



TITLE:

Second Report of the Regular Limnological Survey of Lake Biwa (1967) (III) : Benthos

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CITATION:

Suzuki, Norio ...[et al]. Second Report of the Regular Limnological Survey of Lake Biwa (1967) (III) : Benthos. Memoirs of the Faculty of Science, Kyoto University. Series of biology. New series 1968, 2(1): 107-124

ISSUE DATE:

1968-09-30

URL:

<http://hdl.handle.net/2433/258786>

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Second Report of the Regular Limnological Survey of Lake Biwa (1967)

III. Benthos*

By

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As mentioned in the previous articles "First Report of the Regular Limnological Survey of Lake Biwa (Oct. 1965-Dec. 1966) (1) General Remark and (IV) Benthos (Mori et al. 1967 and Suzuki and Mori 1967)", these investigations have been carrying on to detect the quantitative as well as qualitative changes including seasonal variation in benthic communities in lake Biwa extending over a long period of time.

Because sample size seems to be rather small to estimate exactly the values of standing crop in the areas where the samples were collected and the distribution patterns of benthic animals at the given area of lake bottom were not ascertained yet, it seems to be risky to discuss on seasonal changes in number or biomass of benthic animals on the basis of the data obtained during only two years except one or two species which indicates rather clear seasonal changes. The variations in number and biomass of several species among stations are discussed in this paper.

Our collecting stations and their conditions, and the methods for collection were generally mentioned in the previous articles (Mori et al. 1967, and Suzuki and Mori 1967).

The number of individuals and total fresh weight, and the average values of number of individuals/m² and fresh weight/m² calculated from three samples (sometimes from two or one samples available) are shown in the following tables. The number of individuals of *Oligochaeta* could not always be counted, because they were often cut into small pieces. As animals below 10 mg body weight were generally too small to weight exactly because of rapid drying during operation, so their body weights are given as 0.00. Furthermore, the next

* Contributions from the Otsu Hydrobiological Station, Kyoto University, No. 197
IBP-JPF Publication No. 21.

marks are used in the tables.

- : no specimens were collected

* : these were adhered to the surface of molluscan shells

** : dead shell

? : these were uncountable

A Benthic community at station Ie-1

Station Ie-1 is chosen as a representative of northern part of the lake or main basin, where is oligotrophic. This station is about 74 m in depth and bottom is muddy clay.

Benthic community is chiefly composed of Oligochaeta, Hirudinea and Chironomidae larva. Any Mollusca was not found in the sample collected at this station up to now (Table 1).

Table 1

Ie-1																
Date	January 13, 1967								February 15, 1967							
Sampling No.	1		2		3		Average		1		2		3		Average	
	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	4	0.01	?	0.12	?	0.11	?	3.6	?	0.17	?	0.10	?	0.07	?	5.0
Hirudinea	-	-	-	-	-	-	-	-	1	0.00	1	0.00	-	-	30	0.0
Chironomidae larvae																
<i>Phaenopsectra</i> sp.	-	-	-	-	-	-	-	-	-	1	0.00	-	-	-	15	0.0

Date	March 13, 1967								April 14, 1967							
Sampling No.	1		2		3		Average		1		2		3		Average	
	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	2	0.01	2	0.07	4	0.03	118	1.6	1	0.02	1	0.06	10	0.14	178	3.2
Hirudinea	-	-	-	-	1	0.01	15	0.1	-	-	-	-	-	-	-	-
Chironomidae larvae																
<i>Phaenopsectra</i> sp.	1	0.00	1	0.00	-	-	30	0.0	1	0.00	-	-	-	-	15	0.0

Date	May 11, 1967								June 15, 1967							
Sampling No.	1		2		3		Average		1		2		3		Average	
	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	2	0.17	3	0.18	?	0.30	?	9.6	3	0.06	6	0.12	1	0.07	148	3.7

Date	July 17, 1967								August 16, 1967							
Sampling No.	1		2		3		Average		1		2		3		Average	
	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	4	0.08	3	0.01	2	0.07	133	2.4	4	0.23	1	0.12	2	0.28	104	9.3
Date	September 19, 1967								October 20, 1967							
Sampling No.	1		2		3		Average		1		2		3		Average	
	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	3	0.12	2	0.02	2	0.08	104	3.2	10	0.07	6	0.21	4	0.12	296	5.9
Chironomidae larvae																
(Unidentified sp.)	-	-	-	-	-	-	-	-	2	0.00	-	-	1	0.00	44	0.0
Date	November 15, 1967								December 15, 1967							
Sampling No.	1		2		3		Average		1		2		3		Average	
	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	8	0.29	?	0.15	?	0.23	?	9.9	8	0.17	4	0.17	5	0.33	252	9.9
Crustacea																
<i>Palaemon paucidens</i>																
DeHaan	-	-	-	-	-	-	-	-	-	-	-	-	1	0.13	15	1.9

B Benthic communities at station Nb 2, Nb 5 and Na 3

Stations Nb 2, Nb 5 and Na 3 were chosen as representatives of mesotrophic southern part of lake or accessory basin. Nb 2 and Na 3 are 0.1 km off the east and west coast of the southern part of the lake respectively, and both are about 2 m in depth, while station Nb 5 is middle part of the southern part of the lake and about 4.5 m in depth. The bottom condition of station Nb 2 is sand or sandy mud, while those of stations Nb 5 and Na 3 are muddy.

Benthic communities in those stations are chiefly composed of Oligochaeta, Hirudinea, Chironomidae larvae and Mollusca (Table 2-4).

Table 2

Nb-2

Date	January 14, 1967								February 17, 1967							
Sampling No.	1		2		3		Average		1		2		3		Average	
	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	-	1	0.02	-	-	-	15	0.3	1	0.04	-	-	1	0.02	30	0.9

Nb-2

Gastropoda																
<i>Semisulcospira</i>																
<i>decipiens</i>																
(Westerlund)	-		-		2	1.01	30	15.0	-	1	0.46	1	0.68	30	16.9	
Pelecypoda																
<i>Corbicula</i>																
<i>sandai</i>																
Reinhardt	2	3.1	1	4.91	6	0.22	133	121.8	2	0.13	2	0.67	4	11.79	118	186.3
<i>Unio biwae</i>																
Kobelt	-		-		3	1.10	44	16.3	-	2	2.36	-		30	34.9	
<i>Anodonta</i>																
<i>calipygos</i>																
Kobelt	-		-		1	0.05**	-		-		-		-			

Date	November 16, 1967								December 16, 1967							
	1		2		3		Average		1		2		3		Average	
Sampling No.	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Mollusca																
Gastropoda																
<i>Semisulcospira</i>																
<i>decipiens</i>																
(Westerlund)	-		3	1.1	1	0.21	59	19.4	-		-		-		-	
Pelecypoda																
<i>Corbicula</i>																
<i>sandai</i>																
Reinhardt	-		1	0.18	-		15	2.7	-		-		-		-	
<i>Unio biwae</i>																
Kobelt	-		1	0.29	-		15	4.3	-		-		-		-	

Table 3

Nb-5

Date	January 14, 1967								February 17, 1967							
	1		2		3		Average		1		2		3		Average	
Sampling No.	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	?	0.19	?	0.21	?	0.30	?	10.3	?	0.08	?	0.12	?	0.15	?	5.2
Chironomidae																
larvae																
<i>Tendipes</i>																
<i>plumosus</i>																
(Meigen)	2	0.02	-		3	0.10	74	1.8	1	0.03	2	0.02	-		44	0.8
(Unidentified sp.)	-		-		-		-		-		1	0.00	1	00.0	30	00.0

Nb-5

Mollusca												
Gastropoda												
<i>Semisulcospira</i>												
<i>decepiens</i>												
(Westerlund)	-	1	2.37	-	15	35.1	-	-	-	-	-	
<i>Valvata (Cincinnati)</i>												
<i>japonica</i>												
v. Martens	1	0.02	-	-	15	0.3	-	-	1	0.02	15	0.3
Pisces												
<i>Rhinogobius</i>												
<i>brunneus</i>												
(Temminck et Schlegel)	-	1	0.45	-	15	6.7	-	-	-	-	-	

Date	March 14, 1967				April 17, 1967			
	1	2	3	Average	1	2	3	Average
Sampling No.	No. g.	No. g.	No. g.	Ind./m ² g/m ²	No. g.	No. g.	No. g.	Ind./m ² g/m ²
Oligochaeta	? 0.24	3 0.12	? 0.18	? 8.0	12 0.05	3 0.03	? 0.09	222 2.5
Chironomidae larvae								
<i>Pentaneura</i> sp.	-	-	-	-	-	3 0.01	1 0.01	59 0.2
<i>Spaniotoma</i> sp.	-	1 0.01	-	15 0.1	-	2 0.04	-	30 0.6
<i>Tendipes plumosus</i> (Meigen)	2 0.06	1 0.07	-	44 1.9	1 0.03	-	1 0.02	30 0.8
(Unidentified sp.)	1 0.01	4 0.03	1 0.01	89 0.7	1 0.00	-	1 0.00	30 0.0
Amphipoda								
<i>Anisogammarus annandalei</i> (Tattersall)	1 0.01	-	-	15 0.1	-	-	-	-
Mollusca								
Gastropoda								
<i>Semisulcospira decepiens</i> (Westerlund)	-	-	-	-	-	-	1 2.22	15 32.9
Pelecypoda								
<i>Unio biwae</i> Kobelt	-	-	-	-	1 2.15	-	-	15 31.8
Eggs of some animals*	-	-	-	-	? 0.02	-	-	? 0.3
Pupae of simuliidae*	-	-	-	-	5 0.03	-	46 0.09	754 1.8

Nb-5

Gastropoda													
<i>Semisulcospira</i>													
<i>decipiens</i>													
(Westerlund)	2	1.82	1	0.46	-	44	33.7	-	-	-	-		
Pisces													
<i>Rhinogobius</i>													
<i>brunneus</i>													
(Temminck et Schlegel)	-	-	-	-	-	-	-	2	0.24	-	-	30	3.6

Table 4

Na-3

Date	January 14, 1967				February 17, 1967													
	1	2	3	Average	1	2	3	Average										
Sampling No.	No.	g.	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	?	0.13	?	0.26	?	0.39	?	11.5	?	0.08	?	0.02	?	0.34	?	6.5		
Hirudinea	-	-	1	0.00	15	0.0	-	-	2	0.01	-	-	30	0.1				
Nematoda	-	3	0.00	-	44	0.0	-	-	2	0.00	-	-	30	0.0				
Chironomidae																		
larvae																		
<i>Pentaneura</i>																		
sp.																		
-	-	-	-	-	-	-	-	-	2	0.01	-	-	3	0.1				
<i>Spaniotoma</i>																		
sp.																		
2	0.03	4	0.07	3	0.05	133	2.2	-	4	0.09	3	0.07	104	2.4				
<i>Tendipes</i>																		
<i>plumosus</i>																		
(Meigen)																		
1	0.01	-	-	1	0.02	30	0.4	-	-	-	-	-	-	-				
(Unidentified																		
sp.)																		
-	-	-	-	1	0.00	15	0.0	2	0.00	2	0.01	1	0.01	74	0.4			
Mollusca																		
Gastropoda																		
<i>Semisulcospira</i>																		
<i>decipiens</i>																		
(Westerlund)	-	3	4.5	-	44	66.6	-	-	-	-	3	1.7	44	25.2				
Pupae of																		
Simuliidae*																		
-	-	-	-	-	-	-	-	-	-	-	-	7	0.00	104	0.0			

Date	March 14, 1967				April 17, 1967													
	1	2	3	Average	1	2	3	Average										
Sampling No.	No.	g.	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²	No.	g.	No.	g.	No.	g.	Ind./m ²	g/m ²
Oligochaeta	?	0.16	?	0.22	?	0.07	?	6.7	2	0.03	?	0.10	5	0.07	155	3.0		
Chironomidae																		
larvae																		

Na-3

larvae															
<i>Spaniotoma</i>															
sp.	1	0.02	-	1	0.01	30	0.4	13	0.15	2	0.01	2	0.02	252	2.7
(Unidentified sp.)	1	0.01	-	-	-	15	0.1	-	-	-	-	-	-	-	-
Crustacea															
<i>Macrobrachium nipponense</i>															
(DeHaan)	-	-	-	-	-	-	-	2	0.8	1	0.04	-	-	44	12.4
Mollusca															
Gastropoda															
<i>Semisulcospira decipiens</i>															
(Westerlund)	-	-	2	2.67	1	0.13	44	41.4	3	0.81	-	1	0.13	59	13.9

C Variation in number and biomass of benthic animals among stations

Data obtained over two years (1966 and 1967) were available for this purpose. As several miscalculations and misprints were found in the published data of 1966, recalculations were made from original data.

In the beginning of 1966 the survey were carried out twice or thrice a month so that mean values were obtained from two or three values and they were regarded as representative values of the month.

The comparisons of numbers and biomasses of benthos among stations were performed only on Oligochaeta including several species, two species of Chironomidae larva (*Spaniotoma* sp. and *Tendipes plumosus*) and two species of Mollusca (*Semisulcospira decipiens* and *Corbicula sandai*), since they were rather abundant in these areas and made it possible to compare.

1. Oligochaeta

Table 5

Month	Ie-1		Nb 2		Nb 5		Na 3	
	1966 g/m ²	1967 g/m ²	1966 g/m ²	1967 g/m ²	1966 g/m ²	1967 g/m ²	1966 g/m ²	1967 g/m ²
January	10.0	3.6	0.9	0.3	7.2	10.3	4.3	11.5
February	13.2	5.0	3.6	0.9	7.0	5.2	1.6	6.5
March	13.5	1.6	1.2	0.3	5.5	8.0	4.1	6.7
April	12.0	3.2	0.1	0.1	3.6	2.5	0.8	3.0
May	24.3	9.6	0.1	0.6	1.4	2.8	1.5	1.3

June	0.6	3.7	0.4	0.1	2.5	1.5	1.2	1.0
July	7.8	2.4	0.3	0.0	2.1	1.9	0.6	0.9
August	5.3	9.3	0.0	0.0	0.0	1.3	1.0	1.3
September	3.6	3.2	0.4	0.1	1.8	1.6	1.8	1.3
October	9.0	5.9	0.0	0.0	3.0	4.3	1.5	0.3
November	5.9	9.9	0.0	0.0	3.2	1.8	3.0	2.4
December	7.7	9.9	0.1	0.0	10.7	7.2	2.8	2.7
Average	9.4	5.6	0.6	0.2	4.0	4.0	2.0	3.2

General trend of variations among stations in biomass of *Oligochaeta* in 1967 was very similar with that of 1966, showing the greatest value at station Ie-1 and the least at station Nb 2. High organic content of the bottom mud at station Ie-1 seems to be responsible for the greatest abundance there. Besides, the least biomass of *Oligochaeta* at station Nb 2 seems to be caused by the sandy bottom prevailing there around. These phenomena ought to be investigated in details in future.

2. Chironomidae larva

Table 6

Month	<i>Spaniotoma</i> sp.							
	Nb 5				Na 3			
	1966		1967		1966		1967	
No. /m ²	g/m ²	No. /m ²	g/m ²	No. /m ²	g/m ²	No. /m ²	g/m ²	
January	70	1.6	0	0	677	10.5	133	2.2
February	45	1.4	0	0	170	3.6	104	2.4
March	5	0.1	15	0.1	197	3.9	104	1.9
April	11	4.2	30	0.6	37	0.4	15	0.3
May	0	0	0	0	8	0.2	0	0
June	0	0	15	0.3	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0
November	74	1.5	15	0.4	237	3.7	30	0.4
December	0	0	192	1.9	133	1.8	252	2.7
Average	17	0.7	22	0.3	122	2.0	53	0.8

Tendipes plumosus

Nb 5

Na 3

Month	1966		1967		1966		1967	
	No. /m ²	g/m ²	No. /m ²	g/m ²	No. /m ²	g/m ²	No. /m ²	g/m ²
January	0	0	74	1.8	0	0	30	0.4
February	8	0.3	44	0.8	0	0	0	0
March	40	1.6	44	1.9	5	0.1	15	0.3
April	0	0	30	0.8	0	0	0	0
May	0	0	0	0	15	0.2	89	0.3
June	0	0	15	0.3	0	0	44	1.2
July	15	0.3	74	1.0	0	0	44	0.1
August	15	0.3	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
October	30	0.6	15	0.3	0	0	0	0
November	44	0.9	0	0	0	0	0	0
December	30	0.6	0	0	15	0.1	0	0
Average	15	0.4	25	0.6	2.9	0.0	19	0.2

Tendipes plumosus (Meigen), *Spaniotoma* sp., *Pentaneura*., *Phaenopsectra* sp. and few unidentified species were found in samples. *Spaniotoma* and *Tendipes* appeared abundantly at stations Nb 5 and Na 3, other species were rather scarce in amount.

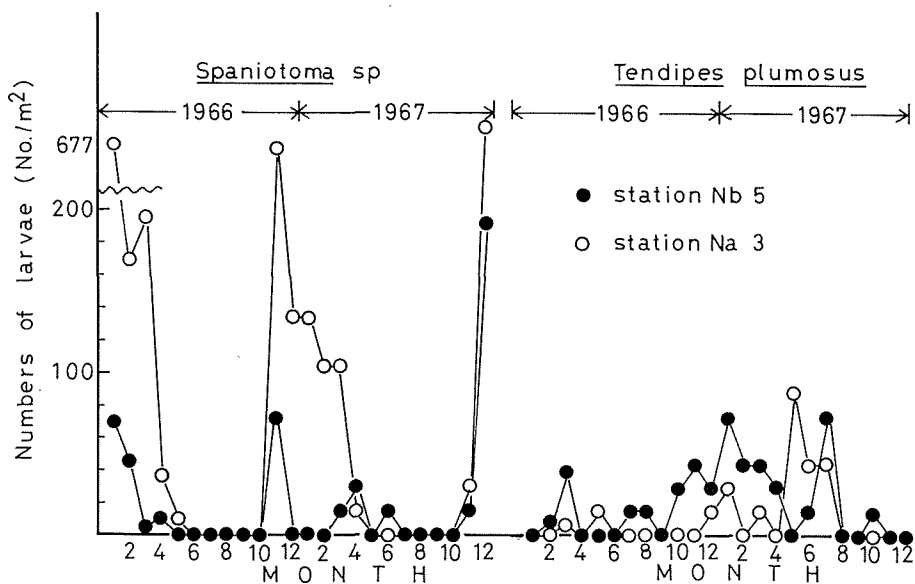


Fig. 1. Seasonal variations in *Spaniotoma* sp. and *Tendipes plumosus*

Table 6 shows that *Spaniotoma* was found much more at station Na 3, whereas larger number of *Tendipes plumosus* was found at station Nb 5. These two species were not found from Ie-1 and Nb 2. This shows that these two species prefer shallow and muddy bottom as their habitat.

Both *Spaniotoma* sp. and *Tendipes plumosus* show rather clear seasonal changes (fig. 1). Larvae of *Spaniotoma* appear from November to June, reach the maximum in November or December at both stations Nb 5 and Na 3. Although larvae of *Tendipes plumosus* appear almost every month at both stations, the maximum number can be seen in March at Nb 5 and in May at Na 3 in 1966, and in January at Nb 5 and in May at Na 3 in 1967.

3. Mollusca

Table 7

Semisulcospira decipiens

Month	Nb 2		Nb 5		Na 3							
	1966	1967	1966	1967	1966	1967						
	No./m ²	g/m ²	No./m ²	g/m ²	No./m ²	g/m ²						
January	37	7.9	15	9.9	19	23.5	15	35.1	33	41.8	44	66.6
February	30	11.8	0	0	8	15.2	0	0	23	19.9	44	25.2
March	5	1.7	0	0	0	0	0	0	34	30.2	59	77.1
April	0	0	30	12.7	8	41.3	15	32.9	22	20.4	15	15.0
May	23	12.5	44	27.2	0	0	15	0.6	8	9.1	59	30.8
June	0	0	0	0	0	0	0	0	30	39.5	0	0
July	15	0.4	59	6.3	15	31.8	0	0	15	8.1	0	0
August	0	0	0	0	0	0	15	1.6	30	53.3	30	31.0
September	15	4.1	30	15.0	0	0	15	0.0	30	32.3	30	6.8
October	30	14.3	30	16.9	0	0	0	0	15	7.3	59	26.2
November	0	0	59	19.4	30	76.9	44	33.7	30	41.4	44	41.4
December	0	0	0	0	0	0	0	0	30	46.2	59	13.9
Average	13	4.4	22	9.0	7	15.7	10	8.7	25	29.1	37	27.8

Corbicula sandai

Month	Nb 2		Nb 5	
	1966	1967	1966	1967
	No. /m ²	g/m ²	No. /m ²	g/m ²
January	59	58.8	15	22.2
February	104	143.6	44	78.3
March	118	89.5	0	0
April	215	255.5	59	37.9
May	111	110.3	15	0.4
June	44	39.1	207	239.9

July	44	29.4	89	37.6	0	0	0	0
August	44	79.9	0	0	0	0	0	0
September	174	152	133	121.8	0	0	0	0
October	89	109	118	186.3	15	30.9	15	60.8
November	15	1.0	15	2.7	0	0	0	0
December	0	0	0	0	0	0	0	0
Average	76	89.0	58	60.6	4	12.1	2.5	9.3

The following species were found in the samples collected at Nb 2, Nb 5 and Na 3 during two years (1966—1967), whereas nothing was found at Ie-1.

Gastropoda

Heterogen longispira (Smith)
Valvata (Cincinna) japonica v. Martens
Parafossarulus manchouricus japonicus (Pilsbry)
Semisulcospira decipiens (Westerlund)
Semisulcospira bensoni reiniana (Brot)

Pelecypoda

Lanceolaria oxyrhyncha (v. Martens)
Unio biwae Kobelt
Inversidens bradti (Kobelt)
Inversidens reiniana (Kobelt)
Anodonta calipygos Kobelt
Corbicula sandai Reinhardt
Pisidium kawamurai Mori
Sphaerium japonicum biwaense Mori

Semisulcospira decipiens and *Corbicula sandai* were the best two in amount which were found in the surveys, so the numbers and biomasses of them are shown in table 7.

Semisulcospira decipiens was found in larger amount at station Na 3 than stations Nb 2 and Nb 5, while *Corbicula sandai* was found considerably more at station Nb 2. It is natural that larger numbers of *S. decipiens* are living at station Na 3 and those of *C. sandai* at station Nb 2, because *S. decipiens* prefers mud substratum to sandy substratum and *C. sandai* prefers sandy substratum. Although Ie-1 has muddy bottom, it is too deep to inhabit for *S. decipiens*.

The authors would like to appreciate here Dr. Eiji Harada for the identification of shrimps.

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[Received July 3, 1968]