BIOLOGY AND FOOD HABITS OF THE SNAIL-KILLING FLY, *SEPEDON PLUMBELLA* WIEDEMANN (SCIOMYZIDAE : DIPTERA)

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INTRODUCTION

The sciomyzid fly, *Sepedon plumbella* Wiedemann, is one of the most common species of snail-killing Diptera found in Southeast Asia. It has been reported in China, Taiwan, Ryukyus, Sumatra, Java, Celebes, Borneo, New Guinea, Philippines, Burma and India (Yano, 1968). In Thailand, records of locations gathered from preserved specimens in the collection of the Department of Entomology and Plant Pathology, Kasetsart University, reveal the heaviest abundance of the species in the central part of the country (Fig. 1). The flies have been captured also in the sandy areas of Prachuap Khiri Khan and dense jungle areas of Kanchanaburi, Chon Buri, and Chanthaburi. This insect has been brought to attention because of an increase in the problem of liver fluke diseases of man and domestic animals carried by some species of snails in the north-eastern part of the country. Outbreaks of the diseases occur in areas where the insect has not been found. Since this insect is a malacophagous fly, it may possess some value in the control of liver fluke snails. Although extensive investigations have been made on the biology and life habits of many sciomyzid flies, none of these studies has been made on *S. plumbella* Wiedemann (Chock *et al.*, 1961; Foote, 1959; Foote *et al.*, 1960; Knutson and Berg, 1964; Neff and Berg, 1966; Rozkosny and Knutson, 1970; Trelka and Foote, 1970). The present report is a part of an investigation of the efficiency and potential advantage of using the fly for biological control of trematode-infected snails in the north-eastern part of the country.

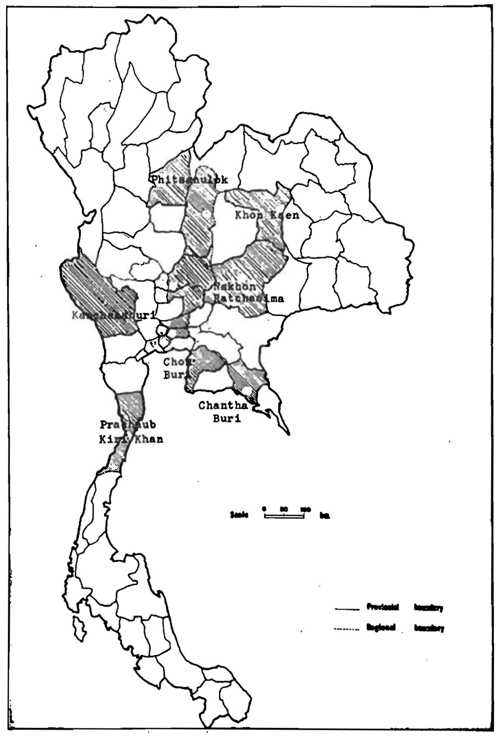

Fig. 1—Distribution of *Sepedon plumbella* Wiedemann in Thailand (shaded parts).

MATERIALS AND METHODS

Life History Study: Adults of *S. plumbella* were collected from their natural habitat and reared in large glass jars each measuring 33 cm in height and 19 cm in diameter. Three or four plants of barnyard and buffalo grasses were provided for resting and oviposition sites in each rearing jar which contained water

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to a height of 7 cm. The insects were allowed to feed on crushed snail meat and 20% aqueous solution of sucrose. Eggs laid by adult flies were collected daily and hatched on filter paper soaked with water in Petri dishes. Newly emerged larvae were fed individually with eggs of *Lymnaea (Radix) auricularia rubiginosa* Michelin and *Indoplanorbis exustus* Deshayes in water in Petri dishes. Changing to new food using fresh snail meat was made during the later instars. They were reared to the pupal stage. Pupation took place in water in plastic cages and pupae were left until the adults emerged. The raising of all immature stages was done in a constant room temperature at 25°C ± 1°C. Adults were exposed to ambient temperatures (24°C-32°C) which favoured egg production.

Survival Test on Crushed Meat of Different Species of Snails: The experiment involved rearing newly emerged larvae on crushed meat of nine species of snails. *Bithynia (Digoniostoma) siamensis siamensis* Lea, *Filopaludina (Siamopaludina) martensi cambodiensis* Mabille & Le Mesle, *Filopaludina (Filopaludina) sumatrensis polygramma* Von Martens, *Gyraulus convexiusculus* Hutton, *Indoplanorbis exustus* Deshayes, *Lymnaea (Radix) auricularia rubiginosa* Michelin, *Melanoides tuberculata* Muller, *Pila ampullaceae* were used in this experiment. Twenty insects were tested on each snail species using the method of rearing described above. Development, oviposition, and survival rates of the insects were recorded and are shown in Table 2.

Snail Killing Ability Test: The ability of different larval stages of the fly to kill different sizes of nine species of live snails was the subject of an experiment. The sizes of the snails were measured at five periods during development as shown in Table 3. Ten insects of each stage were placed separately in large glass jars. Supplement of live snails of definite size numbering 30 to 100 were made daily to ensure that all insect larvae had

Table 1

Growth and life duration of *S. plumbella* Wiedemann at 25°C for immature stages and at ambient temperatures of 24°C-32°C for the adult stage when fed with crushed meat of *Lymnaea (Radix) auricularia rubiginosa* Michelin and *Indoplanorbis exustus* Deshayes.

Insect Stage	Average Size (mm.)[a]		Life Duration (days)	
	Length (Mean ± SD)	Width (Mean ± SD)	Range	Average[a] (Mean ± SD)
Eggs	1.12 ± 0.068	0.33 ± 0.024	3.5- 4.0	3.93 ± 0.67
First Stadium	0.34 ± 0.034[b]	-	3.0- 7.0	4.25 ± 0.94
Second Stadium	0.52 ± 0.332[b]	-	3.0- 7.0	5.00 ± 1.00
Third Stadium	1.02 ± 0.075[b]	-	5.0-10.0	6.65 ± 1.39
Pupae	7.18 ± 0.271	2.89 ± 0.180	8.0-10.0	8.75 ± 0.53
Preoviposition Period	-	-	4.0- 6.0	4.40 ± 0.58
Oviposition Period	-	-	7.0-43.0	24.45 ± 8.77
Adult (Female)	8.17±0.637	1.65 ± 0.103[c]	12.0-52.0	31.50 ± 8.13
Adult (Male)	8.00±0.565	1.65 ± 0.178[c]	19.0-61.0	33.25 ± 10.47
One Complete Generation	-	-	26.5-44.0	32.98 ± 3.11

[a] Based on 20 insects.
[b] Length of cephalopharyngeal skeleton.
[c] Width of thorax.

Table 2

Life duration, oviposition, and survival rates of *S. plumbella* Wiedemann when reared separately on crushed meat of nine species of snail.

Insect Stage	Snail species used in the experiment								
	B. (D.) siamensis siamensis	*F. (S.) martensi cambodiensis*	*F. (F.) sumatrensis polygramma*	*G. convexiuscu-lus*	*I. exustus*	*L. (R.) auricularia rubiginosa*	*M. tuberculata*	*P. ampullaceae*	*P. scutata*
Average Life Duration (Mean in Days ± SD)									
Eggs	3.03 ± 0.11	3.00 ± 0.00	3.00 ± 0.00	3.40 ± 0.187	3.10 ± 0.20	3.10 ± 0.20	3.00 ± 0.00	3.10 ± 0.33	3.12 ± 0.25
First Stadium	4.82 ± 0.83	4.54 ± 0.93	4.29 ± 0.45	5.36 ± 0.98	3.72 ± 0.56	4.69 ± 0.96	4.70 ± 0.78	5.25 ± 0.97	4.33 ± 0.47
Second Stadium	6.00 ± 0.94	5.00 ± 1.05	4.71 ± 1.03	4.36 ± 1.49	3.56 ± 0.50	4.71 ± 0.87	4.17 ± 0.90	8.00 ± 0.00	*
Third Stadium	9.00 ± 2.16	5.86 ± 0.64	8.29 ± 1.98	4.70 ± 0.64	4.79 ± 0.67	5.62 ± 1.00	5.83 ± 1.21	*	-
Pupae	*	6.33 ± 0.47	6.50 ± 0.50	6.00 ± 0.00	6.91 ± 0.29	6.45 ± 0.55	6.00 ± 0.00	-	-
Preoviposition	-	7.00 ± 2.00	4.75 ± 0.43	4.60 ± 0.80	4.00 ± 0.45	4.80 ± 0.75	4.50 ± 0.50	-	-
Oviposition	-	24.50 ± 3.50	29.50 ± 4.82	24.00 ± 4.65	29.00 ± 10.62	25.40 ± 5.39	41.50 ± 1.50	-	-
Adult Female	-	33.00 ± 2.00	36.25 ± 4.66	32.20 ± 3.52	29.50 ± 13.49	33.60 ± 3.32	47.50 ± 0.50	-	-
Adult Male	-	26.00 ± 10.17	34.00 ± 2.00	34.00 ± 6.84	39.60 ± 14.35	30.67 ± 14.40	43.00 ± 5.35	-	-
One Complete Generation	-	31.73 ± 3.89	31.54 ± 3.74	28.42 ± 3.02	26.08 ± 3.69	29.37 ± 3.94	28.20 ± 1.50	-	-
Oviposition rate of female when completed cycle of development (Mean number of eggs/female ± SD)									
	-	313.0 ± 105.0	445.5 ± 128.0	268.2 ± 55.98	440.8 ± 184.7	441.0 ± 199.5	765.0 ± 102.0	-	-
Survival rate of each stage when reared from eggs to adult stage (%)									
Eggs	100	100	100	100	100	100	100	100	100
First Instar	55	65	35	55	90	80	50	20	15
Second Instar	45	45	35	55	80	70	30	5	0
Third Instar	15	35	35	50	70	65	30	0	0
Pupae	0	30	30	50	55	55	25	0	0
Adult	0	30	30	50	55	55	25	0	0

* Died before reaching the successive stage.

Table 3

The sizes of snails used in the feeding ability and host preference tests of *S. plumbella* Wiedemann.

Species of Snail	Average sizes (width × length in mm.) of snails measured at five periods during development					
	Egg	Period of Measurement				
		First	Second	Third	Fourth	Fifth
B. (D.) siamensis siamensis	-	2.32 × 3.71	3.62 × 5.41	4.56 × 8.12	-	-
F. (S.) martensi cambodiensis	-	4.17 × 5.70	5.23 × 6.72	8.27 × 11.25	11.34 × 16.62	22.09 × 37.45
F. (F.) sumatrensis polygramma	-	4.50 × 5.20	5.31 × 6.75	6.96 × 10.90	9.07 × 12.51	10.91 × 18.32
G. convexiusculus	-	0.98 × 2.22	1.16 × 3.00	1.23 × 3.55	1.39 × 4.09	-
I. exustus	0.53 × 0.92	3.50 × 3.00	4.28 × 5.45	5.00 × 8.16	5.75 × 11.43	-
L. (R.) auricularia rubiginosa	0.59 × 1.07	2.42 × 4.49	4.23 × 8.19	6.25 × 11.81	7.70 × 14.90	-
M. tuberculata	-	1.14 × 2.66	2.12 × 6.09	3.05 × 9.44	5.13 × 15.98	6.90 × 21.44
P. ampullacea	-	5.65 × 8.68	7.81 × 10.30	9.90 × 13.95	13.63 × 16.73	15.84 × 18.46
P. scutata	-	5.69 × 8.80	7.48 × 11.72	9.79 × 20.22	11.76 × 27.00	14.83 × 32.40

- Not included in the test.

enough food to complete their development. Attacked snails were collected and counted daily and the results of this experiment are shown in Table 4.

Host Preference Test: Twenty larvae of *S. plumbella* at the third period size were allowed to select nine species of live snails as hosts. Thirty snails of each species were released daily into each rearing jar and the number and kind of snails accepted by fly larvae were recorded daily. The snails used in this experiment included *I. exustus* and *L. (R.) auricularia rubiginosa* at the second period size, and *G. convexiusculus* and *M. tuberculata* at the third period size. For the remaining five species of snail, only the first period size was used.

RESULTS AND DISCUSSION

The life duration of *S. plumbella* in table 1 was obtained from feeding the insects in captivity with crushed meat of the species *L. (R.) auricularia rubiginosa* and *I. exustus*. These showed no marked differences when compared with other species of *Sepedon* reared in the experiment of Neff and Berg (1966). The insect has three larval instars which are common among the flies in this genus. The egg, larval, and pupal stages lasted 3.93, 15.9, and 8.75 days respectively and the fly completed a generation within 32.98 days on the average. The longevity of adults reared on crushed snail meat and sucrose solution averaged 33.25 days for males, and 31.50 days for females. Chock *et al.* (1961) reported the influence of food on the adult longevity of *S. macroplus* Walker and demonstrated that the adult life duration could be extended to 48 days for females and 50 days for males when fed with honey and water. Adult life duration could be prolonged to 69 days for females and 103 days for males when crushed snail meat was added in the food. Whether honey can prolong the adult life of *S. plumbella* needs further investigation.

As indicated in table 2, when nine species of snail were crushed and tested separately as food, the insects could not complete their life cycle on only *B. (D.) siamensis siamensis*, *P. ampullaceae* and *P. scutata*. Survival rates were less than 50% when they

Table 4

Feeding ability of *S. plumbella* Wiedemann on three species of live snails.

Snail species	Period of measurement*	Insect larval stage	No. of snail (or eggs) per insect	% Survival within instar
G. convexiusculus	1st	First	2.8	70
	2nd	,,	3.0	10
	3rd	,,	0.0	0
	1st	Second	6.6	80
	2nd	,,	4.2	70
	3rd	,,	4.6	80
	4th	,,	4.4	90
	1st	Third	24.5	100
	2nd	,,	17.1	100
	3rd	,,	16.5	100
	4th	,,	14.2	90
I. exustus	Egg	First	17.8	100
	1st	,,	3.0	10
	2nd	,,	0.0	0
	Egg	Second	69.8	100
	1st	,,	3.4	90
	2nd	,,	4.4	90
	3rd	,,	2.0	20
	4th	,,	0.0	0
	Egg	Third	206.2	100
	1st	,,	8.7	90
	2nd	Third	8.8	90
	3rd	,,	1.5	30
	4th	,,	0.3	0
L. (R.) auricularia rubiginosa	Egg	First	16.5	100
	1st	,,	0.0	0
	Egg	Second	63.5	100
	1st	,,	4.9	100
	2nd	,,	1.3	100
	3rd	,,	0.0	0
	Egg	Third	203.0	100
	1st	,,	17.1	100
	2nd	,,	5.1	100
	3rd	,,	1.3	0
	4th	,,	0.4	0

*Refer to Table 3.

were fed with *F. (S.) martensi cambodiensis*, *F. (F.) sumatrensis polygramma* and *M. tuberculata*. It should be noted here that even though *M. tuberculata* provided the larvae with a lower survival rate when compared with those reared on *G. convexiusculus*, *I. exustus*, and *L. auricularia rubiginosa*, it resulted in a significantly higher rate of oviposition. The adults, both males and females, also lived longer. In all cases, however, the mortality rate in the larval stages was considered high when they were reared by the method described in this study.

It was observed that larvae of *S. plumbella* only successfully attacked snails which had a part or parts of their body unprotected from the hard operculum, shell or thick slime. Usually, when a snail at the surface is attacked by an enemy it submerges. Since the fly larvae need atmospheric oxygen they must attack snails which are unable to pull them below the water surface. High mortality was found in larvae which had been trapped between snail operculum and shell and suffocated under water. Among nine species of live snail which were used in the test, the insect could survive and complete its cycle only on *G. convexiusculus*, *I. exustus*, and *L. (R.) auricularia rubiginosa*. Results in table 4 indicated their feeding ability on the three species of snail. These showed that each insect larval stage had limited size of snail that they could kill successfully. With the exception of *G. convexiusculus*, the full grown insect larvae were unable to feed on live snails which reached their mature stage.

When third stage larvae were allowed to choose live snails, they preferred the three species which were easiest to attack (Table 5). All, including *G. convexiusculus*, *I. exustus* and *L. (R.) auricularia rubiginosa*, are of medical importance in that they act as intermediate hosts of trematodes of human and veterinary importance. Results in table 5 also showed that the insect occasionally consumed snails of the genus *Filopaludina* but were innocuous to *Bithynia*, *Melanoides* and *Pila*.

Table 5

The kind and number of snails devoured by third stage larvae of *S. plumbella* Wiedemann in the host preference test.

Snail species	Period of measurement*	No. of snail preyed upon by insect	
		Total	Average number per insect
B. (D.) siamensis siamensis	1st	0	0.00
F. (S.) martensi cambodiensis	1st	5	0.25
F. (F.) sumatrensis polygramma	1st	3	0.15
G. convexiusculus	3rd	119	5.95
I. exustus	2nd	129	6.45
L. (R.) auricularia rubiginosa	2nd	175	8.75
M. tuberculata	3rd	0	0.00
P. ampullacea	1st	0	0.00
P. scutata	1st	0	0.00

*Refer to Table 3.

SUMMARY

Eggs of the sciomyzid fly, *Sepedon plumbella* Wiedemann, required 3.39 days on the average to hatch on wet filter paper in Petri dishes at a constant temperature of 25°C ± 1°C. Larval stages lasted 15.9 days at the same temperature when larvae were fed with crushed meat of the snails, *Indoplanorbis exustus* Deshayes and *Lymnaea (Radix) auricularia rubiginosa* Michelin. Incubating pupae, floating on water surface in plastic boxes, required 8.75 days until the emergence of adults.

The longevity of adults, obtained from feeding larvae on crushed snail meat and sucrose syrup at ambient temperature of 24°C-32°C, averaged 33.35 days for males and 31.30 days for females. Under these conditions the average number of eggs laid per female was 495.35.

Survival rates of *S. plumbella* from larvae to adults when reared separately with six species of crushed snails, including *Filopaludina (Siamopaludina) martensi cambodiensis* Mabille & Le Mesle, *Filopaludina (Filopaludina sumatrensis polygramma* Von Martens, *Gyraulus convexiusculus* Hutton, *Indoplanorbis exustus* Deshayes, *Lymnaea (Radix) auricularia rubiginosa* Michelin, and *Melanoides tuberculata* Muller, were 30, 30, 50, 55, 55 and 25% respectively. There were no marked differences in the longevity of insects reared on these snails except the longer life of adults and higher rate of oviposition observed with those feeding on *M. tuberculata*. No evidences of abnormalities in their morphological characteristics nor their activities were observed. The fly could not complete its life cycle when fed on the crushed meat of *Bithynia (Digoniostoma) siamensis siamensis* Lea, *Pila ampullacea* Linneaus, and *Pila scutata* Mousson.

When nine species of live snails were tested separately as the only source of larval food, the fly was able to survive and complete its cycle only on *G. convexiusculus*, *I. exustus*, and *L. (R.) auricularia rubiginosa*. The three snail species were also the preferable food for the third stage insect larvae. *S. plumbella* larvae occasionally attacked *F. (S.) martensi cambodiensis* and *F. (F.) sumatrensis polygramma* but were innocuous toward snails of the genera *Bithynia*, *Melanoides*, and *Pila*.

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