THE BIONOMICS OF THE EUROPEAN EARWIG
Forficula auricularia (L)
IN ST. JOHN'S, NEWFOUNDLAND, 1970-1972

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The Bionomics of the European earwig
Forficula auricularia (L.)
in St. John's, Newfoundland, 1970 - 1972

by

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A Thesis

submitted in partial fulfillment
of the requirements for the degree of

Master of Science

Department of Biology
Memorial University of Newfoundland
St. John's, Newfoundland

April, 1974

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ACKNOWLEDGEMENTS

I wish to thank Professor John Phipps for his guidance, support and amiable company during the course of this study.

My appreciation also to Mr. Carm Rockwell of Modern Pest Control for his advice on the selection of the collecting sites within the city of St. John's. Also to the many city residents who allowed me to invade the privacy of their gardens.

Thanks are also due to the following individuals in the Biology Department, Memorial University of Newfoundland : Mr. Eugene Fitzgerald for so many deeds too numerous to mention; Mr. Alex Coombs for his preparation of marking materials; Mr. Chester Rowe for his assistance in finding outside sources of financial support; Miss Cynthia Long for her expert assistance and advice in the preparation of figures presented in this thesis; and Mr. Roy Ficken for his assistance with the photographic work.

Thanks are also due to Dr. George Moskovits, Biology Department, for his suggestions regarding marking materials; and Dr. Y.A.S. Emara for his checking of the statistics.

Many thanks are also due to Mr. Paul Thompson for his assistance with photographic work and helpful suggestions.

My appreciation also to Memorial University of Newfoundland and the Provincial Government for support during the course of the study.

Finally, and foremost, to Trilby, Stephen, and Andrew.

INTRODUCTION

It is generally believed that earwigs were introduced into St. John's, Newfoundland during the early 1940s either in shipments of lumber from British Columbia or by British naval ships during the second World War. Not until 1962 did the population reach alarming proportions in one particular section of the city, possibly caused by an unusually mild winter.

The object of the study was to discover how far earwigs have spread in St. John's, where the heaviest infestations are and to investigate the life history and compare it with that in other parts of the world. It was further intended to compare the frequency of the two forms of males with that found elsewhere.

Distribution and Spread

The European earwig is native throughout Europe and western Asia and possibly in northern Africa. It has been introduced into East Africa, the East Indies, New Zealand, Tasmania, Australia and more recently into North America. It was first noted in Seattle, Washington in 1907 (Crumb et. al. 1941).

Although possessing well-developed wings, the earwig rarely flies. Its method of spread relies almost entirely on transportation by man. Being a nocturnal insect it hides anywhere by day and as a result may be carried long distances. Ships' cargoes are often infested, especially lumber or flowers. Earwigs have been known to be transported long distances in bundles of newspapers, the luggage of travelers, packages and crates of merchandise, by automobiles and even in mailed letters.

Seasonal History

There are six stages in the life cycle of the European earwig - egg, four nymphal instars and adult. The life span of the female is slightly longer than that of the male, both living approximately one year.

Eggs are usually laid in the soil at a depth of 2 - 3 inches. In the fall, females, usually accompanied by a male, enter the soil to excavate a nest. The eggs (40 - 90) are laid in the cavity during the fall or early spring. The male is evicted from the nest just prior to oviposition. The female protects and cares for the eggs and the young until the nymphs are ready to leave the nest.

Hatching takes place sometime in spring, nymphs appearing on the surface a short while later to search for their own food during the night. Some females re-enter the soil to deposit a second batch of eggs, these hatching in the early part of the summer. Adults from the first brood appear in mid-summer, adults from the second brood in late summer.

Food habits and Economic importance

The earwig is omnivorous, although most of the food is derived from plant sources. Most of the food is dead when eaten yet the earwig is also known to be predaceous on smaller insects, spiders and mites. Plant food includes lichens, mosses, grasses, various cereals, fruit, vegetables and flowers. Under adverse conditions it sometimes displays cannibalism.

Economically the earwig is capable of causing serious damage to crops yet seldom does (Crumb et. al. 1941). It has come into prominence largely as a household pest in residential districts rather than as an important crop pest. The presence of earwigs in large numbers does not necessarily result in injury to crops. In fact, some workers think the earwig is somewhat beneficial because of its predatory habits (Brindley 1918, Maclagan 1932).

Control

The European earwig can usually be controlled by annual applications of various chemicals, by removal trapping, or a combination of both. Biological control attempts have been mostly unsuccessful (Atwell 1927, Thompson 1928, Crumb et. al. 1941).

Origin of the name

The name "earwig" is derived from the Anglo-Saxon word "earwicga" meaning "ear creature". Many variations exist: "ohrwurm"or "ohrbohrer" (German) meaning "ear worm" or "ear borer"; "oorworm" (Dutch), "ormask" (Swedish), "gusano del oido" (Spanish), "verme auricolare" (Italian), all meaning "ear worm"; "orenivist" (Danish) meaning "ear twister"; "perce-oreille" (French) and "fura orelhas" (Portuguese) meaning "pierce-ear" (Fulton 1924 a).

It has also been suggested that the word "earwig" may have arisen from the word "earwing", referring to the auricular shape of the hind-wings.

The popular superstition that earwigs crawl into the ear and bore into the brain is without foundation, although it is true that the human ear canal appropriately accomodates the thigmotactic response characteristic of the insect.

MATERIALS AND METHODS

Collecting sites

Twenty-five collecting sites were selected within the city limits of St. John's. These sites were chosen partly through information supplied by a local pest control company and partly through information received from St. John's residents. The distance between the most easterly and westerly sites was 6.7 km.; between the most northerly and southerly sites 3.2 km. (Fig. 1).

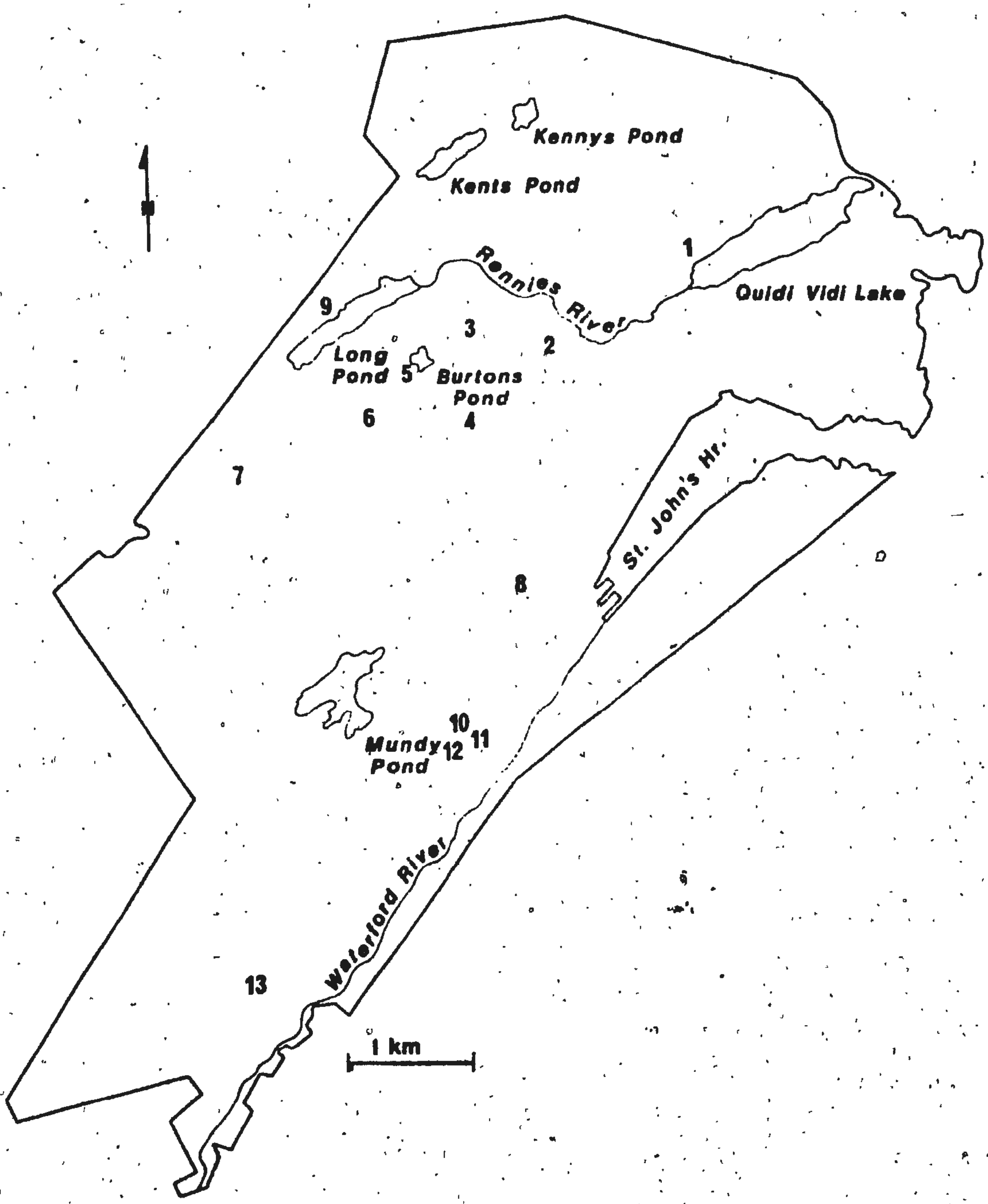
These sites were usually standard-size domestic city lots, grass-covered, containing various trees and usually a number of flower beds and garden sheds. Two traps per site were placed against houses, sheds or trees, in flower beds, in hedges, near fences or wherever a suitable location could be found. They were periodically moved from place to place within the site, depending upon the rate of capture.

Collections were made from July to September 1970; May to October 1971; and July to September 1972. Traps were checked about twice a week depending upon the weather.

Traps

The traps were constructed of two grooved boards held together by metal corners and heavy elastic bands. The top piece measured 304 x 90 x 20 mm., the bottom piece 330 x 90 x 20 mm. Grooves 6 x 10 mm. were cut in both top and bottom pieces with 10 mm. spacing between the grooves.

Fig. 1 Map of St. John's showing the distribution of the thirteen collecting sites sampled for <u>Forficula auricularia</u> (L.), 1970 - 1972


Kennys Pond
Kents Pond
Rennies River
Quidi Vidi Lake
Long Pond
Burtons Pond
St. John's Hr.
Mundy Pond
Waterford River
1 km
1
2
3
4
5
6
7
8
9
10
11
12
13

An air vent 12 x 6 mm. was cut perpendicular to the grooves in the bottom piece to allow for adequate ventilation of the trap (Fig. 2).

The traps were designed to accommodate the well-known nocturnal and thigmotactic habits of the earwig. Most earwig activity takes place during the night, earwigs showing little activity throughout the day. The grooves allow adequate freedom of movement of the earwig's dorso-ventrally flattened body, yet were well-cornered for their thigmotactic behavior. The effectiveness of this trap for capturing earwigs has been well documented, (Crumb et. al.(1941); Morris (1965); Barnes (1946)), but the first record of its use is unknown.

The traps were usually set at the base of a tree or shrub at an angle of 30^{0} to the ground. Some traps were laid on the surface of the ground in flower beds but again were raised at one end on small stones. Traps were concealed as much as possible to prevent any human disturbance. (Fig. 3).

Caution had to be taken removing the trap from its place to avoid the escape or falling out of captured earwigs. Once picked up and the elastic bands removed, the trap was inverted over a plastic bag, the two halves quickly separated, then vigorously shaken until all earwigs had been transferred to the plastic bag, (Fig. 4). These were appropriately labelled and tied off for transportation back to the laboratory. After the samples were analyzed, they were placed in 80% ethyl alcohol for preservation and storage.

Fig. 2 Grooved board trap for collecting *Forficula auricularia* (L.)

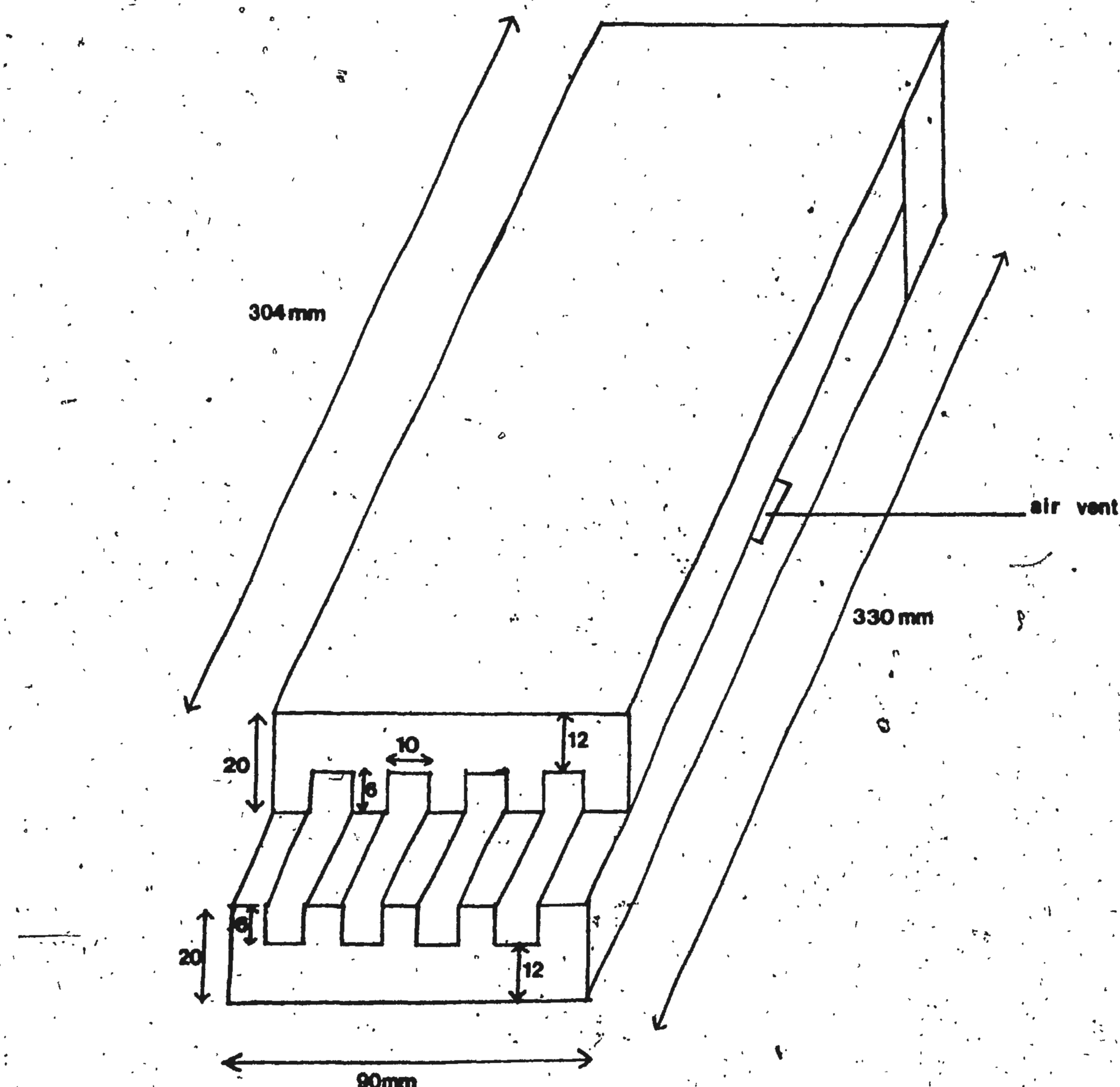

304mm
air vent
330mm
20
10
12
6
6
20
12
90mm

Fig. 3   Grooved board trap set in position.

Fig. 4 Transfer of earwigs from trap to plastic bag.

In 1970 an attempt was made to determine the effect of baiting traps. Peanut butter, a known earwig attractant, (Crumb et. al. (1941); Morris (1965)) was smeared in the grooves at either end of one of the two traps at each collecting site.

Sample analysis

Before attempting to sort the samples, earwigs were anaesthetized by introducing a ball of cotton wool soaked in ethyl acetate into the plastic bag.

Adult earwigs are easily sexed primarily by the shape of the forceps - the heavily sclerotized pincers at the posterior end of the body which are characteristic of the order. (Fig. 5)

Adult females are characterized by very little curvature of the forceps. The dimorphism in forceps development amongst male earwigs has been well-documented (Crumb et. al. (1941); Djakanov (1925); Huxley (1927)). Two distinct forms are evident: the short forceps form or forma brachylabia (Semenov Tian-Shansky, 1910), and the long-forceps form or forma macrolabia (Semenov Tian-Shansky, 1910). Other authors have referred to them as "low" and "high" males respectively (Bateson and Brindley (1892); Sopp (1904)).

The shape of the forceps could not be used as a differentiating characteristic for nymphs because external dimorphism is not evident until the adult stage is reached. Dissection would probably have been

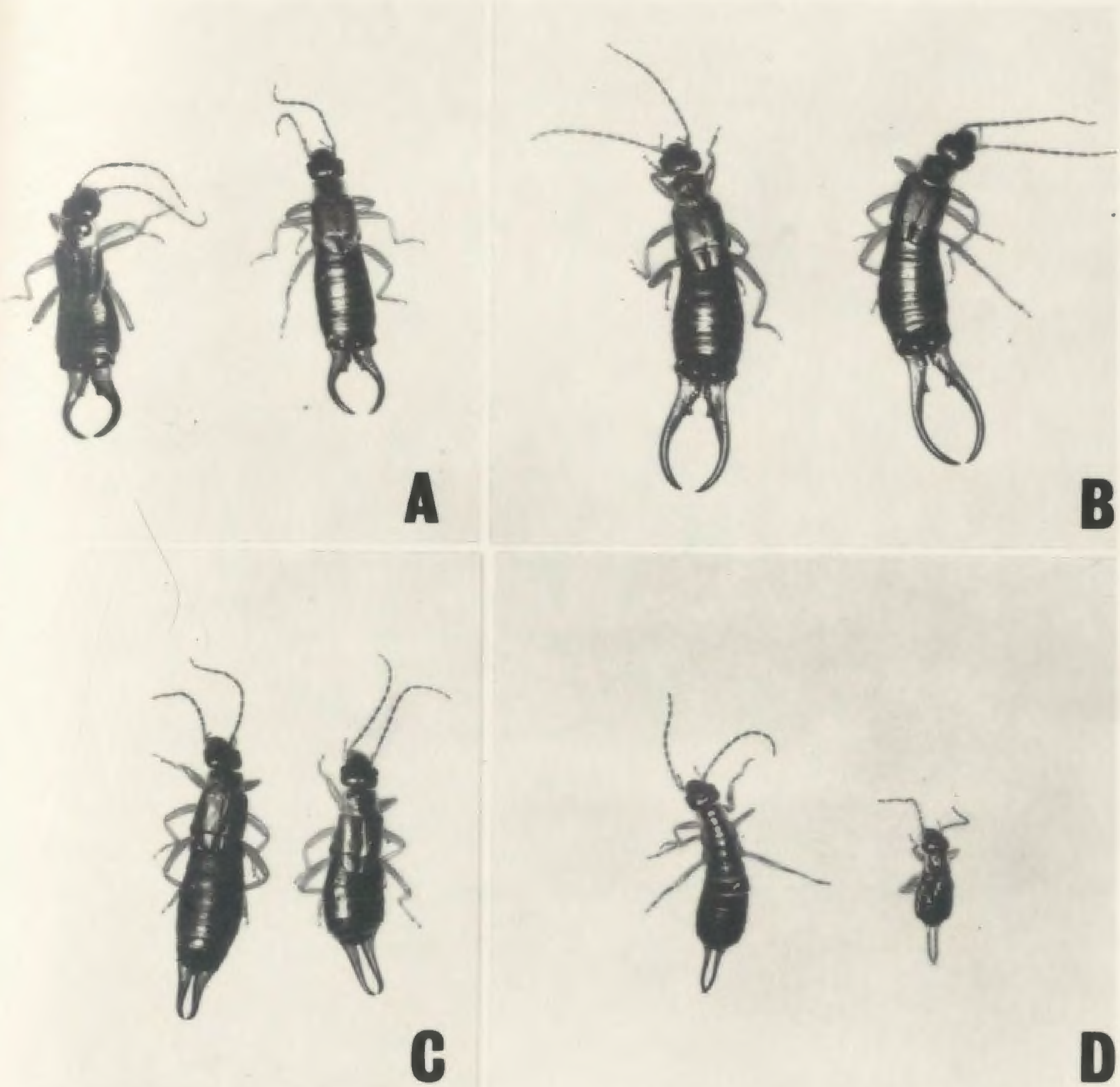
Fig. 5 Variability in <u>Forficula auricularia</u> (L.) forceps.

A - short forceps male

B - long forceps male

C - female

D - nymphs



of little value due to undeveloped reproductive organs. For this reason nymphal earwigs were not sexed but only sorted into instars.

Table 1

criterion	first instar	second instar	third instar	fourth instar
antennal segments	8	10	11	12
body length (in mm.)	4.2	6.0	9.0	9.0 - 11.0
head width (in mm.)	0.9	1.1	1.5	1.9
wing pads	none	none	none	evident

Table 1 Characters used in distinguishing nymphal instars. Number of antennal segments due to Crumb, Bönn & Eide (1941); Henson (1947); Lhoste (1942). Body length due to Crumb et. al. (1941). Head width due to Crumb et. al. (1941), Henson (1947). Evidence of wing pads due to Crumb et. al. (1941).

The criteria for differentiating nymphal instars are given in Table 1. The antennae of F. auricularia are similar to those of other insects having a basal joint or scape, a small pedicel and a varying number of joints in the flagellum, depending upon the instar. The nymphal instars could be differentiated by the differing number of flagellar joints, the number being easily determined under a stereomicroscope. The number of antennal joints in each instar is shown in Table 1.

The body length (excluding antennae and forceps) was determined by measuring from the anterior margin of the labrum to the posterior margin of the last abdominal segment. Measurements were made to the nearest 0.5 mm. using a ruler under a stereomicroscope.

In determining head width, the distance between the epicranial borders was measured to the nearest 0.5 mm. using a plastic ruler under a stereomicroscope.

The appearance of wing pads was used as an extra criterion for differentiating between late third and early fourth instars. Only on the latter are wing pads evident.

Since the danger existed of lost or broken off antennal joints, the segments of both antennae were counted, and along with body length and head width measurements, nymphal instar differentiation was considered reliable.

Capture - recapture experiment

Within location one, an attempt was made to study the movement of individual earwigs by using marked individuals. Thirty-three traps were set within a grass-covered area, 30.5 x 23 m., which was bounded on its north and south sides by a double row of trees and shrubs, the plants in each row being 6.1 m. apart and alternately spaced in the two rows. (Fig. 6)

Eleven traps were placed against these trees and shrubs along the northern and southern sides at an angle of 30^0 to the ground, and eleven traps were placed similarly on the ground midway between the two double rows of trees and shrubs. (Fig. 7)

Marks were placed on earwigs on the left and right forceps and on the pronotum. The forceps were chosen because of their heavily-sclerotized nature and both forceps and pronotum for their prominent position and ease of mark application and recognition.

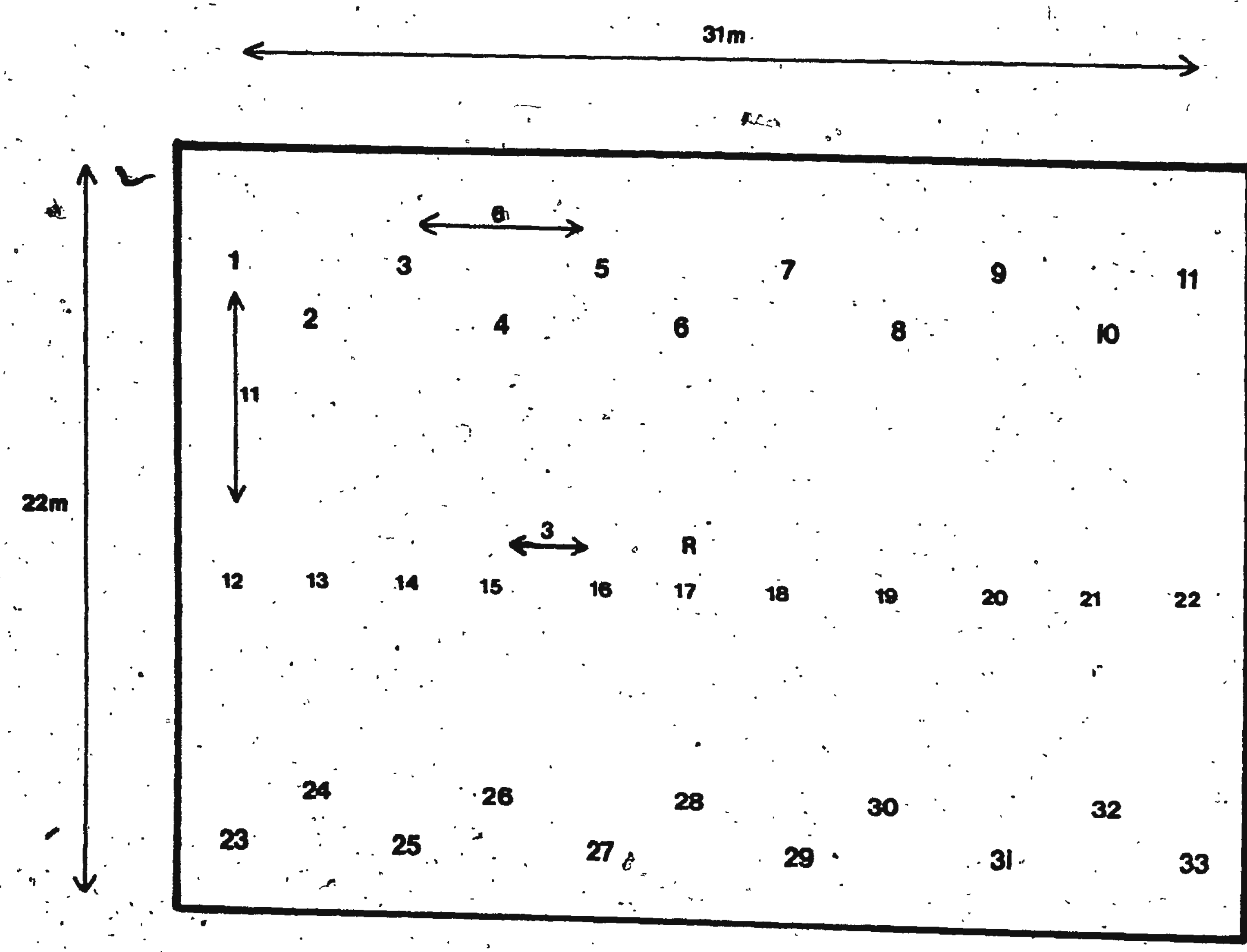
Fifty adult males and fifty adult females were individually marked. To obtain fifty different marks for each sex, three colours were used: white, orange and purple. Paraplast(R) [1] was used for white, paraplast coloured with oil red O[2] for orange, paraplast coloured with basic fuchsin[3] for the purple mark, (see Table 2). Testor's paint, nail polish and pronotal notching (Gangwere et. al. 1964) proved unsuccessful.

[1] Mfd. by Sherwood Medical Industries, Bridgeton, Missouri.

[2] Mfd. by Matheson Coleman & Bell, Norwood, Ohio.

[3] Mfd. by The British Drug Houses (Canada) Ltd., Toronto, Ontario.

Fig. 6 Experimental design for using marked individuals of *F. auricularia* : Site 1, September 1971.



31m
22m
6
11
3
R
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33

Fig. 7 Positioning of 22 of 33 traps used to recapture individual earwigs at site 1, September 1971.

Table 2

Male								Female							
No.	lf.	rf.	pro.	No.	lf.	rf.	pro.	No.	lf.	rf.	pro.	No.	lf.	rf.	pro.
1	W	-	-	26	-	P	P	51	W	-	-	76	-	P	P
2	-	W	-	27	P	P	P	52	-	W	-	77	P	P	P
3	-	-	W	28	P	P	W	53	-	-	W	78	P	P	W
4	W	0	-	29	P	P	0	54	W	0	-	79	P	P	0
5	W	-	0	30	P	0	W	55	W	-	0	80	P	0	W
6	W	P	-	31	P	W	0	56	W	P	-	81	P	W	0
7	W	-	P	32	P	0	0	57	W	-	P	82	P	0	0
8	W	W	-	33	0	-	-	58	W	W	-	83	0	-	-
9	W	-	W	34	-	0	-	59	W	-	W	84	-	0	-
10	-	W	W	35	-	-	0	60	-	W	W	85	-	-	0
11	W	W	W	36	0	W	-	61	W	W	W	86	0	W	-
12	W	W	0	37	0	-	W	62	W	W	0	87	0	-	W
13	W	W	P	38	0	P	-	63	W	W	P	88	0	P	-
14	W	0	W	39	0	-	P	64	W	0	W	89	0	-	p
15	W	0	P	40	0	0	-	65	W	0	P	90	0	0	-
16	W	P	0	41	0	-	0	66	W	P	0	91	0	-	0
17	P	-	-	42	-	0	0	67	P	-	-	92	-	0	0
18	-	P	-	43	0	0	0	68	-	P	-	93	0	0	0
19	-	-	P	44	0	0	W	69	-	-	P	94	0	0	W
20	P	W	-	45	0	0	P	70	P	W	-	95	0	0	P
21	P	-	W	46	0	W	0	71	P	-	W	96	0	W	0
22	P	0	-	47	0	W	W	72	P	0	-	97	0	W	W
23	P	-	0	48	0	P	0	73	P	-	0	98	0	P	0
24	P	P	-	49	0	P	W	74	P	P	-	99	0	P	W
25	P	-	P	50	0	W	P	75	P	-	P	100	0	W	P

Summary of marking scheme used in experiment with individually marked earwigs.

Key: lf = left forceps, rf = right forceps, pro = pronotum, W = white mark (paraplast), 0 = orange mark (paraplast plus oil red 0), P = purple mark (paraplast plus basic fuchsin), - = no mark at this site.

Earwigs were anaesthetized using ethyl ether and placed under a stereomicroscope for marking. Marking solutions when heated were easily applied using fine dissecting probes. The mark, cooling in a few seconds, was approximately 1 mm. in diameter. Caution had to be taken to prevent the marking material from running down and hardening into the genital and thoracic regions, hindering natural activity. Earwigs were captured and marked the same day and released the following day.

Each trap was checked three times. The first check was spread over three days, the second check spread over two, and the final check was done in one day.

Checking of the traps involved emptying the traps into a plastic bucket, the top of which was lined with a one inch ring of Tanglefoot(R)[1] to prevent any escape. Each individual adult was closely inspected for any mark by picking it up with a pair of forceps.

[1] Mfd. by The Tanglefoot Company, Grand Rapids, Michigan, U.S.A.

RESULTS

Complete analyses of samples from 13 collecting sites May to October, 1971 and for 3 sites July to September, 1972 are given in Appendix A. The other 12 sites yielded insufficient numbers and were not further considered. Street addresses of sites used are listed in Appendix B.

Table 3 presents numbers of the nymphal and adult instars, as percentages of total nymphs and adults and also total numbers on the various sampling dates from site 1 for 1971; Fig. 8 shows the seasonal peaks of the four nymphal stages. The seasonal history was also determined using average trap catches for each instar, the same general picture being obtained. For convenience in graphing the percent instars are used in Fig. 8.

In early spring at site 1 only adults were taken, most of which were males. The proportion of males fell from mid-May to mid-June and none were caught between June 25 and July 27, except for two taken on July 14; the possible reason for their occurrence is discussed later. After August 4 the proportion of males fluctuates about 50%; actual percentages are given in Table 3.

Nymphs first appeared at site 1 on June 8 and were almost all in the first instar (Fig. 8 and Table 3). One week later females made up a higher proportion of the reduced total catch of adults. Similar data are given from sites 4 and 5 in Tables 4 and 5 respectively.

Peaks of abundance for 3 collecting sites are presented in Table 6. Of the other sites studied, only 4 and 5 provided sufficiently large samples to permit graphical representation, (Fig. 8). Since the date of

Table 3

Numbers of nymphs and adults as percentages of total nymphs and adults respectively in samples taken on various dates in 1971 from site 1.

Date 1971	Nymphs 1	2	3	4	Total nymphs	Adults M	F	Total adults	Total nymphs and adults
May 14-17*	-	-	-	100.00****	1	85.19	14.81	27	28
May 18-20**	-	-	-	-	0	90.59	9.41	85	85
June 1-3***	-	-	-	-	0	72.59	27.41	135	135
June 8	97.65	2.35	-	-	85	40.59	59.41	170	255
June 16	58.60	41.40	-	-	715	12.12	87.88	33	748
June 21	6.96	92.95	0.09	-	2126	2.13	97.87	47	2173
June 25	3.49	88.21	8.30	-	1145	0	100.00	68	1213
July 1	0.39	37.18	62.43	-	4137	0	100.00	49	4186
July 6	0.04	15.41	84.55	-	2777	0	100.00	20	2797
July 14	0.21	7.98	86.88	4.93	24802	7.14	92.86	28	24830
July 20	0.66	8.25	60.59	30.50	10592	0	100.00	16	10608
July 22	0.87	4.55	41.20	53.38	5888	0	100.00	19	5907
July 27	0.59	2.16	21.32	75.93	7279	0	100.00	13	7292
Aug. 4	0.50	3.98	9.74	85.78	3215	50.33	49.67	761	3976
Aug. 12	0.87	10.54	30.51	58.08	6225	58.28	41.72	1817	8042
Aug. 20	0.54	13.40	41.00	45.06	4656	59.18	40.82	1602	6258
Aug. 29	-	0.30	11.08	88.62	677	58.79	41.21	182	859
Oct. 15	-	0.67	4.11	95.22	1191	45.71	54.29	2131	3322

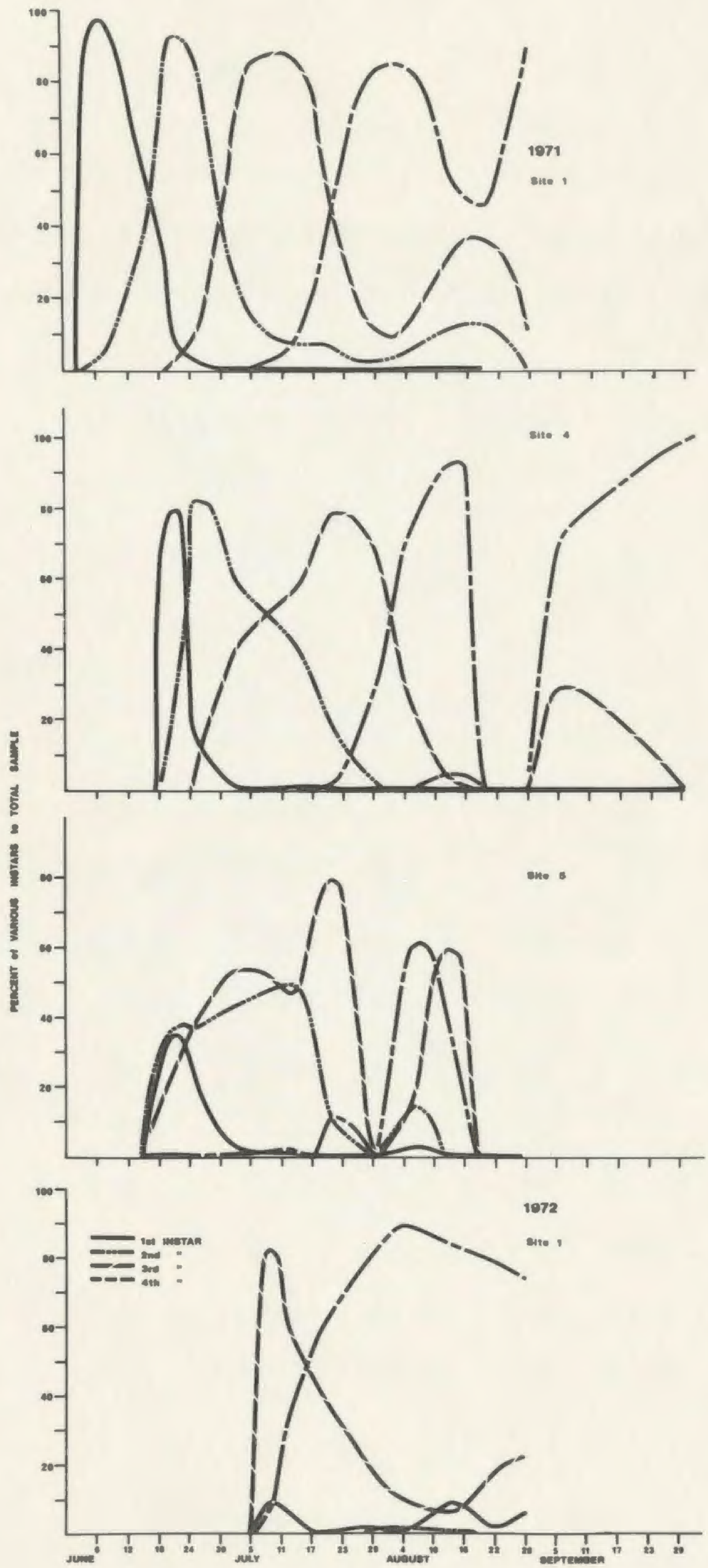
* The period May 14 - 17 includes 3 sampling days: May 14, 15, 17.

** The period May 18 - 20 includes 2 sampling days: May 18, 20.

*** The period June 1 - 3 includes 2 sampling days: June 1, 3.

**** This value is not included in Fig. 8 See explanation in text.

Fig. 8 Seasonal peaks of the four nymphal stages at
site 1, May to August 1971;
site 4, June to September 1971;
site 5, June to September 1971;
site 1, May to August 1972.



1971
Site 1
Site 4
Site 5
1972
Site 1
1st INSTAR
2nd "
3rd "
4th "
PERCENT of VARIOUS INSTARS to TOTAL SAMPLE
100
80
60
40
20
JUNE
6 12 18 24 30
JULY
5 11 17 23 29
AUGUST
4 10 16 22 28
SEPTEMBER
5 11 17 23 29

Table 4

Numbers of nymphs and adults as percentages of total nymphs and adults respectively in samples taken on various dates in 1971 from site 4.

Date 1971	Nymphs 1	2	3	4	Total nymphs	Adults M	F	Total adults	Total nymphs & adults
June 8	0	0	0	0	0	0	100	1	1
June 17	0	0	0	0	0	0	100	1	1
June 21	80.00	20.00	0	0	5	0	0	0	5
June 24	16.67	83.33	0	0	12	0	0	0	12
July 1	0	60.00	40.00	0	5	0	0	0	5
July 14	1.61	41.93	56.45	0	62	0	0	0	62
July 21	0	18.47	79.92	1.62	249	100	0	1	250
July 29	0.37	2.25	68.91	28.46	267	0	0	0	267
Aug. 3	0	0	30.00	70.00	10	0	0	0	10
Aug. 12	0	4.35	2.90	92.75	69	41.67	58.33	12	81
Aug. 19	0	0	0	0	0	66.67	33.33	3	3
Aug. 27	0	0	0	0	0	0	0	0	0
Sept. 2	0	0	28.57	71.43	7	0	0	0	7
Sept.30	0	0	0	100.00	37	50.00	50.00	18	55

Table 5

Numbers of nymphs and adults as percentages of total nymphs and adults respectively in samples taken on various dates in 1971 from site 5.

Date 1971	Nymphs 1	2	3	4	Total nymphs	Adults M	F	Total adults	Total nymphs and adults
June 22	35.93	36.95	26.60	0.49	203	0	100	1	204
June 24	27.78	36.11	36.11	0	36	0	0	0	36
July 1	2.73	42.73	53.64	0.91	110	0	0	0	110
July 13	1.28	49.36	47.44	1.92	156	0	0	0	156
July 16	0	40.00	60.00	0	10	0	0	0	10
July 21	0	8.82	79.41	11.76	34	0	0	0	34
Aug. 6	3.55	15.23	19.29	61.93	197	43.33	56.67	30	227
Aug. 12	0	0	60.00	40.00	5	50.00	50.00	12	17
Aug. 19	0	0	0	0	0	75.00	25.00	4	4
Aug. 27	0	0	0	100.00	1	0	0	0	1
Sept. 2	0	0	0	0	0	50.00	50.00	4	4
Sept. 7	0	0	0	100.00	9	34.38	65.62	32	41

the peak was determined by examination of traps, it was estimated as the date midway between the trap examination before the apparent peak and that after (Tables 3, 4, 5).

An estimate of the average duration of the four nymphal instars for sites 1, 4 and 5 is presented in Table 7. These estimates were obtained from Tables 3 through 6. Because of the lack of an adult peak, the average duration of the fourth instar was determined by calculating the days between the appearance of the first fourth instars and the first appreciable appearance of adults, excluding the two anomalous appearances discussed.

Table 6

Summary of dates of peaks of abundance for the four nymphal instars at sites 1, 4 and 5 for 1971.

Instar	1	2	3	4
Site 1	June 7	June 21	July 14	August 4
Site 4	June 20	June 26	July 21	August 12
Site 5	June 20	July 8	July 22	August 7

Table 7

Summary of estimates of the average instar duration (in days) of the four nymphal instars at sites 1, 4 and 5 for 1971.

Instar	1	2	3	4	Total nymphal duration*
Site 1	14	23	21	21	79
Site 4	6	25	22	22	75
Site 5	18	14	17	17	66

* It must be noted that the average duration of the first instar is subject to error because of the varying number of days they might remain in the nest before emerging.

As a result of this estimation the total nymphal period given in Table 7 is greater than the actual number of days between June 8 and August 4, 1971.

A statistical analysis of the data given in Table 7 showed no significant difference between the estimates of the average durations of the nymphal instars for the three collecting sites given (calculated $F_{3,8}$ value = 2.01, Table 8).

Table 8

Table of analysis of variance on average instar duration of the four instars at sites 1, 4 and 5 for 1971.

Source	d. f.	M.S.	calc. F.	tab. F. (.05)
between	3	43.11	2.01	4.07
within	8	21.41		
total	11			

To compare the total nymphal life of the first and second broods at site 1, the number of days between the peaks of the first and second broods of the four nymphal instars was calculated from Table 3. These results are presented in Table 9. The decreasing interval between the peaks for the two broods indicates a shorter nymphal instar duration for the second brood than the first.

Results of trap catches from site 1 for 1972 are presented in Table 10. Peaks of abundance for the third and fourth instars were on July 11 and August 5 respectively. Estimates of the average instar duration for third and fourth instars were 25 and 22 days respectively. Abundance peaks and estimates of the average instar duration for first and second instars are not

Table 9

Shows peaks of abundance for the various nymphal instars for both first and second broods from site 1 for 1971.

Instar	Peak of abundance 2nd brood	Peak of abundance 1st brood	Days difference
I	July 22	June 7	45 *
II	Aug. 20	June 21	59
III	Aug. 20	July 14	36
IV	Aug. 29	Aug. 4	25

* No discernible peak but it should be noted that first instar nymphs can be found throughout the sampling period; also it is difficult to estimate the time the first instar leaves the nest.

available due to the traps not being laid until July 7, 1972.

Rates of development for 1971 and 1972 were compared at site 1 by comparing numbers of the various instars as percentages of total nymphs for comparable periods for the two years. The data are given in Table 11. Statistical analyses showed no significant differences between rates of development for second, third and fourth instars for the two years, indicating a high degree of similarity between years (calculated t values of 1.55, 0.69, 0.88; 14 d. f. for second, third and fourth instars, respectively).

Table 10

Numbers of nymphs and adults as percentages of total nymphs and adults respectively in samples taken on various dates in 1972 from site 1.

Date	Nymphs				Total	Adults		Total	Total nymphs
1972	1	2	3	4	nymphs	M	F	adults	and adults
July 11	0	9.09	83.64	7.27	55	0	0	0	55
July 14	0	6.67	60.00	33.33	15	0	0	0	15
July 20	0	0	43.90	56.10	41	0	0	0	41
July 28	0	1.90	21.43	76.67	210	100	0	2	212
Aug. 4	0.64	0	10.90	88.46	156	23.08	76.92	13	169
Aug. 15	0.50	9.00	6.50	84.00	200	50.85	49.15	177	377
Aug. 24	0	2.33	18.60	79.07	172	59.14	40.86	186	358
Aug. 29	0	4.39	20.18	75.44	114	51.12	48.88	178	292
Sept.15	0.38	0.38	13.53	85.71	266	48.20	51.80	334	600

Table 11

A comparison of rates of development for three nymphal instars for 1971 and 1972 at site 1. Values given are numbers of the various instars as percentages of total nymphs.

time interval	instar 1 1971	instar 1 1972	instar 2 1971	instar 2 1972	instar 3 1971	instar 3 1972	instar 4 1971	instar 4 1972
July 6-11			15.41	9.09	84.55	83.64	0	7.27
July 14	No comparison		7.98	6.67	86.88	60.00	4.93	33.33
July 20	made;		8.25	0	60.59	43.90	30.50	56.10
July 27-28	insufficient		2.16	1.90	21.32	21.43	75.93	76.67
Aug. 4	numbers		3.98	0	9.74	10.90	85.78	88.46
Aug. 12-15	collected.		10.54	9.00	30.51	6.50	58.08	84.00
Aug. 20			13.40	2.33	41.00	18.60	45.06	79.07
Aug. 29			0.30	4.39	11.08	20.18	88.62	75.44
			t = 1.55		t =0.693		t = 0.88	
			d. f. = 14		d.f. = 14		d.f. = 14	

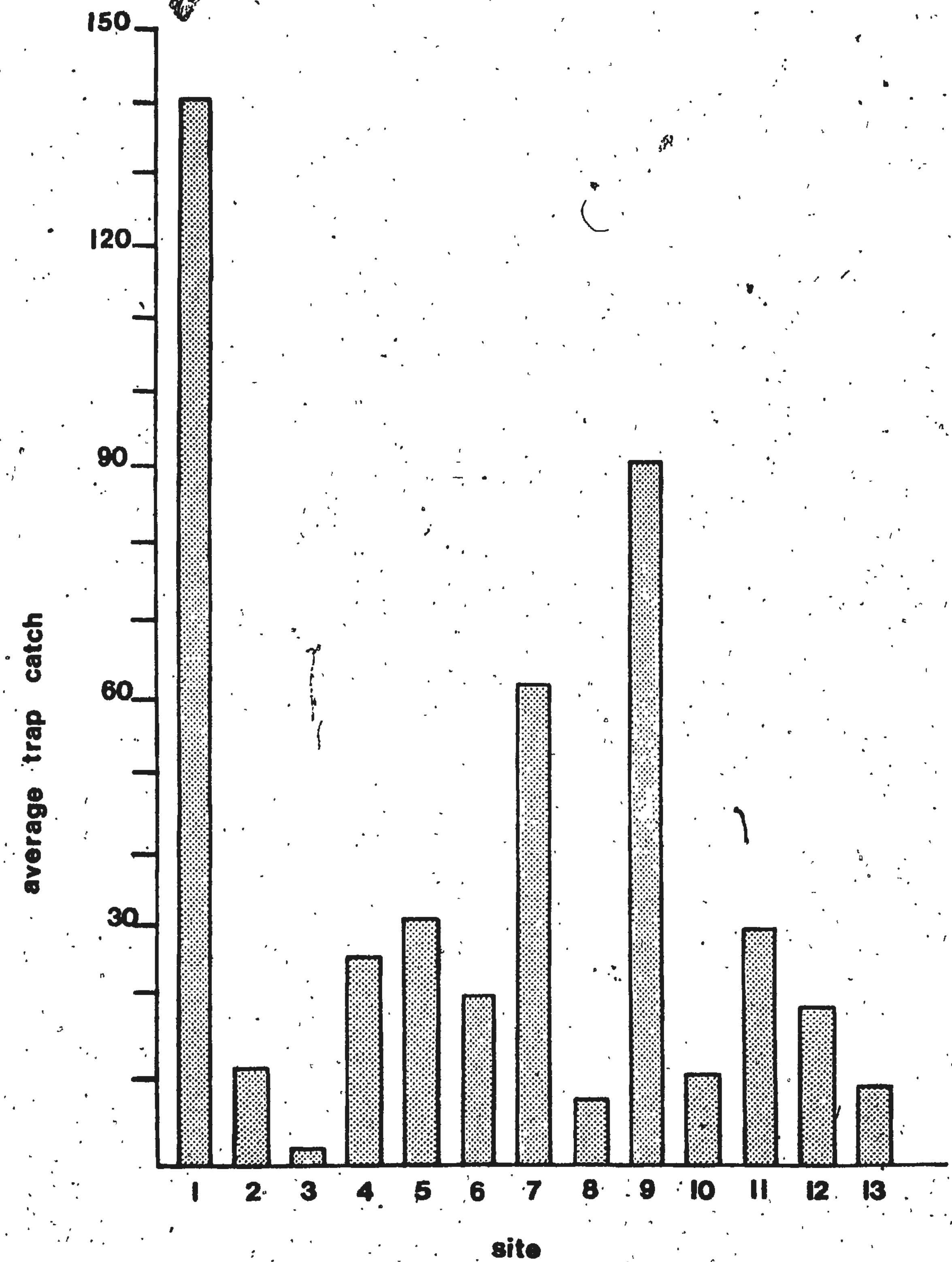
Table 12

Average daily trap catches for 1971 for thirteen collecting sites in St. John's.

Site	Total earwigs captured	Total opportunities*	average daily trap catch
1	89 636	636	140.94
2	304	24	12.67
3	77	28	2.75
4	759	28	27.11
5	844	26	32.46
6	494	22	22.46
7	759	12	63.25
8	247	28	8.82
9	1 110	12	92.50
10	305	26	11.73
11	492	16	30.75
12	334	16	20.88
13	211	20	10.55
Totals	95 572	894	106.90

* Total opportunities is the product of the number of traps at the location and the number of days sampled.

Fig. 9 Average daily trap catches for 1971 for thirteen collecting sites in St. John's.


150
120
90
60
30
average trap catch
1
2
3
4
5
6
7
8
9
10
11
12
13
site

Trap catches

The average daily trap catches in 1971 for 13 St. John's sites are given in Table 12 and illustrated in Fig. 9. A statistical comparison yielded a chi square value of 778.244 (12 d.f.) indicating highly significant differences between the sites ($P < 0.01$).

Average catches per trap for fortnightly periods for eight sites from June 15 to September 15, 1971 are given in Table 13. An analysis of variance showed that significant differences existed for the trap catches between sites ($F_{7,40} = 10.49$; Table 14).

Table 13

Fortnightly average trap catches for 8 sites at St. John's during the period June 15 to September 15, 1971.

Date 1971	Sites 1	2	3	4	5	8	10	13
June 15-30	86.12	0.50	0	3.00	60.00	0.50	0	1.00
July 1-15	363.29	8.25	20.00	16.75	66.50	1.50	0	0.50
July 16-31	208.83	7.75	1.83	129.25	7.33	7.33	37.50	10.25
Aug. 1-15	158.13	30.00	3.75	22.75	61.00	19.00	1.67	38.50
Aug. 16-31	93.65	4.75	1.50	0.75	1.25	2.75	33.50	3.00
Sept. 1-15	135.07	17.00	2.50	3.50	2.00	15.00	5.00	0.50

Table 14

Table of analysis of variance on fortnightly average trap catches for 8 sites at St. John's during the period June 15 to September, 1971.

Source	d.f.	M.S.	calc. F value	Tab. F value (.05)
between	7	19 525.87	10.49	2.25
within	40	1 860.57		
total	47			

The average daily trap catches for site 1 for 1971 and 1972 are given in Tables 15 and 16. Chi square tests yielded values of 3292.15 (23 d.f.) for 1971 and 125.35 (8 d.f.) for 1972, indicating highly significant differences between days for both years for trap catches over the sampling period.

Individual trap counts were made at site 1 on July 6 and October 15, 1971. Results are given in Table 17. A comparison of mean trap catches for these two days showed a significant difference. ($t = 3.661$; 30 d.f. $P < 0.05$).

A comparison of mean number per trap per day at sites 1, 5 and 9 for 1971 and 1972 is given in Table 18. There was a significantly lower mean in 1972 than in 1971 only at site 1.

The average trap catch for the 13 St. John's locations in 1971 are illustrated in Figs. 10, 11 and 12 in which the width of the bars is proportional to the interval between setting and examination of the traps. The results generally indicate that a larger time interval between sampling periods produced a larger average trap catch.

Table 15

The average daily trap catches at site 1 during May to October, 1971.

Date	No.traps checked	Total earwigs capt.	Average trap catch
May 14, 15	32	26	0.81
May 17,18,20	48	87	1.81
June 1	16	118	7.38
June 3	16	17	1.06
June 8	16	255	15.94
June 16	16	748	46.75
June 21	16	2 173	135.81
June 25	16	1 213	75.81
July 1	16	4 186	261.63
July 6	16	2 797	174.81
July 14	38	24 830	653.42
July 20	38	10 608	279.16
July 22	38	5 907	155.45
July 27	38	7 292	191.89
Aug. 4	38	3 976	104.63
Aug. 12	38	8 042	211.63
Aug. 20	38	6 258	164.68
Aug. 29	38	859	22.61
Sept. 7	18	1 390	77.22
Sept. 8	6	1 596	266.00
Sept. 9	9	1 643	182.56
Sept.10	22	1 296	58.91
Sept.11	11	997	90.64
Sept.15	58	3 322	57.28
	636	89 636	$\bar{x}$ = 140.94*

$\chi^2 = 3292.15$ (23 d.f.)

*This figure is mean average trap catch determined from total earwigs captured and total opportunities and is used as the expected value for the chi-square test.

Table 16

Average daily trap catches at site 1, July to September, 1972.

Date	No. traps checked	Total earwigs captured	Average trap catch
July 11	10	55	5.50
July 14	10	15	1.50
July 20	10	41	4.10
July 28	10	212	21.20
Aug. 4	10	169	16.90
Aug. 15	10	377	37.70
Aug. 24	10	358	35.80
Aug. 29	10	292	29.20
Sept. 15	10	600	60.00
	90	2 119	$\bar{x}$ = 23.54*

$$\chi^2 = 125.35; \quad (8\ d.f.)$$

* Not the arithmetic mean. This figure is mean average trap catch determined from total earwigs captured and total opportunities and is used as the expected value in the chi-square test.

Table 17

Individual trap counts for site 1 for July 6 and October 15, 1971.

July 6		October 15	
Trap no.	No. earwigs caught	Trap no.	No. earwigs caught
1	69	1	43
2	247	2	25
3	207	3	49
4	520	4	50
5	19	5	21
6	82	6	18
7	130	7	22
8	2	8	25
9	13	9	21
10	20	10	20
11	159	11	53
23	281	23	13
24	177	24	71
25	162	25	89
26	407	26	39
27	302	27	33

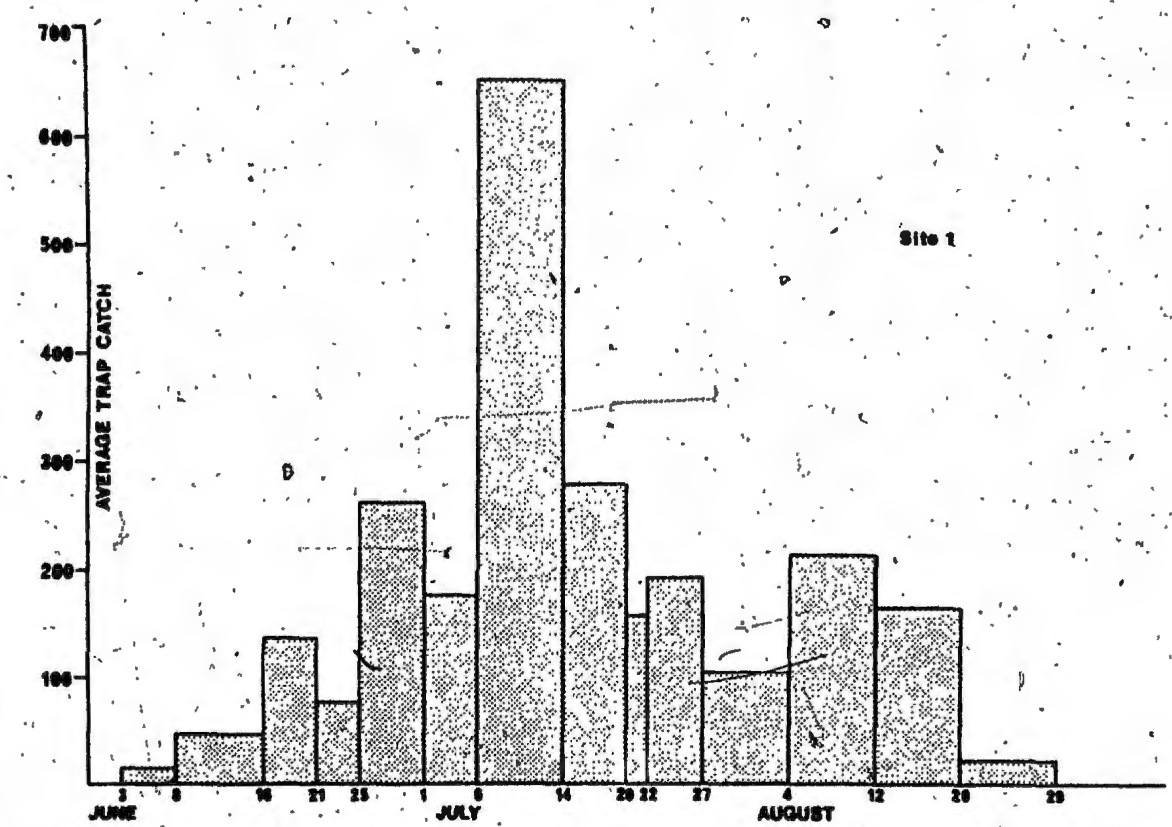
$\bar{x}_1 = 174.81$ $\bar{x}_1 = 37.00$

Table 18

Comparison of average trap catches for sites 1, 5 and 9 for 1971 and 1972.

	1971	1972	
Site 1	$\bar{x}$ = 140.94 n = 24 (days)	$\bar{x}$ = 23.54 n = 9	t = 2.45 d.f. = 31
Site 5	$\bar{x}$ = 32.46 n = 13	$\bar{x}$ = 6.30 n = 5	t = 1.39 d.f. = 16
Site 9	$\bar{x}$ = 92.50 n = 6	$\bar{x}$ = 66.70 n = 5	t = 0.86 d.f. = 9

Fig. 10 Average trap catches on various sampling dates in 1971 from site 1.



700
600
500
400
300
200
100
AVERAGE TRAP CATCH
Site 1
3
8
16
21
25
1
6
14
20
22
27
4
12
20
28
JUNE
JULY
AUGUST

Fig. 11 Average trap catches on various sampling dates in 1971 from sites 2, 4, 5, 6, 7, 8.

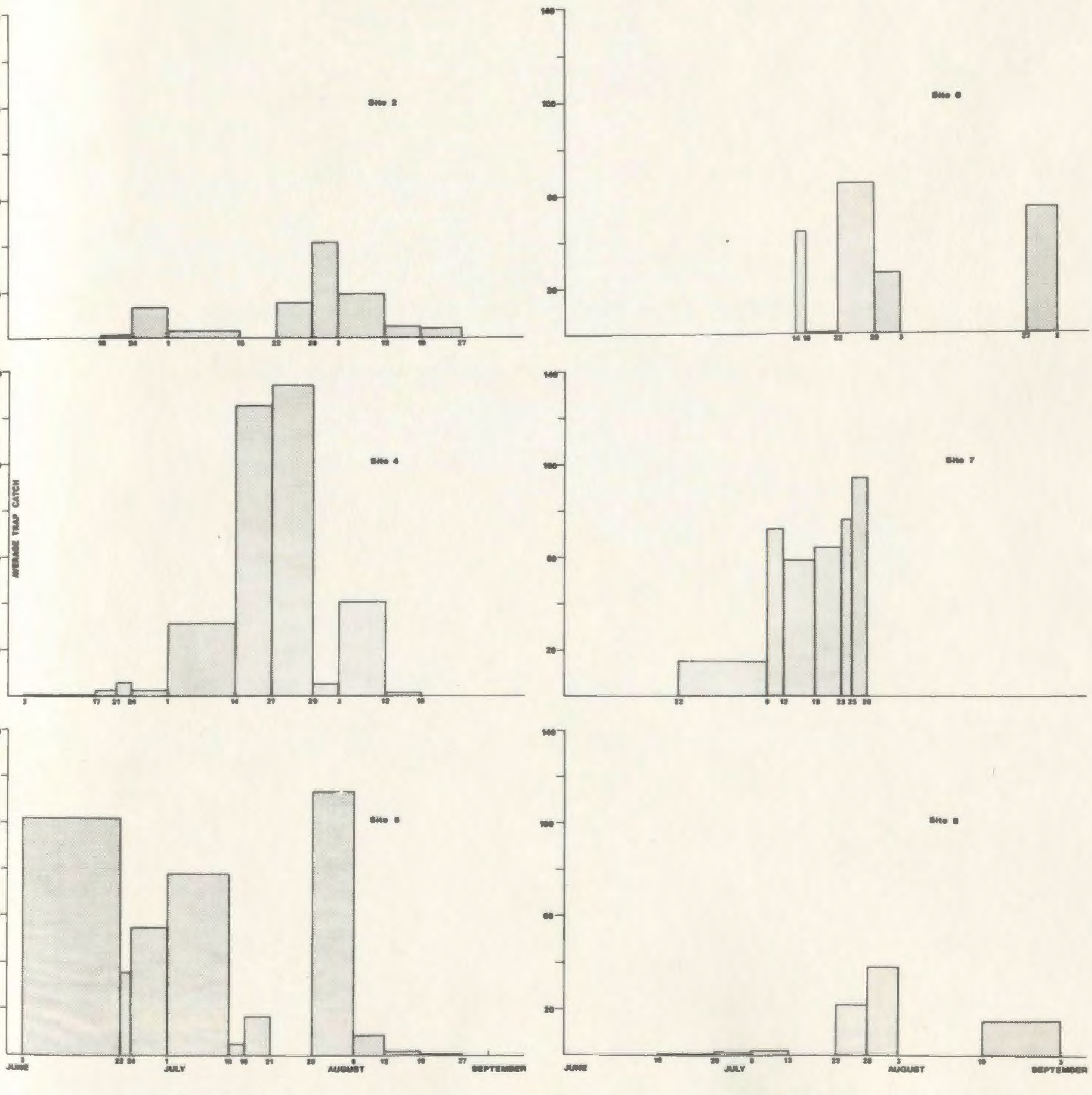
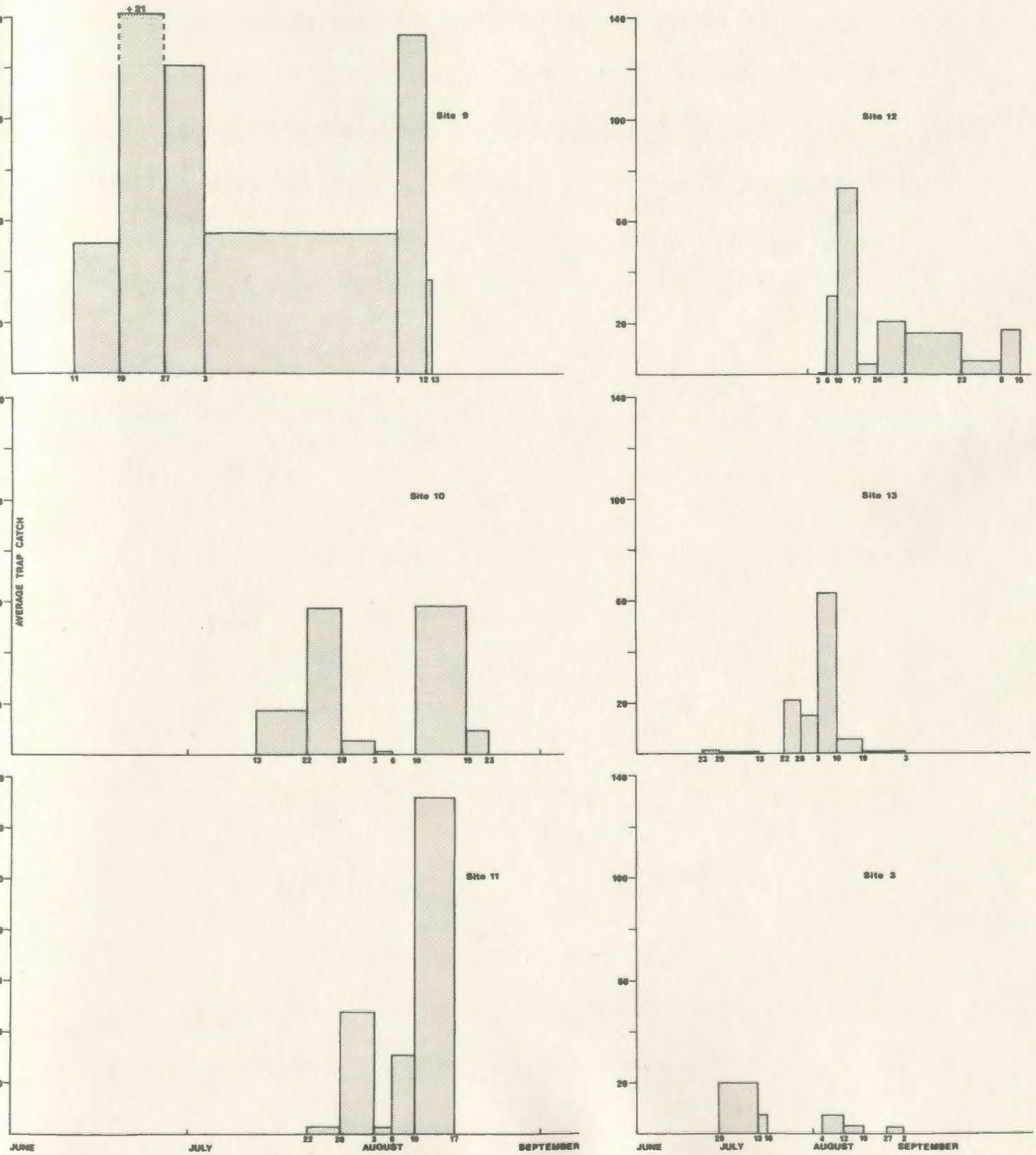

Site 2
Site 4
Site 7
AVERAGE TRAP CATCH
JUNE
JULY
AUGUST
SEPTEMBER

Fig. 12 Average trap catches on various sampling dates in 1971 from sites 9, 10, 11, 12, 13, 3.


Site 9
Site 12
Site 10
Site 13
Site 11
Site 3
AVERAGE TRAP CATCH
JUNE
JULY
AUGUST
SEPTEMBER

The effectiveness of baiting traps was checked during 1970. At six sites one of two traps was baited with peanut butter smeared in the grooves at one end of the trap. The results are given in Table 19. A matched pair design comparison of trap catches for baited vs. non-baited traps did not indicate any significant differences between them ($t = 1.819$; d.f. = 18; $P > 0.05$). This appears surprising in view of the apparent large differences in site 1 and the matter needs further investigation.

Table 19

Site	Baited traps	Non-baited traps
1	77	9
1	103	5
1	219	26
1	87	37
1	283	14
2	7	70
3	0	4
4	11	1
5	3	19
6	4	16

The results of baited vs. non-baited traps at six St. John's sites during 1970. Values are total earwigs caught per trap.

Proportions of the sexes

The sex ratios of earwigs at thirteen St. John's locations are presented in Table 20. A chi square value of 20.3485 (12 d.f.; $P > 0.05$) was obtained using 50% as the expected value. This would indicate that the sex ratio did not vary significantly in the 13 locations, nor differ significantly from 1 : 1.

Table 21 compares the sex ratio of new adults on comparable sampling dates at site 1 for 1971 and 1972. An analysis of variance yielded an $F_{8,1}$ value of 4.03 (Table 22). These data indicate that the proportion of the sexes of new adults did not vary between years.

The overall proportion of the sexes remained remarkably constant at site 1 in 1971 and 1972. These figures were determined as percentages of total adults captured for the complete sampling period, and are presented in Table 23.

Male dimorphism

The heavily-sclerotized terminal forceps of adult earwigs are thought to serve a variety of purposes: in combat and copulation (Lhoste 1942), in holding food (Grimes et. al. 1969), and as weapons of defense (Fulton 1924). It has also been suggested that they are used to facilitate the folding of the wings after flight (Crumb et. al. 1941). Wynne-Edwards (1962) suggests that larger forceps elevate the social status of an individual male. Nymphs and adult females are monomorphic, with a normal distribution over the whole range of their forceps length (Diakonov 1925).

Table 20

Sex ratios at 13 collecting sites at St. John's during 1971.

Site	Total adults collected	Total M	Percent M
1	7 182	3 724	51.85
2	95	53	55.79
3	14	9	64.29
4	36	17	47.22
5	83	35	42.17
6	93	53	56.99
7	115	55	47.83
8	89	40	44.94
9	724	381	52.62
10	92	65	70.65
11	37	21	56.76
12	110	58	52.73
13	126	78	61.90
Total	8 796	4 589	

Table 21

A comparison of the sex ratios of new adults for five comparable sampling dates in 1971 and 1972 at site 1. Values given are percent males.

Sampling date	% males	
	1971	1972
Aug. 4	49.93	77.00
Aug. 12 - 15	58.14	50.84
Aug. 20 - 24	59.04	59.13
Aug. 29	58.79	51.12
Sept. 15 - Oct. 15	45.60	48.20

Table 22

Table of analysis of variance for a comparison of the sex ratios of new adults for five comparable sampling dates in 1971 and 1972 at site 1.

Source	d.f.	M. S.	Calc. F value	Tab. F value (.05)
between	1	21.88	4.03	239.00
within	8	88.29		
total	9			

Table 23

Overall proportions of the sexes at site 1 for 1971 and 1972.

Year	Total adults	Total males	Percent males
1971	7 182	3 724	51.85
1972	890	457	51.34

The existence of two types of males distinguished by different forceps length was first clearly demonstrated by Bateson & Brindley (1892). Various terms have been applied to these two forms: "low and high" (Bateson & Brindley 1892), "forma brachylabia and forma macrolabia" (Diakonov 1925); Stephens (1835) described the species Forficula forcipata to include the form with long forceps, but this has not been accepted by later authorities (Burr 1911). In this thesis they will be referred to as "short and long" forms, as in Beall (1932).

Bateson & Brindley (1892) defined the short form as those with a forceps length of 5 mm. or less, the long form as having forceps 7 mm. or longer, and the intermediate forms in between. Diakonov (1925) considered the individuals up to 5 mm. as the short form and those beginning with 5 mm. upwards as the long form. This tends to overestimate the long form frequency because it includes the intermediate forms. Data on dimorphism collected from St. John's was determined by simple inspection. Intermediate forms were segregated by considering curvature rather than the length of the forceps. Because of the relatively small numbers of intermediate forms, the error in arbitrarily assigning the intermediate forms is not considered significant.

The values for three sites in St. John's in 1971 and 1972 (sites 1, 5, 9) are shown in Table 24. There are no significant differences between sites or years in this case ($F_{3,2}$ = 8.82; Table 25). The highest short-long ratio was found at St. John's during 1971 when 92.05% of 4589 adult males had short forceps.

A comparison of the proportions of short males in the 13 sites in St. John's for 1971 is given in Table 26, which yields $\chi^2 = 46.0225$ (12 d.f.), significant at $P < 0.05$.

Comparison of the proportions of long and short males in the three sites which were sampled in both 1971 and 1972 shows no significant differences (Tables 24 and 26). Thus, the significant differences for 13 sites in 1971 are probably attributable to the larger number of sites, from a larger area.

The local short - long male ratio is usually highly in favour of the short male. Location 13 was the only exception to this, where long males were more numerous. Locations 1 through 12 showed no significant differences for short - long ratio ($\chi^2 = 19.1451$, 11 d.f., insignificant at $P > 0.05$); when location 13 was included the difference became significant. Attempts to explain this difference are made below.

Table 24

Percent males with short forceps of total adult males captured for three collecting sites for 1971 and 1972.

Year	Site 1	Site 5	Site 9
1971	94.90	74.29	84.51
1972	70.46	85.71	73.05

Table 25

Table of analysis of variance for percent males with short forceps of total adult males captured for three collecting sites for 1971 and 1972.

Source	d.f.	M.S.	Calc. F value	tab. F value (.05)
between	2	10.04	8.82	19.16
within	3	88.56		
total	5			

Table 26

Percent males with short forceps of total adult males captured for 13 collecting sites for 1971.

Site	Total male captures	Total short	% short
1	3 724	3 534	94.90
2	53	47	88.68
3	9	7	77.78
4	17	12	70.59
5	35	26	74.29
6	53	49	92.45
7	55	41	74.55
8	40	36	90.00
9	381	322	84.51
10	65	56	86.15
11	21	18	85.71
12	58	43	74.14
13	78	33	42.31
Totals	4 589	4 224	92.05*

*Not the arithmetic mean. This figure is total short as a percentage of total and is used as the expected value for the chi-squared test.

Capture - recapture experiments

Only two of the 100 marked adults that were released were recaptured, both of which were males (earwigs # 1 and 38, see marking scheme in Table 2). Earwig # 1 was recaptured approximately 10 m. from the release point, earwig # 38 about 12 m. away.

Recaptures were made from traps on three occasions, the first on 6, 7 and 9 Sept., the second on 10 and 11 Sept. and the third on 15 Oct. 1971. Total recaptures were 4629 on the first occasion, 2293 on the second and 662 on the third. The two recaptures of marked insects were made on the first occasion.

To calculate the total population from the simple index used by Lincoln (1930):

Total population ÷ original number marked = total second sample ÷ total recaptured

or $$P = \frac{an}{r}$$

where n = total number of individuals in the second sample, a = total number marked and r = total recaptures.

Three population estimates were made, one after each sampling period. These results are given in Table 27. Although population estimates seem high, the estimates for the three sampling periods indicate a marked decrease from September to October. An explanation for this decrease is discussed later.

Table 27

Population estimates and densities for three sampling periods during September and October 1971 at site 1.

Sampling period	Population estimation	Population density per m^2
1.) Sept. 7, 8, 9	231 450	324.61
2.) Sept. 10, 11	229 300	321.60
3.) Oct. 15	66 200	92.85

DISCUSSION

The seasonal history of the earwig has been described from many areas (Crumb et.al., 1941; Worthington 1926; Fulton 1924a; Stearns 1923; Gibson 1924; Jones 1917; Glendenning 1953; Guppy 1947; Beall 1932; Atwell 1927; Muggeridge 1927; Coyne 1928; Treherne 1923).

The eggs hatch at various times during the spring. Beall (1932) suggests that soil drainage may affect the time of hatching. Water would tend to be retained on level ground but to drain away from steep banks. Prolonged submergence of eggs would probably slow development, if it did not destroy them. Another important factor affecting hatching time might be temperature - above and in the ground (Atwell 1927). Coyne (1928) suggests that there may be up to two months variation in incubation time of eggs laid on opposite sides of the same building, eggs deposited on the southern exposure hatching more quickly than those on the northern. Eggs laid in shady places are retarded in their development (Fulton 1924 a).

The most important factor affecting hatching time is the date of oviposition. In the fall males and females enter the soil together to excavate their nest (Crumb et.al. 1941; Worthington 1926; Fulton 1924a; Jones 1917). The time of oviposition depends, in part, upon when the adults excavated the nest which in turn depends upon weather conditions in the fall. Hibernation may be delayed by prolonged warmth in the fall. The incubation period of the eggs varies with the temperature of the location and the depth of the eggs in the soil. Crumb et.al. (1941) found the average incubation period to be 72.8 days in Washington, D.C.

Eggs may be laid in the fall (Fulton 1924a; Jones 1917; Coyne 1928; Treherne 1923) or in the spring (Crumb et.al. 1941; Glendenning 1953; Worthington 1926). Overwintering is either in the egg or the adult. Seldom do nymphs overwinter although the occasional fourth instar nymph can be found early in spring. Whether or not it passed the wihter in a cell of its own or with adults was not determined. It would be difficult to determine when it hatched by counting back through instars as instar duration would have been affected by climate. It may have overwintered as a fourth instar nymph without moulting at all. Even in late fall some fourth instar nymphs are found and probably overwinter in this stage, if they survive the winter at all.

Seasonal History in St. John's

Because of the large numbers collected from site 1, the data from this site are used to determine the local seasonal history of the earwig. Variations of the seasonal history in the other 12 sites are probably slight; it is doubtful whether climatic conditions vary significantly within the St. John's area.

One fourth instar was taken from site 1 on May 14, 1971. It should also be noted that approximately one third of the total sample taken from site 1 on October 15 were fourth instar nymphs. It is probable that many of these died, but perhaps a few survive the winter beneath the soil.

If the eggs are laid in the fall, the female must remain active to care for and tend them, since fungal infections develop in eggs which are not licked by the female. The female usually evicts the male immediately after oviposition, so if fall oviposition were the rule, a high proportion of males in trap catches at this time would be expected. The data from site 1 for October 15, 1971 indicate that males and females occur in approximately equal numbers. This suggests that approximately equal numbers have entered the soil and have remained there.

If the eggs are laid in the spring, both male and female live in the nest together through the cold months of December, January and February, probably in a state of relative quiescence. Once the eggs are laid the male is evicted and must survive on his own. The data from May 14 to June 1, 1971 indicate a preponderance of males, suggesting that the eggs have been laid in the spring and the males evicted from the nest, while the females remain in the soil with the eggs or the first instar nymphs.

After the females have appeared on the surface with the nymphs, they may re-enter the soil to deposit a second batch of eggs. Most workers acknowledge the existence of this second brood although there seems to be some disagreement whether or not it is the rule rather than the exception (Guppy 1947). Fulton (1924a) claims that the females die before the first brood has matured if they do not re-enter the soil to oviposit. It is also possible that the second brood of any given year is the progeny of the previous year's second brood which has oviposited for the first time;

this implies that a number of nymphs overwinter and become adult in the spring. More work is needed in this area to determine the dynamics of the second brood. Most workers think that a varying percentage of overwintered females re-enter the soil to oviposit immediately after the first brood has left the nest (Crumb et.al. 1941; Worthington 1926; Glendenning 1953; Atwell 1927). The data from Table 3 substantiate this because smaller numbers of each instar were found in the second brood than the first.

There is considerable evidence of a second brood from the data given in Fig. 8, where two peaks of abundance for instars II, III and IV occur. The absence of a second peak for the first instar is probably due to their remaining in the nest until the first moult, but may also be due to the extremely large samples taken throughout the summer, but it should be noted that first instars were captured right through the sampling period.

Second peaks for instars II and III, shown in Fig. 8 for site 1 coincide; this is probably due to the overlap of instars in any sample. The existence of the second brood is also evident in the data given for sites 4 and 5 for 1971, although it is not as distinct as the data from site 1 for 1971 (Fig. 8).

The conspicuous absence of females in early spring is explained by their remaining in the nest to care for the eggs or young. The occasional female is found on the surface; these probably laid no eggs at all, or have left the nest in search of food for the brood (Fulton 1924a).

The appearance of young in late spring is accompanied by an increase in the number of females. These females have emerged from the nest with their young and may re-enter the soil to oviposit again while the males have reached the end of their life span and are dying off rapidly. Adult females are taken regularly during the summer as they emerge from their nests with their second brood, some of them still containing eggs in various stages of development. Males are totally absent until the new adults appear in late summer. One exception to this was found on July 14, 1971 when two adult males were taken. These probably became adult early.

The four nymphal instars overlap widely and there is no sudden disappearance of any one instar before the appearance of another. Each instar reaches its peak and declines as the following instar increases. Nymphs of all instars can be found throughout the later part of the summer. This is explained by variations in time of hatching which, in turn, depends primarily on climatic conditions, and the existence of the second brood.

The average instar duration, determined from the peaks of abundance, did not vary significantly between sites 1, 4 and 5 for 1971. It should be noted that the average duration of the first instar is somewhat subject to observational error because of the varying number of days they might remain in the nest before emerging. The consistency of the duration of each instar between sites is probably due to the relatively constant climatic conditions within such a small geographical area. Variations in the time of peaks of abundance for the various nymphal instars depend on the conditions that affect both time of oviposition and the incubation period of the eggs, as well as climatic conditions during nymphal development.

The seasonal histories described from British Columbia (Glendenning 1953), the northwestern United States (Fulton 1924a), and England (Brindley 1914), are generally similar. Hibernation takes place in the fall and winter, eggs are laid in very early spring, hatching takes place in March or April, and new adults appear in June.

In St. John's, all the stages occur somewhat later because of the colder winter and shorter spring and summer. Although time of oviposition was not determined, it is presumed that eggs are laid around the end of March and hatch usually around early June. New adults appear in early August. Because of the early autumn frost it seems likely that many earwigs, especially the second brood, die before reaching maturity. It seems then that local climatic conditions exert a controlling effect preventing excessive numbers of earwigs being produced, unlike the milder climates of British Columbia, England and the northwestern United States.

Trap catches

The results shown in Table 12 indicate significant differences for the average trap catches between the 13 St. John's sites for 1971. The highest average trap catch was recorded at site 1. This site has been described under "Materials and Methods". It is bounded on its western side by an old cemetery. As previously mentioned, earwigs' main mode of dispersal is transportation by man, and it seems quite conceivable that earwigs have been brought into the cemetery in flowers for many years and have eventually spread to site 1. Other sites that showed relatively high average trap catches were mostly in areas of the city where earwigs were first introduced. Although all 13 sites were generally similar, slight differences in climatic conditions, nature of the soil, owner's activity and in elevation could affect earwig populations and activity.

The differences between days in trap catches at site 1 for both 1971 (Table 15) and 1972 (Table 16) are strongly influenced by the seasonal history of the earwig. In early spring catches consist mainly of adult males, survivors from the previous year, which have been ejected by the females who remain in the nest to tend the eggs or young. Trap catches might be expected to be higher once the nymphs leave the nests and to increase thoughout the summer until the new adults begin hibernating in the fall. This progressive increase is not evident from the data given. Trap catches are highest during July when weather conditions are optimal; The trap catch is influenced by the activity of the insect which is affected by both its diurnal cycle and weather. Southwood (1966) suggests that trap catch can also be influenced by the stage of the animal, although there is no particular evidence to support the suggestion that any earwig instar is more inclined to enter a trap. It is possible that feeding rate may decline in the adult, but this is not known.

The data given in Table 18 indicate that only site 1 produced lower mean trap catches in 1972 than in 1971. Although environmental factors might influence abundance, the reduction is probably, at least in part, due to the large numbers removed in 1971.

Morris (1965) recommends removal trapping as an effective method of control of earwigs. Although the earwig population of a city lot is unlikely to reach the proportions of site 1, removal trapping, augmented with some form of chemical control, is usually sufficient to keep their numbers in check.

The effect of increased time interval between trap examinations in producing an increased trap catch is occasionally indicated in Figs. 10, 11 and 12. This effect could be due to a tendency for earwigs to remain in a trap once they have entered, as a result of which the number steadily increases. Other factors obviously affect this finding: the activity determined by weather, possibly the stage of the insect, along with the experimental error introduced by the patchiness of the samples and the differences in the sizes of populations in different sites.

Extensive baiting experiments have been carried out by Crumb et.al. (1941), commercial peanut butter being one bait recommended. The data given in Table 19 indicate that peanut butter was not effective in increasing trap catches.

Proportions of the sexes

The proportions of the sexes of the earwig have been investigated by Brindley (1912, 1914) and Fox-Wilson (1940). Both authors agree that the proportions of the sexes differ considerably in different localities in the same year and sometimes differ considerably in the same locality in different years.

The data given in Table 20 suggest that the proportion of the sexes does not vary significantly within the St. John's area. The results in Tables 21 and 23 indicate that the sex ratio does not vary in the same locality in different years and that the sex ratio was constant at site 1 in St. John's in 1971 and 1972.

Attempts to explain stability or variation in sex ratios often depend upon the life histories of the species under consideration (Lack 1954). The sex ratio of trapped earwigs varies widely during a year. The preponderance of males in early spring is explained by the females remaining in the nest with the eggs or young while males are expelled (Crumb et.al, 1941). Females live slightly longer than males and can usually be found throughout the summer. When the new adults appear the proportions of the sexes are approximately equal. The trap itself is a possible source of bias favouring one sex or the other (Southwood 1966). Brindley (1912) suggests that the characters of the soil or vegetation might affect the proportions of the sexes but admits that there is only slight evidence of this.

The relative consistency of the sex ratio of the 13 St. John's locations and the remarkable consistency between 1971 and 1972 suggest that the mortality rates of males and females are very similar, and that approximately equal numbers of the sexes hatch successfully. This suggestion is supported by the (approx.) 1: 1 ratio found for new adults, which further suggests little trap bias for either sex.

Male dimorphism

Bateson & Brindley (1892) showed that for each body size class, the forceps length is strongly bimodal, i.e. for each body length there were both short and long forms. This was verified by Diakonov (1925) and Huxley (1927) who further stated that bimodality existed in all body size classes except that in longest (17 mm.) and shortest (10 mm.) earwigs the forceps length was monomorphic, showing an obvious correlation between extremes of body length and forceps length. With increasing body length the mean forceps length also increases (Huxley 1927).

Giard (1894) proposed that forceps dimorphism among male earwigs may be due to the number of gregarines in the alimentary canal, causing some kind of parasitic castration. This view was supported by Wheeler (1910), but has been disputed by many later authors. Brindley (1918) offers evidence to the contrary pointing out that the gregarine Clepsydrina ovata (Dufour) occurs in the alimentary canal of both long and short forms, and that no correlation could be traced between the number of parasites and the length of the forceps. This refutation is also supported by Diakonov (1925), who also suggested that parasitization by the tachinid Digonichaeta setipennis (Fall) reduces the final body size and also inhibits the development of long forceps. He also suggests that the characters for "long" and "short" in males are not genetically fixed but depend on environmental conditions during development.

> "All severe exhaustion of the larva and unfavorable conditions as to nutrition lead to the formation of forcipes of the short type. This is observed on infection with the parasitic fly, causing general exhaustion, as well as on unilateral regeneration of the forcipes themselves resulting in local exhaustion, and on raising the larvae under conditions of starvation or under generally unfavorable conditions of a laboratory." (Diakonov (1925), p. 227).

Kuhl (1928) suggested that the form ultimately taken by the forceps in an adult male was determined largely, if not entirely, by i) the nutritional level and consequent size and vigor of the antecedent larva and nymph, and ii) the physiological state of the insect at the time of the last moult, when, in a matter of minutes, the pressure exerted by the haemolymph on the expanding cerci would govern whether they were to be partially or fully distended, and so determine their permanent shape.

The earwig male is polymorphic with regard to its sex chromosomes (Webb and White 1970). Henderson (1970) claims that XY (24 chromosomes) and XXY (25 chromosomes) males are the most common and exist in the same population. He further suggests that the extra sex chromosome affects the rate of development. Diakonov (1925) had previously assumed that a rapid rate of development would generally produce a longer body and in turn, increasing body length would produce a higher proportion of long forms. It would seem then that a relationship might exist between the extra sex chromosome and the shape of the forceps but this has been disputed by Morgan (1928) who is supported by Callan (1941).

Table 28 presents a statistical comparison of data from Perm, Russia (Diakonov 1925), Farne Islands (Bateson & Brindley 1892), other selected English sites (Sopp 1904), and data collected at St. John's 1971 and 1972 well illustrating the variation in the frequency of occurrence of short and long males from place to place.

Table 28

Comparison of the frequency of occurrence of short and long males between Perm, Russia (Diakonov 1925), Farne Islands (Bateson & Brindley 1892), other selected English sites (Sopp 1904), and data collected at St. John's 1971 and 1972.

Locality	Total M	Short	Long	% Short
Perm, U.S.S.R.	2815	1501	1314	53.32
Farne Islands, U.K.	583	268	315	45.97
Hilbre-, Brownsea-, Tresco Island , U.K.	173	83	90	47.98
St. John's, Nfld.	5220	4674	546	89.54
Total	8791	6526	2265	74.24*

*This figure is total short as a percentage of total and is used as the expected value for the chi-square test.

A large significant difference exists when the data from the four localities are compared (χ^2 = 29.1018; 3 d.f.), but when the data are compared between Russia and the two sites in England (excluding the data from St.John's), the difference is highly insignificant. An attempt is made below to explain the large difference in the St. John's data.

The proportion of long and short males may also vary from year to year within the same locality, as shown in the data from Perm, Russia in Table 29. (χ^2 = 15.18; 4 d.f.).

Table 29

Data from Perm, Russia (Diakonov 1925) from 1918 to 1922 showing proportions of long and short males.

Date	Total M	Short	Long	% Short
1918	450	136	314	30.22
1920	1135	723	412	63.70
1921 a**	754	348	406	46.15
1921 b**	376	235	141	62.50
1922	100	59	41	59.00
Total	2815	1501	1314	53.32*

*This figure is total short as a percentage of total and is used as the expected value for the chi-square test.

**The data for 1921 are presented in two sections because of a variation in the collecting method.

Bateson & Brindley (1892) proposed the idea that both forms exist in a population, usually in equal numbers:

> "this will be recognized as an instance of variation about two positions of stability, the intermediate position being one of less stability".

Crumb et. al. (1941) suggest that F. auricularia does best in moderate temperatures and in rather humid places, although outbreaks in Russia (1918 - 1922) appear to have followed periods of rather low rainfall. The areas compared here have generally similar climates, that of Britain being milder with a shorter winter than that of St. John's, which, in turn, has a shorter, milder winter than Perm Russia. But the results indicate no significant differences for long - short ratio between Russia and Britain, but both differ significantly from St. John's. Assuming the effect of climate on the rate of development it would seem reasonable to assume that the ratio of short - long males in St. John's would be intermediate between the ratios of Russia and Britain - but this is not the case.

Tables 24 and 29 indicate a significant difference for Russia from year to year but no significant differences for the three St. John's locations for two successive years. The Russian population may be more variable than that of St. John's, but the significance may also be due to the larger number of comparisons over five years.

The data from Table 26 indicate that significant differences for the long - short ratio exist for the 13 St. John's sites, suggesting that the local populations may be quite discrete. This is substantiated by the large difference between the percent short males from site 13 and the percent short male of total.

There is little indication in the literature of the factors that might affect the long - short ratio. To explain the extremely high long - short ratio in St. John's would involve a more comprehensive detailed study on the effect of environmental conditions on rate of development and also possible genetic factors.

<u>Capture - recapture experiment</u> :

The underlying principle of the estimation of population density by marking methods -, the Lincoln or Petersen Index - is simply that in a representative sample of a population of which some members have been marked, the ratio of marked to total is an estimate of that ratio in the whole population, and the numerator of the latter ratio is known.

Southwood (1966) proposes seven assumptions that underlie capture - recapture analysis methods:

i) The marked animals are not affected by being marked and the marks will not be lost.

ii) The marked animals become completely mixed in the population.

iii) The population is sampled randomly with respect to its mark status.

iv) Sampling must be at discrete time intervals and the actual time involved in taking the samples must be small in relation to the total time.

v) The population is a closed one or if not, immigration and emigration can be measured or calculated.

vi) There are no birth or deaths in the period between sampling or if there are, allowance must be made for them.

vii) Being captured one or more times does not affect an animal's subsequent chance of capture.

With regard to assumption i), earwigs were captured and individually marked the same day and kept in a glass vivarium overnight before being released the following day. All earwigs retained their marks. The only possible effect from the mark would be the extra weight on the forceps and/or pronotum depending on where the mark was made. It seems unlikely that this extra weight would have any significant effect on the animals behavior.

It is very difficult to determine whether condition ii) was met. On release earwigs seemed to scatter in all directions, but to what extent they distributed themselves homogeneously is unknown.

Assumption iii) has two aspects: firstly, that all individuals of the different age groups and of both sexes are sampled in the proportion in which they occur; secondly, that all the individuals are equally available for capture irrespective of their position in the habitat. The trap used for earwigs is not known to show any bias toward any age group or sex. Samples from any site showed varying captures of all age groups and no sex preference. The second aspect of assumption ii) can only be considered assuming the marked individuals distributed themselves homogeneously and that the traps are randomly placed within the sampling area. Placement of traps is shown in Fig. 6.

With regard to assumption iv), sampling was carried out on five successive days for 10 - 12 hours per day. It is thought that the actual time involved in taking and analysing the samples was small in relation to the total time. Marks, if present, could easily be detected without any visual aid.

The sampling plot had no boundaries to prevent earwigs from either entering or leaving the area, although there is no reason to suspect that either immigration or emigration predominated, although it is in the fall that earwigs begin entering the soil to deposit eggs. This would tend to underestimate the population density.

Because the experiment was attempted rather late in the season, it seems unlikely that birth would have any significant effect on the population. Because of this only adults were considered in the recapture counts and it is the adult population density that is estimated. Mortality is not considered to be a significant factor. By mid-August most of the previous year's adult females have died.

With reference to assumption vii), it is unlikely that the short time involved in analysing samples would either cause any injury to the insect or affect its subsequent chance of capture.

Though the number recaptured was low and it might be thought that a disproportionate amount of time has been spent in consideration of the results, they are presented here because of the possible use of the technique by other workers, and as a guide to some of the difficulties encountered in the use of a simple Lincoln Index for estimating earwig populations. Although modifications of the simple Lincoln Index have been developed to compensate for changes due to emigration, immigration, natality and mortality, these manipulative procedures and their formidable mathematical exercises have been avoided because of the low recapture rate. However, the results indicate that the population density decreases markedly between September and October - mostly due to the hibernation of adults.

SUMMARY

Population studies of the European earwig Forficula auricularia (L.) were made at St. John's, Nfld. during 1970, 1971 and 1972 by means of traps consisting of grooved boards. 13 sites provided sufficient numbers for study. These were usually standard-size domestic city lots, on each of which two traps were usually set. Traps were checked about twice a week. An attempt was made to study the movement of individual earwigs by marking and releasing 100 individuals.

The first nymphs appear in early June and become adult in mid-August, though there is much overlap between the nymphal instars. The adults are active until late fall, then they excavate nests in which they overwinter and in which the females oviposit and care for their eggs. *

Two distinct broods were found. Some females, having emerged with the first instar nymphs, re-enter the soil to oviposit again. The incubation period for the second brood is shorter than for the first. Peaks of abundance of nymphal instars are fairly well synchronised between certain sites. The total nymphal life was also found to vary only slightly between selected sites. Rates of development for 1971 and 1972 were compared showing no significant differences for second, third and fourth instars. The durations of the nymphal stages were, for the first, 14 - 18 days, for the second 14 - 25 days, for the third and fourth each 17 - 22 days.

* A comparison between the seasonal history in Britain, British Columbia, U.S.A. and St. John's indicated that the first 3 locations were similar but that at St. John's all stages occur somewhat later.

Mean trap catches varied significantly between different sites. Trap catches were significantly reduced in 1972 at one site only. Longer time intervals between trap inspections usually produced a larger trap catch.

Peanut butter as a bait did not increase the number of insects in traps.

The proportion of the sexes did not vary significantly between sites.

Male dimorphism was evident from collections, although short males predominate in the local population. Except on one site, the short - long male ratio did not vary significantly. For three selected sites the short - long ratio did not vary between sites.

Although only two of the 100 marked individuals were recaptured, the method of marking could be applied to other species.

One site had a much larger earwig population than either of the others.

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Site 4 (1971) 2 traps used on each date

Sample number	date	ADULTS MALES short	long	Female	Gynand-Romorphs	Total Adults	NYMPHS I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	8-VI	0	0	1	0	1	0	0	0	0	0	1	0.50
2	17-VI	0	0	1	0	1	0	0	0	0	0	1	0.50
3	21-VI	0	0	0	0	0	4	1	0	0	5	5	2.50
4	24-VI	0	0	0	0	0	2	10	0	0	12	12	6.00
5	1-VII	0	0	0	0	0	0	3	2	0	5	5	2.50
6	14-VII	0	0	0	0	0	1	26	35	0	62	62	31.50
7	21-VII	0	1	0	0	0	0	46	199	4	249	250	125.00
8	29-VII	0	0	0	0	0	1	6	184	76	267	267	133.50
9	3-VIII	0	0	0	0	0	0	0	3	7	10	10	5.00
10	12-VIII	2	3	7	0	12	0	3	2	64	69	81	40.50
11	19-VIII	1	1	1	0	3	0	0	0	0	0	3	1.50
12	27-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
13	2-IX	0	0	0	0	0	0	0	2	5	7	7	3.50
14	30-IX	9	0	9	0	18	0	0	0	37	37	55	27.50
TOTALS		12	5	19	0	36	8	95	427	193	723	759	

Site 5 (1971) 2 traps used on each date

Sample number	date	ADULTS: MALES short	long	Female	Gynand-Romorphs	Total Adults	NYMPHS: I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	22-VI	0	0	1	0	1	73	75	54	1	203	204	102.00
2	24-VI	0	0	0	0	0	10	13	13	0	36	36	18.00
3	1-VII	0	0	0	0	0	3	47	59	1	110	110	55.00
4	13-VII	0	0	0	0	0	2	77	74	3	156	156	78.00
5	16-VII	0	0	0	0	0	0	4	6	0	10	10	5.00
6	21-VII	0	0	0	0	0	0	3	27	4	34	34	17.00
7	29-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
8	6-VIII	9	4	17	0	30	7	30	38	122	197	227	113.50
9	12-VIII	4	2	6	0	12	0	0	3	2	5	17	8.50
10	19-VIII	1	2	1	0	4	0	0	0	0	0	4	2.00
11	27-VIII	0	0	0	0	0	0	0	0	1	1	1	0.50
12	2-IX	1	1	2	0	4	0	0	0	0	0	4	2.00
13	7-X	11	0	21	0	32	0	0	0	9	9	41	20.50
	TOTALS	26	9	48	0	83	95	249	274	143	761	844	

Site 8 (1971) 2 traps used on each date

Sample number	date	ADULTS MALES short	long	Female	Gynand-Romorphs	Total Adults	NYMPHS I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	22-VI	0	0	0	0	0	0	0	0	1	1	1	0.50
2	29-VI	0	0	0	0	0	0	0	0	1	1	1	0.50
3	6-VII	0	0	1	0	1	0	0	0	1	1	2	1.00
4	13-VII	0	0	0	0	0	0	1	3	0	4	4	2.00
5	16-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
6	22-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
7	28-VII	2	0	0	0	2	0	0	26	16	42	44	22.00
8	3-VIII	2	1	0	0	3	0	0	9	64	73	76	38.00
9	12-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
10	19-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
11	27-VIII	2	0	8	0	10	0	1	0	0	1	11	5.50
12	3-IX	9	3	9	0	21	0	0	2	7	9	30	15.00
13	23-IX	17	0	17	0	34	0	0	0	20	20	54	27.00
14	30-IX	4	0	14	0	18	0	0	0	6	6	24	12.00
	TOTALS	36	4	49	0	89	0	2	40	116	158	247	

Site 7 (1971) 2 traps used on each date

Sample number	date	ADULTS MALES short	long	Female	Gynand-Romorphs	Total Adults	NYMPHS I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	9-VII	0	1	0	0	1	0	3	22	4	29	30	15.00
2	12-VII	1	2	7	0	10	0	4	111	19	134	144	72.00
3	18-VII	11	6	15	0	32	0	0	18	67	85	117	58.50
4	23-VII	5	1	14	0	20	0	0	2	106	108	128	64.00
5	25-VII	9	3	9	0	21	0	1	10	120	131	152	76.00
6	28-VII	15	1	15	0	31	0	0	3	154	157	188	94.00
	TOTALS	41	14	60	0	115	0	8	166	470	644	759	

Site 6 (1971) 2 traps used on each date

		ADULTS					NYMPHS						
		MALES											
Sample number	date	short	long	Female	Gynand-Romorphs	Total Adults	I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	13-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
2	14-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
3	16-VII	0	0	0	0	0	0	21	66	1	88	88	44.00
4	22-VII	0	0	0	0	0	0	0	1	0	1	1	0.50
5	29-VII	0	0	2	0	2	1	4	8	114	127	129	64.50
6	3-VIII	1	1	3	0	5	0	2	6	39	47	52	26.00
7	12-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
8	19-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
9	27-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
10	2-IX	5	1	14	0	20	0	0	15	73	88	108	54.00
11	13-X	43	2	21	0	66	0	0	0	50	50	116	58.00
		49	4	40	0	93	1	27	96	277	401	494	

Site 2 (1971) 2 traps used on each date

		ADULTS					NYMPHS						
		MALES											
Sample number	date	short	long	Female	Gynand-Romorphs	Total Adults	I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	18-VI	0	0	0	0	0	0	0	0	0	0	0	0.00
2	24-VI	0	0	0	0	0	2	0	0	0	2	2	1.00
3	1-VII	0	0	0	0	0	26	1	0	0	27	27	13.50
4	15-VII	0	0	1	0	1	1	3	1	0	5	6	3.00
5	22-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
6	29-VII	0	0	0	0	0	0	0	10	21	31	31	15.50
7	3-VIII	0	1	1	0	2	0	0	17	63	80	82	41.00
8	12-VIII	5	2	2	0	9	0	0	5	24	29	38	19.00
9	19-VIII	1	1	1	0	3	0	0	4	3	7	10	5.00
10	27-VIII	5	0	4	0	9	0	0	0	0	0	9	4.50
11	2-IX	11	0	11	0	22	0	0	3	9	12	34	17.00
12	30-IX	25	2	22	0	49	0	0	3	13	16	65	32.50
	TOTALS	47	6	42	0	95	29	4	43	133	209	304	

Site 1 (1971) 16 traps 14 May - 6 July, 38 traps 14 July - 29 Aug. 18 traps on 7 Sept., 6 on 8 Sept., 9 on 24 Sept., 22 on 10 Sept., 11 on 11 Sept., and 58 on 15 Oct.

		ADULTS					NYMPHS						
		MALES											Average
Sample number	date	short	long	Female	Gynand-Romorphs	Total Adults	I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Trap Catch
1	14-V	22	1	1	0	24	0	0	0	0	1	25	1.56
2	15-V	0	0	1	0	1	0	0	0	0	0	1	0.06
3	17-V	0	0	2	0	2	0	0	0	0	0	2	0.12
4	18-V	68	9	7	0	84	0	0	0	0	0	84	5.25
5	20-V	0	0	1	0	1	0	0	0	0	0	1	0.06
6	1-VI	83	7	28	0	118	0	0	0	0	0	118	7.38
7	3-VI	8	0	9	0	17	0	0	0	0	0	17	1.06
8	8-VI	64	5	101	0	170	83	2	0	0	85	255	15.94
9	16-VI	3	1	29	0	33	419	296	0	0	715	748	46.75
10	21-VI	1	0	46	0	47	148	1976	2	0	2126	2173	135.81
11	25-VI	0	0	68	0	68	40	1010	95	0	1145	1213	75.81
12	1-VII	0	0	49	0	49	16	1538	2583	0	4137	4186	261.63
13	6-VII	0	0	20	0	20	1	428	2348	0	2777	2797	174.81
14	14-VII	2	0	26	0	28	52	1978	21549	1223	24802	24830	653.42
15	20-VII	0	0	16	0	16	70	874	6418	3230	10592	10608	279.16
16	22-VII	0	0	19	0	19	51	268	2426	3143	5888	5907	155.45
17	27-VII	0	0	13	0	13	43	157	1552	5527	7279	7292	191.89
18	4-VIII	323	54	378	6	761	16	128	313	2758	3215	3976	104.63
19	12-VIII	1005	48	758	6	1817	54	656	1899	3616	6225	8042	211.63
20	20-VIII	910	33	654	5	1602	25	624	1909	2098	4656	6258	164.68
21	29-VIII	86	21	75	0	182	0	2	75	600	677	859	22.61
22	7-IX					1390						1390	77.22
23	8-IX					1596						1596	266.00
24	9-IX					1643						1643	182.56
25	10-IX					1296						1296	58.91
26	11-IX					997						997	90.64
27	15-X	959	11	1157	4	2131	0	8	49	1134	1191	3322	57.28
	TOTALS	3534	190	3458	21	14125	1018	9945	41218	23330	75511	89636	

NOTE: Samples 22-26 were used for an experiment using marked individuals. As a result only total adults were recorded.

Site 3 (1971) 2 traps used on each date

Sample number	date	ADULTS: MALES short	ADULTS: MALES long	Female	Gynand-Romorphs	Total Adults	NYMPHS: I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	16-VI	0	0	0	0	0	0	0	0	0	0	0	0.00
2	21-VI	0	0	0	0	0	0	0	0	0	0	0	0.00
3	24-VI	0	0	0	0	0	0	0	0	0	0	0	0.00
4	29-VI	0	0	0	0	0	0	0	0	0	0	0	0.00
5	13-VII	0	0	0	0	0	8	29	3	0	40	40	20.00
6	16-VII	0	0	0	0	0	0	9	2	0	11	11	5.50
7	21-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
8	29-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
9	4-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
10	12-VIII	2	2	5	0	9	0	0	0	6	6	15	7.50
11	19-VIII	0	0	0	0	0	0	0	0	6	6	6	3.00
12	27-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
13	2-IX	5	0	0	0	5	0	0	0	0	0	5	2.50
14	12-X	0	0	0	0	0	0	0	0	0	0	0	0.00
	TOTALS	7	2	5	0	14	8	38	5	12	63	77	

Site 11 (1971) 2 traps used on each date

Sample number	date	ADULTS: MALES short	MALES long	Female	Gynand-Romorphs	Total Adults	NYMPHS: I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	28-VII	0	0	0	0	0	0	0	5	0	5	5	2.50
2	3-VIII	0	0	2	0	2	0	5	48	41	94	96	48.00
3	6-VIII	0	0	0	0	0	0	1	0	4	5	5	2.50
4	10-VIII	1	1	0	0	2	0	1	12	47	60	62	31.00
5	17-VIII	2	1	5	0	8	9	96	90	62	257	265	132.50
6	23-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
7	3-IX	15	1	9	2	27	0	1	17	14	32	59	29.50
8	14-X	0	0	0	0	0	0	0	0	0	0	0	0.00
	TOTALS	18	3	16	2	39	9	104	172	168	453	492	

Site 9 (1971) 2 traps used on each date

Sample number	date	ADULTS: MALES short	ADULTS: MALES long	ADULTS: Female	ADULTS: Gynand-Romorphs	ADULTS: Total Adults	NYMPHS: I	NYMPHS: II	NYMPHS: III	NYMPHS: IV	NYMPHS: Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	19-VII	20	12	36	0	68	0	1	8	24	33	101	50.50
2	27-VII	97	32	94	0	223	0	5	40	54	99	322	161.00
3	3-IX	75	6	82	2	165	0	6	30	39	75	240	120.00
4	7-X	23	0	30	2	55	0	0	2	52	54	109	54.50
5	12-X	74	6	77	0	157	0	0	10	98	108	265	132.50
6	13-X	33	3	24	0	60	0	0	0	13	13	73	36.50
	TOTALS	322	59	343	4	728	0	12	90	280	382	1110	

Site 10 (1971) 2 traps used on each date

Sample number	date	ADULTS MALES short	long	Female	Gynand-Romorphs	Total Adults	NYMPHS I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	22-VI	0	0	0	0	0	0	0	0	0	0	0	0.00
2	25-VI	0	0	0	0	0	0	0	0	0	0	0	0.00
3	29-VI	0	0	0	0	0	0	0	0	0	0	0	0.00
4	13-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
5	22-VII	0	0	1	0	1	0	0	15	19	34	35	17.50
6	28-VII	0	0	0	0	0	0	0	23	92	115	115	57.50
7	3-VIII	0	0	0	0	0	0	0	1	8	9	9	4.50
8	6-VIII	0	0	0	0	0	0	0	0	1	1	1	0.50
9	10-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
10	19-VIII	45	7	21	0	73	0	1	18	24	43	116	58.00
11	23-VIII	6	2	3	0	11	0	0	3	4	7	18	9.00
12	3-IX	4	0	2	0	6	0	0	0	4	7	10	5.00
13	14-X	1	0	0	0	1	0	0	0	0	0	1	0.50
	TOTALS	56	9	27	0	92	0	1	60	152	213	305	

Site 12 (1971) 2 traps used on each date

Sample number	date	ADULTS: MALES short	MALES long	Female	Gynand-Romorphs	Total Adults	NYMPHS: I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	6-VIII	0	0	0	0	0	0	0	0	1	1	1	0.50
2	10-VIII	2	0	4	0	6	0	0	6	49	55	61	30.50
3	17-VIII	13	8	15	0	36	1	9	12	88	110	146	73.00
4	23-VIII	1	0	1	0	2	0	1	3	2	6	8	4.00
5	3-IX	6	2	12	0	20	0	2	10	9	21	41	20.50
6	23-IX	8	3	9	0	20	0	0	0	12	12	32	16.00
7	7-X	3	0	0	0	3	0	0	1	6	7	10	5.00
8	14-X	10	2	11	0	23	0	0	1	11	12	35	17.50
		43	15	52	0	110	1	12	33	178	224	334	

Site 13 (1971) 2 traps used on each date

Sample number	date	ADULTS MALES short	ADULTS MALES long	ADULTS Female	ADULTS Gynand-Romorphs	ADULTS Total Adults	NYMPHS I	NYMPHS II	NYMPHS III	NYMPHS IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	29-VI	0	0	0	0	0	0	1	1	0	2	2	1.00
2	13-VII	0	0	0	0	0	0	0	1	0	1	1	0.50
3	22-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
4	28-VII	0	0	0	0	0	0	0	4	37	41	41	20.50
5	3-VIII	2	3	2	0	7	0	3	0	19	22	29	14.50
6	10-VIII	28	36	45	0	109	0	0	0	16	16	125	62.50
7	19-VIII	1	6	1	0	8	0	0	0	3	3	11	5.50
8	23-VIII	1	0	0	0	1	0	0	0	0	0	1	0.50
9	3-IX	1	0	0	0	1	0	0	0	0	0	1	0.50
10	13-X	0	0	0	0	0	0	0	0	0	0	0	0.00
	TOTALS	33	45	48	0	126	0	4	6	75	85	211	

Site 1 (1972) 10 traps used on each date

		ADULTS					NYMPHS						
		MALES											
Sample number	date	short	long	Female	Gynand-Romorphs	Total Adults	I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	11-VII	0	0	0	0	0	0	5	46	4	55	55	5.50
2	14-VII	0	0	0	0	0	0	1	9	5	15	15	1.50
3	20-VII	0	0	0	0	0	0	0	18	23	41	41	4.10
4	28-VII	0	2	0	0	2	0	4	45	161	210	212	21.20
5	4-VIII	1	2	10	0	13	1	0	17	138	156	169	16.90
6	15-VIII	49	41	87	0	177	1	18	13	168	200	377	37.70
7	24-VIII	65	45	76	0	186	0	4	32	136	172	358	35.80
8	29-VIII	64	27	87	0	178	0	5	23	86	114	292	29.20
9	15-IX	143	18	173	0	334	1	1	36	228	266	600	60.00
	TOTALS	322	135	433	0	890	3	38	239	949	1229	2119	

Site 5 (1972) 2 traps used on each date

Sample number	date	ADULTS MALES short	long	Female	Gynand-Romorphs	Total Adults	NYMPHS I	II	III	IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	28-VII	0	0	0	0	0	0	0	0	0	0	0	0.00
2	4-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
3	15-VIII	0	0	0	0	0	0	0	0	0	0	0	0.00
4	24-VIII	6	0	6	0	12	0	3	12	31	46	58	29.00
5	16-IX	0	1	4	0	5	0	0	0	0	0	5	2.50
TOTALS		6	1	10	0	17	0	3	12	31	46	63	

Site 9 (1972) 2 traps used on each date

Sample number	date	ADULTS: MALES short	ADULTS: MALES long	ADULTS: Female	ADULTS: Gynandromorphs	ADULTS: Total Adults	NYMPHS: I	NYMPHS: II	NYMPHS: III	NYMPHS: IV	Total Nymphs	Total Adults Plus Nymphs	Average Trap Catch
1	28-VII	0	0	1	0	1	1	0	1	37	39	40	20.00
2	4-VIII	1	1	0	0	2	1	1	3	56	61	63	31.50
3	15-VIII	28	16	39	0	83	1	3	6	30	40	123	61.50
4	24-VIII	39	18	49	0	106	0	3	30	26	59	165	82.50
5	16-IX	54	10	49	0	113	0	2	40	121	163	276	138.00
	TOTALS	122	45	138	0	305	3	9	80	270	362	667	

Appendix B

Addresses of twenty-five St. John's sites.

Site	1	C.N.I.B., The Boulevard
	2	3, First Avenue
	3	165, Elizabeth Ave.
	4	2, Allandale Road
	5	5, Clarke Place
	6	22, Wallace Place
	7	13, Blackall Place
	8	151, LeMarchant Road
	9	Mt. Scio Road
	10	7, Cornwall Crescent
	11	Craigmillar Ave.
	12	48, Craigmillar Ave.
	13	24, Holbrook Ave.

Insufficient numbers collected from:

Site	14	57, Tupper St.
	15	40, Vancouver St.
	16	31, Fox Ave.
	17	7, Maypark Place
	18	40, Tobin Crescent
	19	35, Diefenbaker St.
	20	45, Prince of Wales St.
	21	Mt. Scio Road
	22	2, Rodney St.
	23	267, Empire Ave.
	24	Smallwood Drive, Mt. Pearl
	25	61, Pennywell Road W.