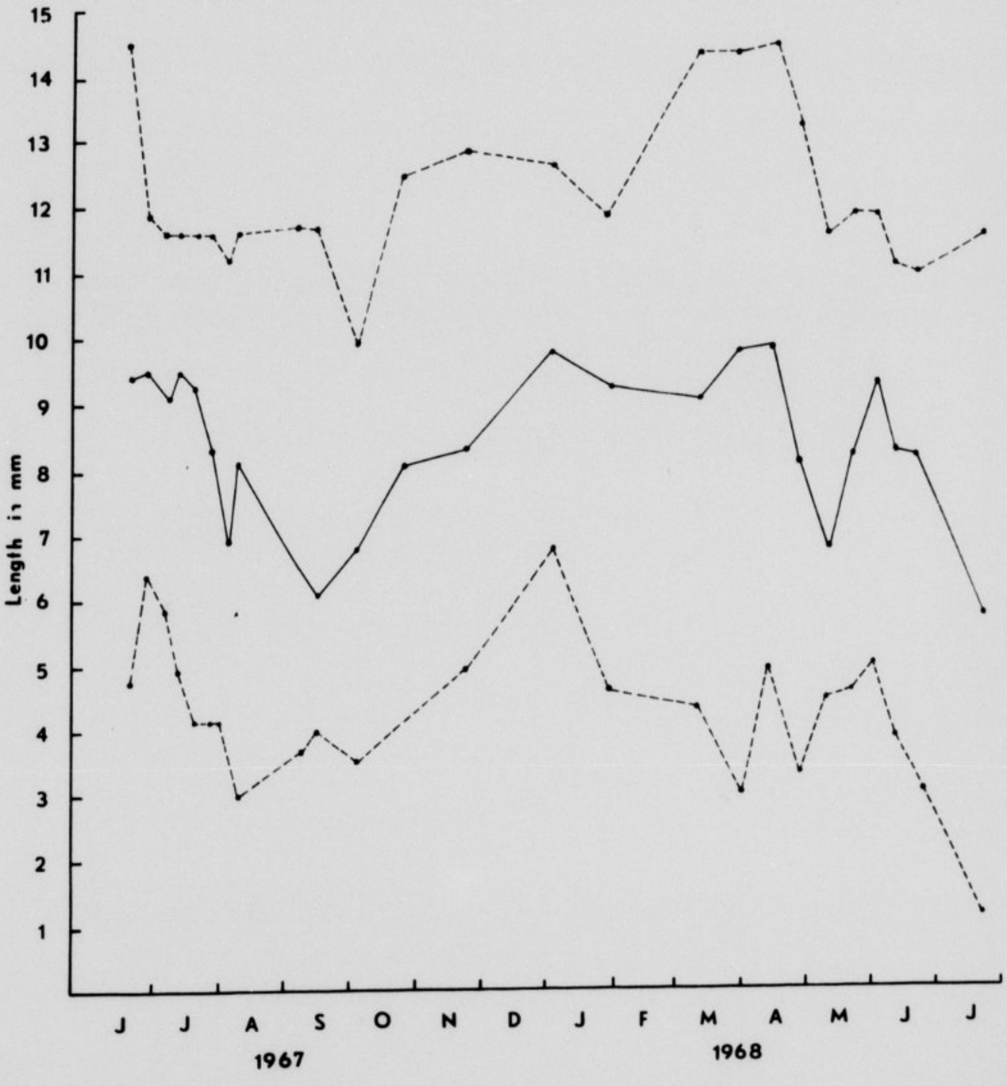
The changes in average length of larvae other than those in the final instar are represented in Figure 2B. The pattern of increase or decrease in average length followed somewhat that of the final instar larvae. However, the points of sharp increase represented increased growth of the population just before periods of emergence. The sudden decreases in the average length were indicative of the periods between emergence pulses, or the addition of new animals to the population.

Comparisons of successive sample averages were plotted to show changes in the average length of all larvae combined. The averages were made for all measurements made on *I. posita* sampled. These averages are represented in Figures 3 and 4, and data are shown in Table 1.

Figure 3. Changes in largest, smallest, and average body length of <u>Ischnura posita</u> larvae collected in 1967-1968.

Solid line indicates average body length; broken lines indicate largest and smallest individual larvae collected.





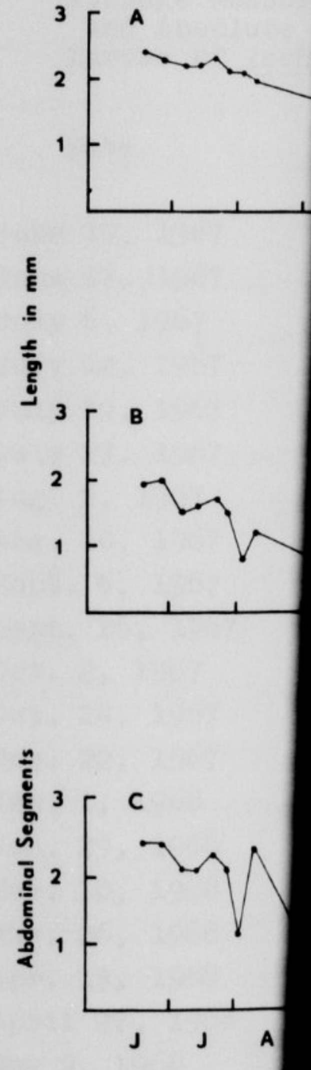
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Length in mm
J
J
A
S
O
N
D
J
F
M
A
M
J
J
1967
1968

Figure 4. Changes in average head width, absolute and relative wing-pad lengths of <u>Ischnura</u> <u>posita</u> larvae collected in 1967-1968.

A. Head width

B. Absolute wing-pad length

C. Relative wing-pad length



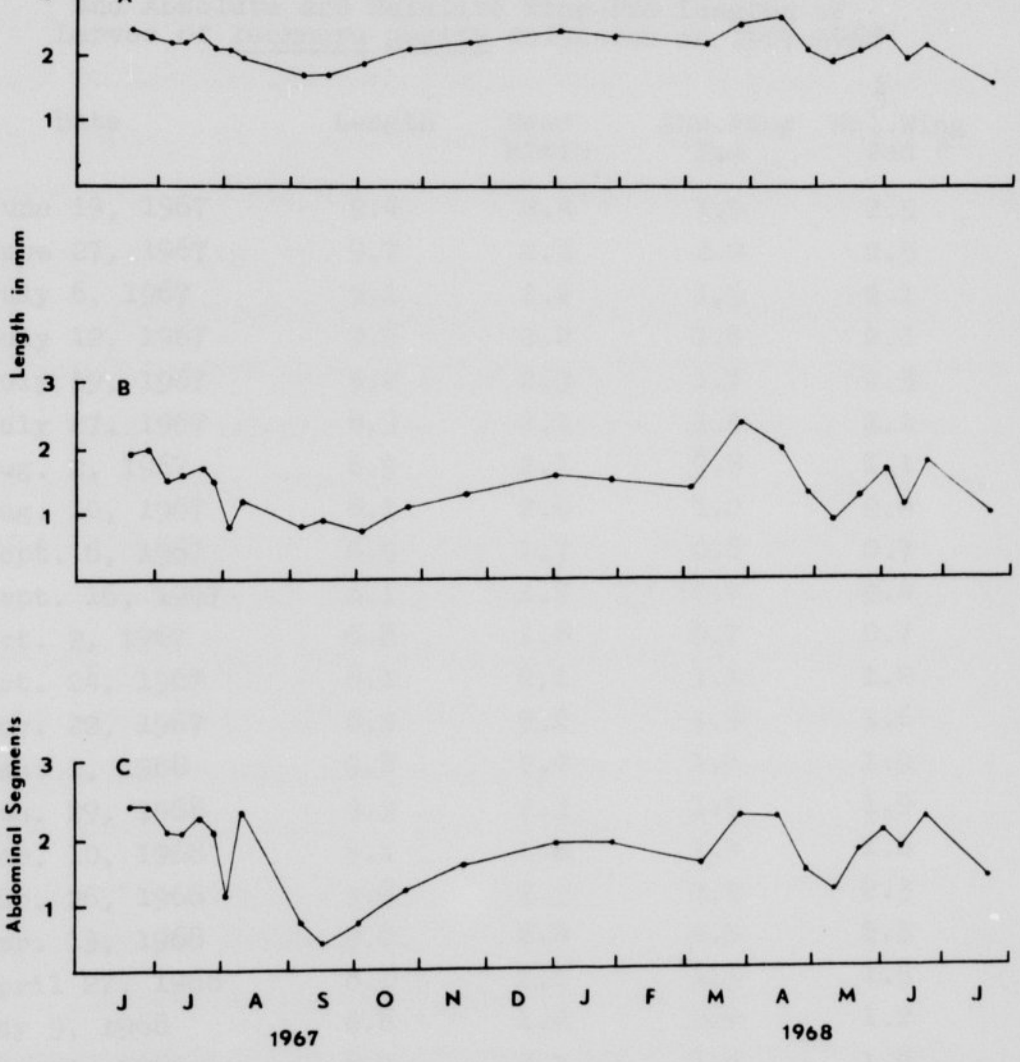

A
B
C
3
2
1
Length in mm
Abdominal Segments
J
J
A
S
O
N
D
J
F
M
A
M
J
J
1967
1968

TABLE I

Average Measurements of Body Length, Head Width, and Absolute and Relative Wing-Pad Lengths of Larvae of *Ischnura posita* Collected in 1967-1968

Date	Length	Head Width	Abs. Wing Pad	Rel. Wing Pad
June 19, 1967	9.4	2.4	1.9	2.5
June 27, 1967	9.7	2.3	2.0	2.5
July 6, 1967	9.1	2.2	1.5	2.1
July 12, 1967	9.5	2.2	1.6	2.1
July 19, 1967	9.2	2.3	1.7	2.3
July 27, 1967	8.3	2.1	1.5	2.1
Aug. 2, 1967	6.9	2.1	0.8	1.1
Aug. 10, 1967	8.1	2.0	1.2	2.4
Sept. 6, 1967	6.5	1.7	0.8	0.7
Sept. 16, 1967	6.1	1.7	0.7	0.4
Oct. 2, 1967	6.8	1.8	0.7	0.7
Oct. 24, 1967	8.1	2.1	1.1	1.2
Nov. 22, 1967	8.3	2.2	1.3	1.6
Jan. 1, 1968	9.8	2.4	1.6	1.9
Jan. 29, 1968	9.3	2.3	1.5	1.9
Mar. 10, 1968	9.1	2.2	1.4	1.6
Mar. 26, 1968	9.8	2.5	2.4	2.3
Apr. 13, 1968	9.9	2.6	2.0	2.3
April 27, 1968	8.1	2.1	1.3	1.5
May 9, 1968	6.8	1.9	0.9	1.2
May 20, 1968	8.2	2.1	1.3	1.8
June 1, 1968	9.3	2.3	1.7	2.1
June 11, 1968	8.3	2.2	1.8	2.3
June 21, 1968	8.2	2.2	1.8	2.3
July 20, 1968	5.9	1.6	1.8	2.3

In addition to showing the changes in average length of larvae, Figure 3 is also representative of the extremes in sizes of the animals. The largest and smallest larva in each collection has been plotted with the average size of the sample. It is significant to note how the changes in average length compared with the changes in the other parameters (Fig. 4).

The decrease in average length as represented in Figure 3 between July 12 and August 10, 1967 was indicative of continued emergence over the summer. The drop in the average of this parameter in September was also due to the continued addition to the population. There were fewer animals present in the final instar and those instars preceeding the final than during the spring and summer. At this time, those larvae which were hatched in June were probably emerging, after having grown at ar accelerated rate during the summer. This allowed them to complete their larval development in about four months and they emerged in September and October.

Growth continued through the fall and winter. A significant increase in average length was noted in the samples of January, 1968. The marked increase in March was indicative of the impending initiation of emergence, when the overwintering population was growing at a faster rate.

A sharp decline in average length during April and the first of May represented the first emergence. Another increase in average length was observed in the samples of May 20 and June 1, followed by a drop in the average length between June 1 and July 20. As forestated, an abundance of adults was present on June 1. Activity was also at a peak on July 1.

Due to the long emergence and flying period, distinct emergence peaks were not observed, but there was a number of pulses or periods of increased emergence. This was evidenced by increases in the average sizes of the larval samples followed by decreases. The increase in average length of the population samples indicated periods of growth. The growth increases were followed by sharp declines in average size, which was evidenced by emergence having occurred, and by addition of new animals to the population. From the compiled data, there was obviously a sequence of growth and emergence pulses throughout the period of this study.

The fact that there was such a wide variation of sizes during the entire study, and that there was overlapping of size classes in the final instar group seems to show the lack of synchrony of emergence, and the wide temporal variation that exists in the population.

I. posita is a summer species. Larval growth is probably rapid throughout the emergence and oviposition period due to a high thermal coefficient for growth at higher temperatures.

Emergence

Emergence in *I. posita* was first seen on April 13, 1968, but must have occurred earlier, since the first adult was seen flying on April 10. On April 13, five larvae were found in the process of emergence upon the vegetation mat covering the water surface.

On April 22, 1968, a piece of lumber protruding from the water was examined; it was found to contain large numbers of exuviae, some of which were those of *I. posita*. There were, in addition, emerging larvae clinging to the board. For the most part, emergence occurred on the stems of emergent plants at a point 1 or 2 cm above the water, or on the floating algal mat. No skins of *I. posita* were found on shore vegetation on dry land. These findings indicate that emergence occurred only on emergent plants or on objects which protruded from the surface of the water. At the time emergence of *I. posita* individuals was observed, large numbers of *Enallagma geminatum* were also seen emerging in the same specific habitat. Emergence of *I. posita* continued from early April until early October. The last exuviae were found on September 24, 1967.

The Adult

I. posita is a small eastern damselfly. It is a dimorphic species, with the head, thorax and abdomen black. The male has green and black markings; the female is similar to the male except that the markings are metallic blue. On June 1, when large numbers of adults were flying, many females had developed a bluish gray pruinosity, which was an indication of sexual maturity. Walker (1958) described the mature female of I. posita as having this same appearance.

Flight Period

I. posita has a long flight period extending from early spring until late autumn. The flight season of this species is progressively lengthened in more southerly localities. Walker (1958) reported that the flying season for this species in Ontario was from June through September. In New England, adults are present from May 25 through September (Garman, 1927, cited by Walker, 1958). In Indiana, Montgomery (1944) noted the adults from the second week in April through late September. Brimley (1938) reported adults flying statewide in North Carolina from March to November. I observed males flying as early as April 10, 1968, and as late as November 1, 1967.

By June 1, 1968, there was an abundance of adults flying. Males and females were flying in approximately equal numbers. On June 12, I counted 63 animals of which 35 were females and 28 males. Of the 211 adults counted between June 12 and June 21, 86 were males and 125 females.

Individuals of I. posita were observed to be weak fliers. They always flew close to the water when venturing out over the open pond. Most flights occurred about 2 to 10 cm above the water's surface. Adults were abundant among the clumps of Potamogeton and Typha as well as among the rushes, sedges and grasses along the shoreline. They seemed to prefer the shade of the emergent plants more than the open areas of a particular habitat. This characteristic was reported by Walker (1958) for I. posita in Canada.

Flying was observed as early as 7:30 AM, and as late as 6:30 PM. Activity increased during the day, with the peak of activity occurring from about mid-morning to late afternoon. Activity of the adults was at a high level on warm sunny days, while on cool cloudy days, a marked reduction in the numbers flying was observed. This study was unable to elucidate whether the degree of activity was related to temperature, light intensity, a combination of these two factors, or some other factor.

Since the population of I. posita had such an extended flight period, it was impossible to determine the duration of the life span of individual adults. The existence of specimens throughout the flying period indicated that emergence occurred throughout most of the flying season.

Mating and Oviposition

I was unable to observe mating in I. posita before July 16, 1968. It obviously occurred earlier because oviposition was observed on June 4. Difficulties with observing mating were encountered, since this activity occurred among the shore vegetation where the animals were protected from view. Flights of large numbers of I. posita among the shoreline vegetation at mid-morning seemed to indicate that mating occurred away from the water, probably among the vegetation bordering the pond.

Adults were seen flying in tandem among the Eleocharis at the edge of the water. Copulation took place on the surface of leaves bordering the pond, such as Potamogeton. This lasted from 4 to 9 minutes, after which flight was resumed in the copulatory position.

Males were seen in the act of making contact with females as the female perched in a vertical position on a stem. The male repeatedly made contact with her by grasping her thoracic region with his prothoracic legs. This was interpreted as being a type of courtship behavior, a very unusual event in adult zygopterans.

Oviposition was first observed on June 4, 1968. It probably occurred earlier, perhaps as much as three weeks earlier. Females perched on pieces of emergent vegetation or on flowers or apical tips of Anacharis (Elodea) were observed flexing their abdomens and backing down along the vegetation until the abdomen was partly submerged. The females appeared to drop their eggs in the water near the vegetation on which they perched. On June 5, five females were seen ovipositing, and two males exhibited what appeared to be protective displays by constantly flying around the females and returning to the same twig while the females were ovipositing. On June 21, twenty-one females were observed engaged in this activity. One female was seen perched in the oviposition posture for one minute. She then moved to another part of the same stem for another minute. Another female was observed for 15 minutes. She remained at one spot for 5 minutes with the abdomen submerged, straightened her abdomen and flew around, and returned to the same piece of vegetation where she continued ovipositing for another 10 minutes. Females of I. posita deposited their eggs alone. Although two males were observed in what appeared to be protective displays, in the rest of the observed females oviposition was without the accompaniment of the males.

DISCUSSION

Among the Odonata two types of life histories have been recognized: spring and summer species. These two ecological categories of dragonflies are distinguished from one another by the manner in which they achieve synchronization for emergence. They were first recognized by Corbet (1956) in studies on larval populations of several species. The Odonata have been classified as "spring" or "summer" species, depending upon the position of a diapause in the life history. Spring species have been typified by *Anax imperator* and *Pyrrhosoma nymphula*. This ecological type was defined as possessing a diapause in the final larval instar. Completion of diapause results in synchronized emergence early in the spring of the following year. In summer species, emergence was found to be less well-synchronized and spread over a longer period of time. Although summer species may have a diapause stage in the life history, it is not present in the final instar. It has been suggested that in summer species the final larval instar is entered just before emergence, and since growth is not interrupted at this stage, there is temporal variation in emergence (Corbet, 1954).

Summer species may be further categorized by:

(a) those which complete only one generation in a year (univoltine), (b) those which require two years or more to complete a generation (semivoltine), and (c) those completing two generations in one year (bivoltine) (Corbet, 1963).

Corbet (1956a) reported a study of Sympetrum striolatum, a univoltine summer species. The larvae were found to overwinter in instars other than the final. He observed an accumulation of larvae of S. striolatum in the final instar just before emergence. It was concluded that the first larvae to enter the final instar were obliged to postpone metamorphosis until environmental conditions became suitable; then they proceeded to emergence. In this way, temporal variation was reduced resulting in a surge of emergence, although emergence continued over a longer period of time.

Another study was made on temperature as it affects seasonal development in S. striolatum (Corbet, 1956b). He found that S. striolatum was able to reduce temporal variation by having a lower temperature threshold for metamorphosis above that permitting entry to the final instar. This was the reason for the accumulation of larvae in the final instar as discussed above. Metamorphosis was inhibited until environmental temperatures had risen high enough to permit it. This species has a flying period of 100 days, so the lower temperature (LTT) was employed only before emergence. Most emergence occurred at the beginning of the emergence period.

Lutz (1968 a, b) conducted studies of the effects of temperature and photoperiod on Lestes eurinus, another univoltine summer species. His findings supported Corbet's model of LTT's. He found that there was a progression of ecdyses among three groups of instars (Final, F-1, F-2) as the water temperature increased in the spring, and the optimal temperature for growth was achieved for each group. In laboratory experiments where various larval instars were subjected to different temperature and light conditions, he observed that younger instars developed at a faster rate at lower temperatures, whereas final instar development was accelerated at higher temperatures. This indicated that the younger instars had lower temperature thresholds than that for the final instars. He (Lutz) was able to demonstrate that there is a progression of partially overlapping, but rising thermal coefficient ranges for the initiation of development. Through the mechanism of LTT's, temporal variation of emergence was reduced in L. eurinus.

Coenagrion mercuriale, a semivoltine species, was found to achieve synchronization by a system of LTT's which permitted entry to the final instar, commencement of metamorphosis, and emergence in an ascending order, so there was considerable reduction of variation just before emergence (Corbet, 1956b).

The present study was concerned with larval development in _I_. _posita_, a univoltine, or possibly bivoltine summer species. It was found that the larvae existed in a wide variation of sizes over the winter. There was no indication of an accumulation of any instar group as winter approached; however, there was an accumulation of final instar larvae during the winter and early spring. Although _I_. _posita_ is characterized by an extended emergence period, there was a surge of emergence at the initial emergence period and throughout the spring. This may indicate that temporal variation had been reduced to some slight extent.

Univoltine species, with a high thermal coefficient for growth, are probably unable to employ either system of LTT's for reduction of variation as stated above, except just before emergence. Since there was an accumulation of larvae of _I_. _posita_ in the final instar during the winter and early spring just before emergence, there is a possibility that the LTT mechanism may be operative in this species, but there is no experimental evidence to support this hypothesis.

Johnson (1964) reported on the life history of _Ischnura_ _damula_. He found a large sample of penultimate and final instar larvae as winter approached, and attributed this finding to the development of larvae hatched in July and August. The observation was also made that _I_. _damula_ possessed two peaks of emergence, in early April and a second in early July. The initial emergence and the dispersed phase was interpreted as the staggered emergence of larvae which had existed as final, penultimate, and earlier instar larvae at the beginning of the emergence period. The second peak was interpreted as emergence of offspring from the previous April oviposition and hatching period. _I_. _damula_ is a bivoltine species. In the present study, a second generation was observed in _I_. _posita_. This was revealed by the presence of two age groups in the larval samples of September and October. Needham (1903) reported that _I_. _posita_ appeared early in the spring and probably had several overlapping broods each season.

Emergence and the flight period of _I_. _posita_ were comparable to findings of other investigators in North Carolina and this geographical latitude. Brimley (1934) reported adults flying from March to November. The first adult was seen flying on April 10, 1968 at A. and T. pond. Emergence was observed on April 13. The last exuviae were seen on September 24, 1967. Adults were seen flying as late as November 1.

Bick (1965) reported on mating and territoriality in the Zygoptera. He found that territorial behavior was poorly developed, and courtship to be entirely absent in species of _Lestes_. In general studies of reproductive behavior in Zygoptera, Bick found that the same was true for several genera. He attributed this to the primitive position of Zygoptera in phylogenetic development. Courtship was observed in I. posita before tandem was achieved. What appeared to be protective display was seen at an oviposition site.

SUMMARY

Through a program of population sampling and field observations of the damselfly, Ischnura posita, information was obtained concerning the life history of this species and its response to seasonal changes.

I. posita is a univoltine, and possibly bivoltine summer species. The adults were found from early spring to late autumn, and emergence extended over most of this period. There was evidence of a second generation in the same year. Eggs laid early in the spring hatched and probably grew at a fast rate, and completed larval development before the end of the season (October). Males and females were found in approximately equal numbers. Courtship was observed prior to mating.

The overwintering population was found in a large number of sizes, and there was no indication of a diapause stage. Temporal variation may have been reduced to some extent in this species, which was evidenced by the accumulation of final instar larvae in the winter and early spring just before the initial emergence.

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