EFFECTS OF FYKE NET MESH SIZE AND SAMPLING PERIOD ON THE CATCH OF NEKTON IN AN INTERTIDAL CREEK

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Abstract: The present study was carried out in an intertidal creek in Jiuduansha saltmarsh of the Yangtze River Estuary, China. Fyke nets of two mesh sizes, 4mm and 8mm, were applied to determine the effects of mesh size and day-night period on the catch of nekton. Through the sampling of five consecutive 24 h periods, a total of 5476 fish of 16 species and 4982 shrimp of two species were collected. Analyses indicated that mesh size had no significant effect on the species number and abundance of fish caught, but smaller mesh had higher catch rates of crustaceans. More individuals of fish were caught at night than in the daytime for both 4mm and 8mm mesh nets, but more crustacean individuals were caught by day. In the daytime, different mesh sizes had no significant effect on the length distribution of five most abundant nekton species caught by the nets. In night sampling, nets with smaller mesh captured a greater proportion of large individuals of some predominant species (e.g. *Synechogobius ommaturus* and *Exopalaemon carinicauda*), but reverse result occurred in other species such as *Liza haematocheila*. Community structures of nekton in night and day samples were different. Nets with smaller mesh sizes show relatively low sampling precision values.

Key words: Fish; Shrimp; Sampling efficiency; Yangtze River estuary;
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Intertidal marshes, creeks as well as open estuarine waters have been recognized worldwide as important habitats for fish and nektonic macro-crustaceans[1]. Many studies have been carried out in these habitats that it should be possible to look for general pattern of nekton use. However, comparisons of results from different studies are usually confounded by the use of different sampling techniques, net sizes, and mesh sizes[2].

The use of appropriate sampling methods is crucial to understand the functional role of nekton[3]. Several modified conventional methods have been used to collect nekton in tidal marshes and similar environments[1]. Methods of capturing nekton fall into two categories: passive methods (e.g. fyke nets, traps and block nets), which rely on fish swimming into a net or a trap, and active methods (e.g. seines, trawls and throw nets), where fish are pursued[4]. The efficiency of a passive sampling gear is affected by mesh size, gear design, soak time, gear size, tidal stage, and a variety of other factors[4—6]. Comparisons of different sampling gear types have been made in some studies[7—9], but little is known about the efficiency of different mesh sizes of passive gears in sampling nekton.

Previous researchers used passive gears with mesh sizes ranging from 0.5mm to 80mm, with the majority from 1mm to 8mm[10—12]. In this study, fyke nets were chosen to evaluate catching ability of different mesh sizes and diel variability. Two mesh sizes, 4mm and 8mm, were used day and night to compare catch rates, faunal composition and size range of nekton in an estuarine intertidal creek.

1 Materials and Methods

1.1 Study Site The study site was located in the Jiud-

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uansha saltmarsh (31°03′ N to 31°17′ N, 121°46′ S to 121° 15′ S), in the Yangtze River Estuary, China. Sampling was done in an intertidal creek measuring 2 km long and 3 m deep at spring tide. Tides in the area were dominated by semidiurnal tides. The creek was inundated twice daily, and the tidal raige varied with diel condition. The creek was drained during the spring tide series. The predominant vegetations around marshes were *Scirpus mariqueter*, *Phragmites australis* and *Spartina alterniflora*.

1.2 Field Sampling During 23—28 June 2004, fyke nets with two different mesh sizes were installed in the creek for sampling nekton over five consecutive 24 h periods. Each fyke net had its mouth measuring 1m × 1m, with two wings both measuring 8 m in length and 1m in height. A total of four fyke net pairs, each formed by nets of 4mm mesh and 8mm mesh, were concurrently set up in pair at an interval of 150 m along the creek. All the nets were deployed when the creek was drained and the net mouths were facing ebbing current to enable nets retaining fish and shrimp as they moved off the marsh at ebbtide. In each 24 h period, the nets were retrieved at low tide for day samples and night samples, respectively. The samples were preserved in 10% formalin water solution. In the laboratory, all specimens were counted, identified, and measured. Standard lengths (SL) of fish and total length (TL) of crustaceans were recorded.

1.3 Data Analyses To test the differences in catch rates between mesh sizes (4mm and 8mm) and temporal variation (day and night), abundance data were lg (x+1) transformed and analyzed using multivariate analysis of variance (ANOVA). A Kolmogorov-Smirnov asymptotic two-sample test (KSa) was used to compare length-frequency distributions of the 5 most abundant species. Multidimensional scaling (MDS) was used to compare nekton assemblages based on the Bray-Curtis similarity coefficient. The data were fourth root transformed prior to the MDS analyses.

2 Results

2.1 Catch rates A total of 5476 fish of 16 species and 4982 crustaceans of two species were collected in this study. For both 4mm mesh nets and 8mm mesh nets, more individuals of fish were caught at night, but more individuals of crustaceans were caught by day (Tab. 1). Species number of both fish and crustaceans were not significantly different between the two mesh size nets. The most abundant species (relative abundance more than 2%) were *Exopalaemon carinicauda*, *Synechogobius ommaturus*, *Liza haematocheila*, *Ophichthys apicalis*, and *Periophthalmus cantonensis*, contributing 46.40%, 28.72%, 15.40%, 4.08% and 2.38%, respectively, of the total catch.

Tab. 1 Abundance of nekton species caught by fyke nets in the study

Species	8mm mesh		4mm mesh		Abundance(%)
	Day	Night	Day	Night	
Fish					
Synechogobius ommaturus	520	1033	485	966	28.72
Liza haematocheila	239	608	307	453	15.37
Ophichthys apialis	45	165	36	181	4.08
Periophthalmus cantonensis	54	86	48	61	2.38
Collichthys lucidus	4	51	0	29	0.80
Odontamblyopus rubiaundus	13	8	15	5	0.39
Lateolabrax japonicus	15	7	11	2	0.33
Trypauchen vagina	0	4	0	6	0.10
Boleophthalmus pectinirostris	3	0	3	2	0.08
Cirrhimuraena chinensis	1	0	1	1	0.03
Pseudobrama simoni	1	1	0	0	0.02
Carassius auratus	0	0	1	1	0.02
Anguilla japonica	0	0	1	0	0.01

Continued

Species	8mm mesh		4mm mesh		Abundance(%)
	Day	Night	Day	Night	
Gambusia affinis	0	0	0	1	0.01
Macropodus chinensis	0	1	0	0	0.01
Caranx sexfasciatus	0	1	0	0	0.01
Total number of fish	895	1965	908	1708	52.36
Total number of fish species	10	11	10	12	
Shrimp					
Exopalaemon carinicauda	1242	981	1394	1236	46.40
Macrobrachium nipponensis	26	25	36	42	1.23
Total number of shrimp	1268	1006	1430	1278	47.64
Total number of shrimp species	2	2	2	2	

The catch rates (total number of individuals caught per tide) of four most abundant fish species were significantly greater in night sampling (*O. apicalis*, $F=28.16$, $p<0.001$; *S. ommaturus*, $F=47.62$, $p<0.001$; *L. haematocheila*, $F=9.95$, $p=0.003$; *P. cantonensis*, $F=9.76$, $p=0.003$), whereas there was no significant difference between two nets of different mesh sizes. The catch rates of *E. carinicauda* were significantly greater ($F=7.18$, $p=0.01$) in the nets with 4mm mesh size than those in 8mm mesh size, but they are not significantly different between day and night.

2.2 Length distribution The mesh size had no significant effect on the length distribution of the five abundant nekton by day. At night, the 4mm nets caught greater proportions of larger individuals of two species (*E. carinicauda*, $p<0.001$ and *S. ommaturus*, $p<0.001$), whereas the greater proportion of *L. haematocheila* ($p<0.001$) in larger size classes were caught within 8mm mesh nets (Fig. 1). Dealing with the temporal sampling variation, 8mm mesh nets caught grater proportions of larger individuals of *L. haematocheila* ($p=0.002$), and *S. ommaturus* ($p<0.001$) at night, but 4mm mesh nets only caught more larger individuals of *S. ommaturus* ($p=0.022$) than 8mm mesh nets at night.

2.3 Nekton assemblage The multidimensional scaling (MDS) based on the Bray-Curtis similarity coefficient was used to compare fish and shrimp assemblages of the four groups: 8mm mesh-day, 8mm mesh-night, 4mm mesh-day and 4mm mesh-night samples (Fig.2). Night samples were clearly separated from day samples, but the samples caught by the two mesh sizes had similar community structure. The samples from 4mm mesh size nets were more widely dispersed than those from 8mm mesh size nets (Fig.2).

3 Discussion

For most abundant fish species, higher catch rates, both in 8 and 4mm mesh nets, were obtained at night. This is in accordance with previous studies of nekton in saltmarsh habitats[13-15]. But the opposite results were reported by other studies[16,17]. Jansson *et al.*[18] and Fell *et al.*[19] pointed out that the diel differences in nekton density vary with the species. The different number of individuals caught between day and night may be due to biological and physical reasons, such as (1) visual net avoidance during day-time; (2) activity of individuals different during day and night; (3) sampling method[15,20]. In Jiuduansha saltmarsh, tidal stage varied with the time of day. During the sampling period, the tides and the surface current velocity of flood and ebb tide were higher at night, which may affect individual behaviors and foraging opportunities. Therefore, the tide effects should be considered in a sampling design.

In our study, mesh size had no significant effect on the species number and the abundance of fish caught by fyke nets, but had a significant effect on the abundance of crustacean (*E. carinicauda*). It is most likely a result of more crustacean individuals that are more able to swim and escape from the bigger mesh nets. Anyhow, our results show that the fyke nets with smaller mesh size have higher catch rates of crustaceans.

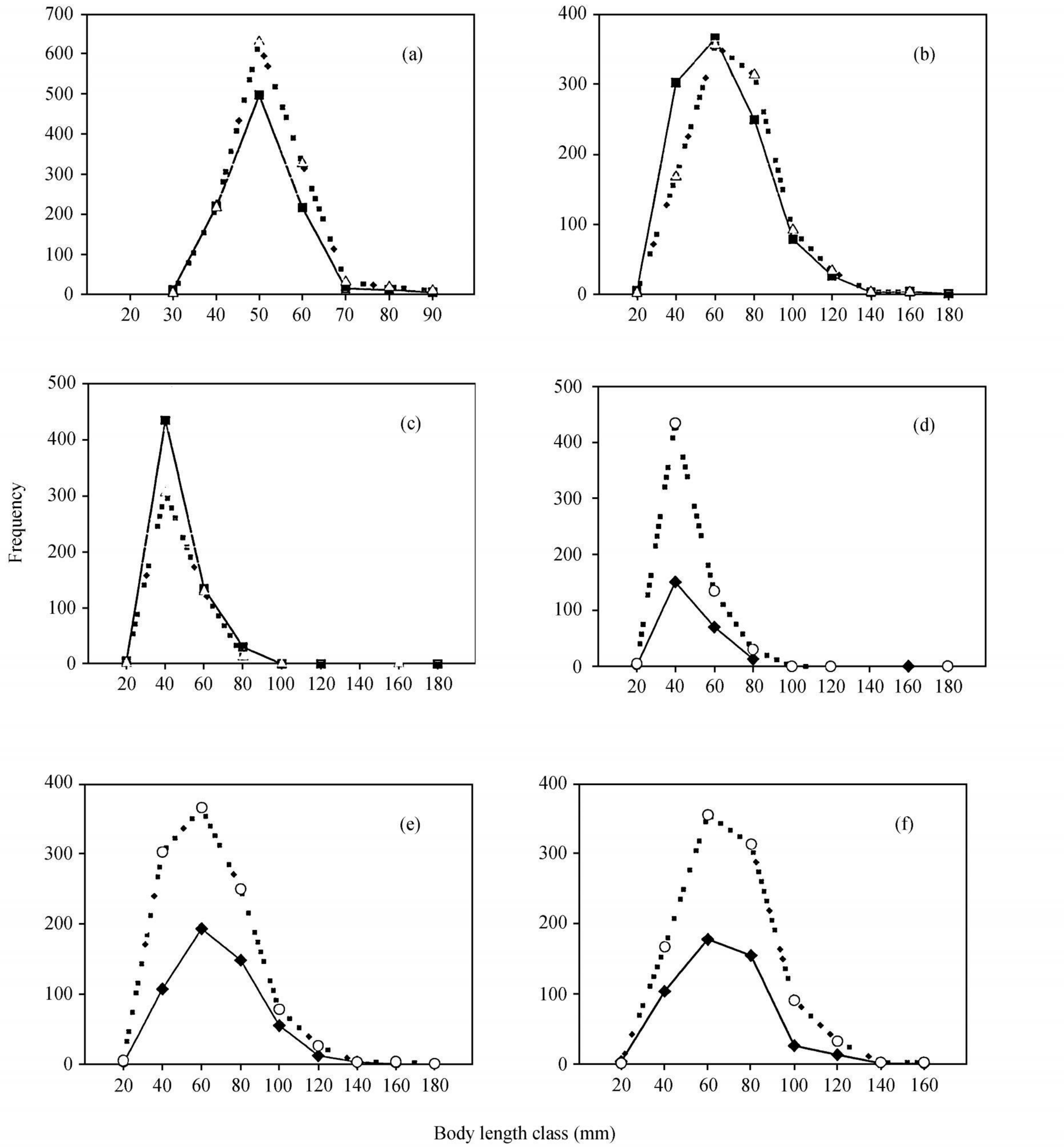

Fig. 1 Standard length for fish and total length for shrimp distributions of (a) *E. carinicauda*: 8 vs. 4mm mesh size of night samples; (b) *S. ommaturus*: 8 vs. 4mm mesh size of night samples; (c) *L. haematocheila*: 8 vs. 4mm mesh size of night samples; (d) *L. haematocheila*: day vs. night of 8mm mesh size samples; (e) *S. ommaturus*: day vs. night of 8mm mesh size samples; (f) *S. ommaturus*: day vs. night of 4mm mesh size samples (■:8mm mesh sizes; △: 4mm mesh sizes; ◆: day; ○: night)

No other study of saltmarsh creek nekton has compared the length distribution of species collected by nets of different mesh sizes. Newman and Williams[21] investigated the traps with four mesh sizes (12.5mm, 30mm, 40mm, and 50mm mesh) on the central Great Barrier Reef and found that the length frequency distributions of catches from 30, 40 and 50mm were significantly different one another. They found that the size range of target species (*Lutjanus* and *Lethrinus*) caught in 40mm mesh size was greater than that in the 50mm mesh. In our study, the size ranges among three species (*S. ommaturus*, *E. carinicauda* and *L. haematocheila*) were not significantly differ-

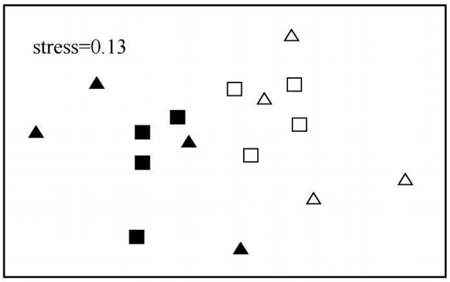

Fig. 2 MDS ordination plots based on the abundance data of nekton caught in fyke nets with two mesh sizes by day and night(□: 8mm mesh-day; ■: 8mm mesh-night; △: 4mm mesh-day; ▲: 4mm mesh-night)

ent, but the trends of their length frequency were different between mesh sizes. As indicated by the night sampling, the fyke nets with smaller mesh captured a greater proportion of large individual of two nekton species, *S. ommaturus* and *E. carinicauda*, but greater proportion of larger individuals of *L. haematocheila* were captured by the larger mesh nets. Guest *et al.*[15] compared the length distribution of individuals collected by day and night in shallow seagrass habitats and found that night-seines captured a greater proportion of larger individuals of some species. Our result also indicates that some species (*S. ommaturus* and *L. haematocheila*) captured were larger during night sampling. It may be explained by both the diel tide stages and the gear avoidance[13]. During the day, larger individuals are able to avoid the gear more easily, but the avoidance ability may vary with species.

Night samples of nekton assemblages were clearly separated from day samples. This result is in agreement with the findings of Guest *et al.*[15]. The wider dispersion of nekton assemblages from fyke nets with 4mm mesh size showed low precision values for species collection. It suggests that when using fyke nets with small mesh size more samples are needed to represent nekton assemblages properly.

4 Ecological implications

A proper sampling method should maximize the catch (number of species and abundance) and the size range of individuals[21]. The present study is instructive in selecting an appropriate mesh size of fyke nets and diel stage for ecological sampling in Jiuduansha saltmarsh creeks.

1) The selection of mesh sizes of fishing gears should be in accordance with different research purposes and sampling objectives. The fyke nets with smaller mesh resulted in more efficient sampling of crustaceans in the present study. Therefore, fishing gears with smaller mesh sizes would be more suitable if we intend to study shrimps or entire nekton community in estuarine creeks.

2) The determination of the most effective diel stage for sampling is important for the design of sampling programs. Faunal surveys covering only daytime are believed to be less accurate than the studies including night time sampling due to the daytime sampling bias and gear avoidance[22]. Our study also shows that more and larger individuals of fish can be caught at night. Therefore, night sampling is essential for estimating the fish use of estuarine marsh and creeks.

3) The variation in nekton faunal assemblages was more pronounced in nets with smaller mesh sizes than bigger mesh sizes. Therefore, more replicates are needed when small mesh size nets is applied in the sampling.

4) The analyses of available reports on nekton indicate that the mesh sizes of fishing gears and the sampling period should be considered. In this study, mesh size had no significant effect on the catch rate of fish but affected shrimps significantly. The length frequency varied with mesh sizes and fish species. These results suggest that research data from nets ranging from 4 mm to 8 mm mesh sizes may be used for the comparison of fish catch rate, but hard for that of shrimp catch and fish size frequency.

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插网网目尺寸及采样时间对潮沟游泳动物采样的影响

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摘要: 在长江河口九段沙盐沼湿地的一条潮沟中, 我们比较了两种不同网目尺寸(4mm 和 8mm)的插网(fyke net)及日夜潮对游泳动物群落采样效率的影响。共捕获鱼类 16 种 5476 尾、虾 2 种 4982 只。采用方差分析、柯尔莫诺夫-斯米尔诺夫非参数检验法和无度量多维标定分析对两种网目插网的捕获效率, 样品的体长分布, 群落结构及日夜潮间的差异进行了分析。结果表明, 网目尺寸对样品中游泳动物的物种数和鱼类的多度没有影响, 但是小网目的插网对虾类有较高的捕获率。两种网目尺寸的插网均在夜潮中捕获较多的鱼类个体, 但虾类在日潮捕获较多。在日潮中, 网目尺寸对捕获物中五种优势游泳动物的体长分布无显著影响。在夜间, 小网目的插网对斑尾复 虎和脊尾白虾的较大个体具有较高的捕获率, 但对较大个体 的捕获率不如大网目的插网。样品中游泳动物的群落组成在日夜潮间存在明显差异, 大网目捕获物的样本间差异比小网目小。

关键词: 鱼; 虾; 采样效率; 长江河口