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THE NICHE OF FISH AND SHELLFISH IN THALE SAP SONGKHLA, SOUTHERN THAILAND

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ABSTRACT

Fish and shellfish communities in Thale Sap Songkhla were investigated during 1991-1993. Samples were taken at 7 stations using 70 x 3 m surrounding net with 1 mm mesh size. One hundred and one species in 43 families of fish and shellfish were found. Most faunas were brackish (50 species) or marine species (47 species) with only 13 freshwater species. Aquatic faunas found were mostly fish (97 species) with the remainder being marine shrimps (9 species), marine crabs (3 species) and mantis shrimps (2 species). The maximum fresh weight was observed in December (heavy rain period). The 4 most abundant groups of aquatic fauna were fish in the families Clupeidae, Leiognathidae, Atherinidae and marine shrimps in the family Penaeidae. The average abundance and biomass of aquatic fauna were 4,997.6 individuals ha⁻¹ and 7,084.96 g ha⁻¹, respectively. Planktivorous fish comprised the major fish families found in Thale Sap Songkhla. The dominant families of planktivorous fish which peaked in the same period as the phytoplankton bloom were Clupeidae ($r^2 = 0.893$), Mugilidae ($r^2 = 0.968$), Atherinidae ($r^2 = 0.939$) and Centropomidae ($r^2 = 0.780$), with the exception for Leiognathidae which can spawn almost all year round. In addition, benthic fauna tended to show a positive correlation with Gobiidae ($r^2 = 0.844$), Sillaginidae ($r^2 = 0.925$) and Penaeidae ($r^2 = 0.894$).

Key words : Niche, Fish and Shellfish, Thale Sap Songkhla, Species Composition

INTRODUCTION

Most aquatic faunas are the top predators in the aquatic ecosystem. Studies of their abundance and diversity are important part of understanding the dynamics of the ecosystem. The present study emphasizes seasonal changes in species compositions and abundance to form a data base for a description of the relationship with other biotic factors and a production assessment of Thale Sap Songkhla.

Songkhla Lake is located between latitudes 7° 08' N and 7° 50' N, and between longitudes 100° 07' E and 100° 37' E, in the provinces of Songkhla and Pattalung. It is the only lake in Thailand and covers a total area of 986.8 km² (98,680 ha), divided into 3 parts (Fig. 1) as follows (Brohmanonda and Sungkaseem, 1982) : (1) Thale Noi - It is a freshwater lagoon located in the uppermost part of the lake which covers a total area of 28 km² (2,800 ha) with a perimeter of 20 km. (2) Inner Lake or Middle Lake or Thale Luang - It is located adjacent to the southern part of Thale Noi; the two are connected to each other by a few short canals. It covers a total area of 782.8 km² (78,280 ha), with a perimeter of 200 km. In general, its upper part contains freshwater while its lower part contains brackish water. (3) Outer Lake or Thale Sap - This is the lowermost part of the lake, connecting with the open sea. Thus it is a brackish-to-seawater lake according to season. It covers a total area of 176 km² (17,600 ha) and is located in Songkhla province; hence, it is often called Thale Sap Songkhla.

MATERIALS AND METHODS

Due to various limitations, the study area was confined to only part of the Outer Songkhla Lake (Thale Sap Songkhla). Samples were taken at 7 stations (Fig. 1) using 70 x 3 m surrounding net with 1 cm mesh size. The net was set by a 20-foot boat equipped with an 85 HP engine. Samples were taken using 2 different techniques. At stations close to the shore, the net was encircled and pulled onto the beach. At stations in the open water, the net was set in a circular pattern and closed by drawing the moving wall of webbing past the end held in place to make the circumference smaller before the bottom edge was closed. All species of fauna caught were sorted, identified, weighed (in grams) and their length measured (in centimeters). In addition, a study on the stomach content of the predominant fish was carried out.

The relationship between fish or shellfish and other aquatic organisms such as phytoplankton, zooplankton and benthic fauna was analyzed using linear correlation whilst the data of plankton and benthic fauna were acquired from Angsupanich and Arruga (1994) and Angsupanich and Kuwabara (1994), respectively.

RESULTS AND DISCUSSION

Diversity of Aquatic Fauna in Thale Sap Songkhla

Aquatic fauna found during sam-

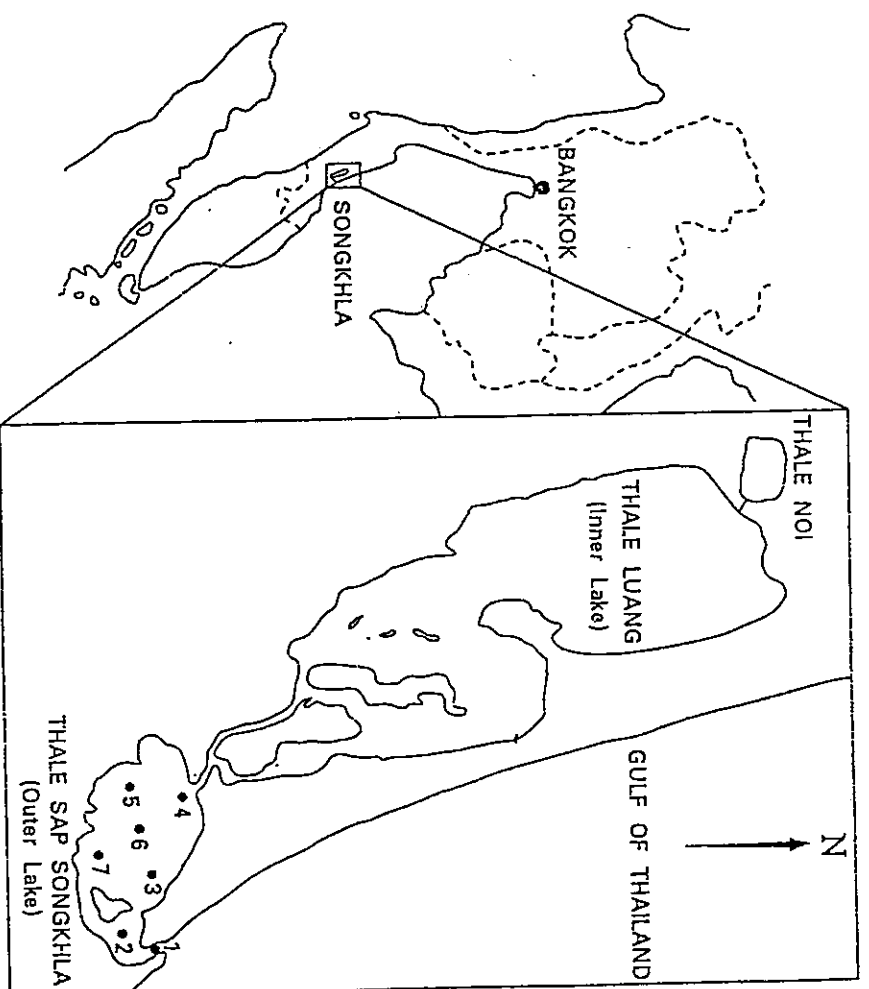


Figure 1 Map showing Songkhla Lake and study station.

plings in August, October and December 1991, June 1992 and January 1993 comprised 111 species in 43 families. Most faunas were brackish (50 species) or marine species (47 species) with only 13 freshwater species. Aquatic faunas found were mostly fish (97 species) with the remainder being marine shrimps (9 species), marine crabs (3 species) and 2 species of mantis shrimps (Table 1). The most abun-

dant and frequently found fish family was Leioagnathidae with *Leioagnathus brevivirostris* and *L. equulus* as the dominant species. Other important families of fish were Clupeidae and Atherinidae. Families Centropomidae and Gobiidae were frequently found but not in high abundance. The most abundant marine shrimp was *Metapenaeus ensis*. Both crab and mantis shrimp were rarely found.

Table 1 List of Pisces and Crustacea investigated in Thale Sap Songkhla in August 1991, October 1991, December 1991, June 1992 and January 1993.

Taxa	Habitat / Niche
Pisces	
1. Family Clupeidae	
1. <i>Anodontostoma chacunda</i>	Estuarine sp. / phytoplankton feeder
2. <i>Corica soborna</i>	Freshwater sp. / phytoplankton feeder
3. <i>Escualosa thoracata</i>	Estuarine sp. / phytoplankton feeder
4. <i>Herkotisichthys dispilonotus</i>	Estuarine sp. / phytoplankton feeder
5. <i>Alosa toli</i>	Estuarine sp. / phytoplankton feeder
6. <i>Nematolosa nasus</i>	Estuarine sp. / phytoplankton feeder
7. <i>Goniolosa modestus</i>	Marine sp. / phytoplankton feeder
8. <i>Sardinella albella</i>	Marine sp. / phytoplankton feeder
2. Family Engraulidae	
9. <i>Engraulis haniltonii</i>	Estuarine sp. / zooplankton feeder
10. <i>Stolephorus commersonii</i>	Estuarine sp. / zooplankton feeder
11. <i>S. indicus</i>	Marine sp. / zooplankton feeder
12. <i>S. tri</i>	Estuarine sp. / zooplankton feeder
3. Family Cyprinidae	
13. <i>Rasbora argyrotaenia</i>	Freshwater sp. / phytoplankton feeder
14. <i>R. trilineata</i>	Freshwater sp. / phytoplankton feeder
15. <i>Hampala macrolepidota</i>	Freshwater sp. / carnivore
16. <i>Osteochilus hasselti</i>	Freshwater sp. / phytoplankton feeder
17. <i>Puntius gonionotus</i>	Freshwater sp. / phytoplankton feeder
18. <i>P. leucanthus</i>	Freshwater - estuarine sp. / phytoplankton feeder
4. Family Bagridae	
19. <i>Mystus gulosus</i>	Freshwater sp. / omnivore
5. Family Ariidae	
20. <i>Arius maculatus</i>	Estuarine sp. / omnivore
21. <i>A. sagor</i>	Marine sp. / omnivore
22. <i>Osteogeneiosus militarius</i>	Estuarine sp. / omnivore
6. Family Plotosidae	
23. <i>Plotosus canius</i>	Marine sp. / omnivore
7. Family Batrachoididae	
24. <i>Halophrynne trispinosus</i>	Estuarine sp. / carnivore

Table 1 (continued).

Taxa	Habitat / Niche
8. Family Excoetidae	
25. <i>Hemiramphus gainardi</i>	Estuarine sp. / plankton feeder
26. <i>Zenarchopterus dunckeri</i>	Estuarine sp. / plankton feeder
27. <i>Z. ectunthio</i>	Estuarine sp. / plankton feeder
9. Family Belonidae	
28. <i>Tylosurus strongylurus</i>	Estuarine sp. / carnivore
29. <i>Xenentodon cancula</i>	Freshwater sp. / carnivore
10. Family Atherinidae	
30. <i>Atherina duodecimalis</i>	Marine sp. / plankton feeder
31. <i>A. valenciennesi</i>	Marine sp. / plankton feeder
11. Family Symbbranchidae	
32. <i>Monopterus albus</i>	Freshwater sp. / omnivore
12. Family Centropomidae	
33. <i>Ambassis commersonii</i>	Marine sp. / zooplankton feeder
34. <i>A. gymnocephala</i>	Marine sp. / zooplankton feeder
35. <i>A. kopsii</i>	Estuarine sp. / zooplankton feeder
36. <i>Lates calcarifer</i>	Estuarine sp. / carnivore
13. Family Serranidae	
37. <i>Epinephelus suillus</i>	Estuarine sp. / carnivore
14. Family Theraponidae	
38. <i>Pelates quadrilineatus</i>	Marine sp. / carnivore
39. <i>Therapon jorbuva</i>	Marine sp. / carnivore
40. <i>T. puta</i>	Marine sp. / carnivore
15. Family Sillaginidae	
41. <i>Sillago sihama</i>	Marine sp. / zoobenthos feeder
16. Family Carangidae	
42. <i>Caranx sexfasciatus</i>	Marine sp. / plankton feeder
43. <i>Carangoides praeustus</i>	Marine sp. / plankton feeder
44. <i>Chorinemus lysan</i>	Marine sp. / plankton feeder
45. <i>Alepes vari</i>	Marine sp. / plankton feeder
17. Family Leiognathidae	
46. <i>Leiognathus brevirostris</i>	Estuarine sp. / plankton feeder
47. <i>L. elongatus</i>	Marine sp. / plankton feeder
48. <i>L. equulus</i>	Estuarine sp. / plankton feeder
49. <i>L. splendens</i>	Estuarine sp. / plankton feeder

Table 1 (continued).

Taxa	Habitat / Niche
50. <i>Secutor incidiator</i>	Marine sp. / plankton feeder
51. <i>S. ruconius</i>	Marine sp. / plankton feeder
18. Family Lutianidae	
52. <i>Lutianus lutianus</i>	Marine sp. / carnivore
53. <i>L. madras</i>	Marine sp. / carnivore
54. <i>L. russelli</i>	Marine sp. / carnivore
19. Family Gerreidae	
55. <i>Gerres macrostoma</i>	Estuarine sp. / plankton feeder
20. Family Sciaenidae	
56. <i>Dendrophysa russelli</i>	Marine sp. / carnivore
57. <i>Johnieops sina</i>	Marine sp. / carnivore
58. <i>Johnius carutta</i>	Marine sp. / carnivore
21. Family Scatophagidae	
59. <i>Scatophagus argus</i>	Estuarine sp. / plankton feeder
22. Family Chaetodontidae	
60. <i>Chaetodon sp.</i>	Marine sp. / plankton feeder
23. Family Nandidae	
61. <i>Unidentified sp.</i>	
24. Family Pristolepidae	
62. <i>Pristolepis fasciatus</i>	Freshwater sp. / phytoplankton feeder
25. Family Mugilidae	
63. <i>Liza subviridis</i>	Estuarine sp. / phytoplankton feeder
64. <i>Valamugil crunnesius</i>	Estuarine sp. / phytoplankton feeder
26. Family Sphyraenidae	
65. <i>Sphyraena jello</i>	Marine sp. / carnivore
27. Family Mullidae	
66. <i>Lipenaus trugula</i>	Marine sp. / plankton & benthos feeder
67. <i>U. suphureus</i>	Marine sp. / plankton & benthos feeder
28. Family Blenniidae	
68. <i>Petrocirtes kraniensis</i>	Estuarine sp. / plankton & benthos feeder
29. Family Gobiidae	
69. <i>Acentrogobius baliuroides</i>	Marine sp. / carnivore
70. <i>A. caninus</i>	Estuarine sp. / carnivore
71. <i>A. chlorostigmatoides</i>	Estuarine sp. / carnivore
72. <i>A. cyanomos</i>	Estuarine sp. / carnivore

Table 1 (continued).

Taxa	Habitat / Niche
73. <i>A. decoratus</i>	Marine sp. / carnivore
74. <i>A. honkongensis</i>	Estuarine sp. / carnivore
75. <i>Boleophthalmus boddarti</i>	Marine sp. / carnivore
76. <i>Brachygobius xanthomelas</i>	Estuarine sp. / carnivore
77. <i>Glossogobius biserratus</i>	Estuarine sp. / carnivore
78. <i>G. aureus</i>	Estuarine sp. / carnivore
79. <i>Gnatholepis alluvis</i>	Estuarine sp. / carnivore
80. <i>Gobiopterus chuno</i>	Estuarine sp. / carnivore
81. <i>Opiopomus caninoides</i>	Estuarine sp. / carnivore
82. <i>Oxyurichthys microlepis</i>	Marine sp. / carnivore
83. <i>Parapocryptes serpentaster</i>	Estuarine sp. / carnivore
84. <i>Pseudapocryptes lanceolatus</i>	Estuarine sp. / carnivore
85. <i>Stigmatogobius javanicus</i>	Marine sp. / carnivore
86. <i>S. sadanundio</i>	Estuarine sp. / carnivore
87. <i>Yonichthys criniger</i>	Estuarine sp. / carnivore
30. Family Trichiuridae	
88. <i>Trichiurus savala</i>	Marine sp. / carnivore
31. Family Siganidae	
89. <i>Siganus canaliculatus</i>	Marine sp. / benthic microalgae feeder
90. <i>S. javus</i>	Marine sp. / benthic microalgae feeder
32. Family Belontiidae	
91. <i>Trichogaster trichopterus</i>	Freshwater sp. / zooplankton feeder
92. <i>Trichopsis vittatus</i>	Freshwater sp. / zooplankton feeder
33. Family Callionymidae	
93. <i>Callionymus sagitta</i>	Marine sp. / zooplankton & zoobenthos feeder
34. Family Cynoglossidae	
94. <i>Solea ovata</i>	Marine sp. / zooplankton & zoobenthos feeder
35. Family Cynoglossidae	
95. <i>Cynoglossus puncticeps</i>	Marine sp. / carnivore
36. Family Triacanthidae	
96. <i>Triacanthus biaculeatus</i>	Marine sp. / carnivore
37. Family Tetraodontidae	
97. <i>Tetraodon fangxi</i>	Estuarine sp. / carnivore

Table 1 (continued).

Taxa	Habitat / Niche
Crustacea	
Shrimp and crab	
1. Family Penaeidae	
98. <i>Metapenaeus brevicornis</i>	Estuarine sp. / zoobenthos feeder
99. <i>M. ensis</i>	Estuarine sp. / zoobenthos feeder
100. <i>M. lysianassa</i>	Marine sp. / zoobenthos feeder
101. <i>Penaeus indicus</i>	Marine sp. / zoobenthos feeder
102. <i>P. merguensis</i>	Marine sp. / zoobenthos feeder
103. <i>P. monodon</i>	Estuarine sp. / zoobenthos feeder
2. Family Palaemonidae	
104. <i>Macrobrachium</i> sp.	Estuarine sp. / zoobenthos feeder
3. Family Alpheidae	
105. <i>Alpheus</i> sp.	Estuarine sp. / zoobenthos feeder
4. Family Portunidae	
106. <i>Portunus gladiator</i>	Marine sp. / benthos & detritus feeder
107. <i>P. pelagicus</i>	Estuarine sp. / benthos & detritus feeder
108. <i>Scylla serrata</i>	Estuarine sp. / benthos & detritus feeder
5. Family Squillidae	
109. <i>Oratosquilla nepa</i>	Estuarine sp. / carnivore
110. <i>O. woodman-soni</i>	Estuarine sp. / carnivore
6. Family Sergestidae	
111. <i>Acetes</i> sp.	Marine sp. / plankton feeder
Total No. of Freshwater species	13
Total No. of Estuarine species	50
Total No. of Marine species	47

Aquatic Fauna Population in Thale Sap Songkhla

All 111 species in 43 families of aquatic fauna were categorized into 19 groups. The first 18 groups were comprised of 18 major fish families while the last group was comprised of 31 species of fish in the rest 23 families plus 2 families of shellfish (Table 2). Families with high

abundance were Clupeidae, Leiognathidae, Atherinidae and Penaeidae. Fish in families Centropomidae and Gobiidae were found in every sampling but only in moderate numbers. The family Clupeidae comprised 8 species of anchovies and freshwater clupeid. Only 1 species lived in freshwater (*Corica soborna*); the other 7 species were

Table 2 Number of aquatic animals (individuals ha⁻¹) investigated in Thale Sap Songkhla.

Family	Aug 1991	Oct 1991	Dec 1991	Jun 1992	Jan 1993	Average	%
1. Clupeidae	66.4	745.4	3247.5	68.3	1304.9	1086.5	21.73
2. Engraulidae	19.9	79.0	98.4	555.6	60.1	162.6	3.25
3. Cyprinidae	-	4.4	34.9	11.9	27.9	19.8	0.32
4. Bagridae	-	49.8	18.8	101.6	53.7	56.0	0.90
5. Ariidae	-	23.0	61.5	2.4	0.7	21.9	0.35
6. Exocoetidae	33.2	98.1	41.9	9.5	50.8	46.7	0.93
7. Centropomidae	354.0	316.5	682.4	205.6	44.3	320.6	6.41
8. Theraponidae	41.6	7.4	2.8	0.8	0.7	10.7	0.21
9. Sillaginidae	6.6	27.6	5.6	11.9	2.1	10.8	0.21
10. Carangidae	-	0.7	4.9	0.8	0.7	1.8	0.03
11. Leiognathidae	1285.3	998.5	1708.3	1233.3	362.3	1117.5	22.35
12. Gobiidae	127.8	338.7	246.9	359.6	35.7	221.7	4.44
13. Atherinidae	207.7	431.1	1866.1	108.7	85.9	539.9	10.80
14. Mugilidae	9.9	242.2	2686.8	1.6	5.7	589.2	11.79
15. Penaeidae	445.5	669.4	118.1	232.5	26.5	298.4	5.97
16. Sergestidae	-	-	-	1711.9	98.8	905.4	7.24
17. Portunidae	8.3	2.9	16.4	4.0	0.7	6.5	0.13
18. Squillidae	13.3	3.7	4.8	7.9	1.4	6.2	0.12
19. Others ^a	64.8	240.0	117.0	218.2	63.7	140.7	2.82
Total	2684.3	4278.4	10963.1	4846.1	2226.6	4999.7	
Total no. ^b	47.24	75.30	192.95	85.29	39.19	88.00	

a, including small families of fish, crab and shrimp.

b, million per 17,600 ha (Total area of Thale Sap Songkhla).

found in brackish and seawater. The average abundance of *Corica soborna* was 37 fish ha⁻¹ and it was found only around St. 5, which received freshwater from Rattaphum Canal. The average abundance of the other 7 species was 1,274 fish ha⁻¹. Ninety-eight percent of these fish were found between the mouth of the lake and Kor Yor and the other 2% in the middle of Thale Sap Songkhla.

Aquatic Fauna Biomass in Thale Sap Songkhla

The average fresh weight of aquatic fauna was 7,084.96 g ha⁻¹ (ranging from 4,097.27 - 10,627.92 g ha⁻¹). The order of aquatic fauna from high to low fresh weight was Clupeidae, Leiognathidae, Atherinidae, Centropomidae, Gobiidae and others. The total weight of these 6 groups accounted for 70.93% of total aquatic fauna weight (Table 3). The maximum fresh weight was observed in December (heavy rain period) and the lowest in August (light rain period), the former being 2.6 times the latter.

Two species of fish in family Atherinidae were found: *Atherina duodecimnata* and *A. valentini*, with an average abundance of 475 and 436 fish ha⁻¹, respectively. Both species were found from the mouth to the middle of Thale Sap Songkhla.

Two genera of marine shrimps (6 species) in family Penaeidae were found: *Metapenaeus* and *Penaeus*. The most abundant species was *Metapenaeus ensis* with an average density of 208 shrimps ha⁻¹, accounting for 77.9% of marine shrimps. The average density of the other species in the genus *Metapenaeus* was 14 shrimps ha⁻¹, accounting for 5.3%. *Penaeus* spp. ac-

counted for 15.8% of total marine shrimps with an average density of 45 shrimps ha⁻¹. All marine shrimps were found throughout Thale Sap Songkhla.

The diversity of aquatic fauna in Thale Sap Songkhla was high, and comprised both local and migratory species. The composition of these migratory species changed seasonally as salinity governs their migration (Lowe-McConnell, 1987). The distribution of these migratory species depends upon the amount of rain and seawater intrusion. Fish in the family Atherinidae, the marine species, were limited in their distribution to an area of Thale Sap Songkhla close to the sea, and did not extend beyond the middle of Thale Sap Songkhla. Fish in the families Leiognathidae and Clupeidae, mostly brackish water species, were found in all

Table 3 Biomass of aquatic animals (g ha⁻¹) investigated in Thale Sap Songkhla.

Family	Aug 1991	Oct 1991	Dec 1991	Jun 1992	Jan 1993	Average	%
1. Clupeidae	69.84	1303.74	2414.58	101.99	1957.97	1169.62	16.51
2. Engraulidae	41.57	103.80	111.04	663.08	97.72	203.44	2.87
3. Cyprinidae	-	20.06	80.31	15.87	183.27	74.88	0.85
4. Bagridae	-	578.80	78.22	926.20	187.92	442.79	5.00
5. Ariidae	-	101.79	276.59	454.76	1.43	208.64	2.36
6. Exocoetidae	129.71	624.86	215.14	37.30	248.42	251.09	3.54
7. Centropomidae	595.33	432.76	1534.73	362.31	72.31	599.49	8.46
8. Theraponidae	44.89	42.65	11.17	3.17	0.36	20.45	0.29
9. Sillaginidae	11.64	123.49	45.50	69.44	9.66	51.95	0.73
10. Carangidae	-	2.97	27.24	0.74	2.86	8.45	0.10
11. Leiognathidae	1295.39	1031.51	1544.88	926.99	647.52	1089.26	15.37
12. Gobiidae	608.61	977.78	246.54	718.67	120.25	534.37	7.54
13. Atherinidae	207.86	2527.76	1588.51	138.09	140.32	920.51	12.99
14. Mugilidae	330.92	351.07	1392.62	15.88	20.76	422.25	5.96
15. Penaeidae	450.56	517.35	183.31	263.11	51.55	293.18	4.14
16. Sergestidae	-	-	-	451.59	26.85	239.22	1.35
17. Portunidae	53.21	50.53	33.17	300.00	35.80	94.54	1.33
18. Squillidae	44.89	23.78	26.31	88.89	8.59	38.49	0.54
19. Others ^a	212.85	1122.00	818.06	682.14	729.14	712.84	10.06
Total	4097.27	9936.70	10627.92	6220.22	4542.70	7084.96	
Total weight ^b	72.11	174.89	187.05	109.48	79.95	124.70	

a, including small families of fish, crab and shrimp.

b, metric tons per 17,600 ha (Total area of Thale Sap Songkhla).

parts of Thale Sap Songkhla. Food quality (Angsupanich and Aruga, 1994), fish were and quantity are also other important factors. Marine shrimps were more abundant during the southwest monsoon (August to October) as benthos, an important part of the shrimps' diet (Ikematsu, 1963), are also abundant during this time of the year (Angsupanich and Kuwabara, 1994). In the middle of the wet season (December), when plankton were most abundant

season, the number and biomass of leiognathids were not significantly different from those in the wet season, while the number and biomass of clupeids were substantially lower in the dry season. In favorable conditions, clupeids were more abundant than leiognathids, suggesting that they might be a better competitor. The correlation between fish or shellfish and

Table 4.

Three groups of the aquatic organisms mentioned above tend to have a positive linear correlation with some major fish families which were more than 4% of total fish caught by weight. Planktivorous fish comprise the major fish families found

Table 4 Correlation between the fish or shellfish and other aquatic organisms.

Fish family	Phytoplankton (r ²)	Zooplankton (r ²)	Benthos (r ²)
1. Clupeidae	0.8973	0.5100	-0.6515
2. Engraulidae	0.0014	-0.2945	0.3918
3. Cyprinidae	0.7745	0.1111	-0.9473
4. Bagridae	-0.2151	-0.1861	0.4631
5. Ariidae	0.8819	0.7585	-0.1942
6. Exocoetidae	-0.2111	0.7410	0.3130
7. Centropomidae	0.7800	0.5914	-0.0591
8. Theraponidae	-0.3672	-0.2781	0.6361
9. Sillaginidae	-0.3487	0.6549	0.9251
10. Carangidae	0.9875*	0.5061	-0.4550
11. Leiognathidae	0.1038	0.1037	0.6169
12. Gobiidae	0.1340	0.5092	0.8442
13. Atherinidae	0.9391	0.6144	-0.3307
14. Mugilidae	0.9679*	0.5471	-0.4068
15. Penaeidae	-0.5093	0.4534	0.8944
16. Sergestidae	-0.1021	-0.4211	0.3534
17. Portunidae	0.8449	0.3331	-0.3075
18. Squillidae	-0.2086	-0.4018	0.4860
Total	0.9532	0.5627	-0.2016

*: 2-tailed significance 0.01

in Thale Sap Songkhla. The dominant families of planktivorous fish which peaked in the same period as the phytoplankton bloom were Clupeidae ($r^2 = 0.897$), Mugilidae ($r^2 = 0.968$), Atherinidae ($r^2 = 0.939$), and Centropomidae ($r^2 = 0.780$). In addition, a minor group of fish of the Carangidae family showed a significant correlation to phytoplankton with $r^2 = 0.988$. Atherinidae normally inhabits the sea and sometimes enters Thale Sap Songkhla for food, while Centropomidae, Clupeidae and Mugilidae are permanent inhabitants of Thale Sap Songkhla. There was no linear correlation between the large number of fish in families of Leiognathidae and plankton. Fish in this family can spawn almost all year-round and there is no outstanding peak. They are a unique and important group in the lake, since they can tolerate a wide range of environmental changes. Among the demersal fish, there is a positive linear correlation between the number of fish in families of Gobiidae ($r^2 = 0.844$) and Sillaginidae ($r^2 = 0.925$) with benthic fauna. Gobiidae is generally a carnivorous fish, the collected gobies were fingerlings (2.5 g per individual). Therefore, catching benthic fauna should be easier for them than hunting other pelagic organisms. Furthermore, there is a positive linear correlation between the number of penaeid shrimp and benthic fauna. Although benthic fauna in Thale Sap Songkhla are not very productive, there are enough to serve the immigrated juvenile penaeids. Macrobenthos has been suggested as a major food source for penaeid shrimp (Ikematsu, 1963). Epifaunal suspension

feeders and deposit feeders have been found to be preferable to infaunal deposit feeders for shrimp (Kuwabara and Akimoto, 1986). Penaeid shrimp is of great economic value to fishermen around the lake, as evidenced by the thousands of shallow stake shrimp traps in Thale Sap Songkhla. *Metapenaeus ensis* in particular has made up to 47.34% of total marine shrimp harvested in the area (Brohmanonda and Sungkasem, 1982).

Although correlation between fish and zooplankton showed no significance, this does not mean that zooplankton is not important in the food chain. Small size zooplankton such as protozoan, rotifers and nauplius found in the lake are suitable food for fish larvae. Rotifer *Brachionus plicatilis* has been cultured as feed for seabass larvae (Pechmanee and Assavaaree, 1991) and grouper larvae (Pechmanee *et al.*, 1988). Moreover, freshwater rotifers have also been cultured for goby larvae (Pasookdee and Sirikul, 1983a; Pasookdee and Sirikul, 1983b). The abundance of fish larvae in this lake is thus worthy of further study, in order to get baseline data for an estimation of fish production, and for more understanding of the food chain in Thale Sap Songkhla.

The number of aquatic fauna species found in the present study (111 species) is quite high compared to what was found (48 species) by Sirimontaporn *et al.* (1985), who used the same methods to obtain data. However, the average biomass of these two studies are not significantly different

($p < 0.05$). Average biomass (\pm S.E.) in 1985 and in the present study was 5.8657 ± 0.3602 and 7.0906 ± 3.0266 kg ha⁻¹, respectively. It should be noted that a high standard error in the present study could be a cause of the lack of difference in biomass. Production in Thale Sap Songkhla reported in this study, however, falls within the same levels reported elsewhere (Marten and Polovina, 1982; Pauly, 1983).

It should be noted that in the present study, a net of small mesh size was used to make an efficient diversity study. However, the use of such a net caused a slow net hauling speed; therefore, aquatic fauna caught were mostly small to moderate in size with slow swimming speed. Consequently, all samples may be considered to underestimate the abundance and biomass of fast swimmers.

CONCLUSION

One hundred and eleven species in 43 families of aquatic fauna were found in Thale Sap Songkhla. The 4 most abundant groups of aquatic fauna were fish in the families Clupeidae, Leiognathidae, Atherinidae and marine shrimp in the family Penaeidae. Fish in the families Centropomidae and Gobiidae were found in every sampling but in low amounts. The abundance of aquatic fauna ranged from 2,226.6 - 10,963.1 individual ha⁻¹. The range of their fresh weight was 4,097.27 to 10,627.92 g ha⁻¹. Calculated from the surface area of Thale Sap Songkhla (17,600 ha),

aquatic fauna was estimated to be 88 million individuals. The families Clupeidae, Leiognathidae and Atherinidae made up 21.73%, 22.35% and 10.8% of the total number of fauna, respectively. The total biomass was estimated to be 124.70 metric tons. The ratio between the biomass in the most productive month and the least productive month was 2.6.

Seasonal availability of various natural food makes fish catches feasible almost all year-round, and there are seasonal changes to the range of fish species present. Water quality has a great influence on the biotic community and the food chain. Seasonal changes in salinity are an important factor affecting the number and species diversity of plankton in Thale Sap Songkhla. Salinity is regulated by the volume of rainfall and annual discharge from the land.

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