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Population biology and feeding habits of the nephropid lobster *Metanephrops thomsoni* (Bate, 1888) in the East China Sea

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Abstract: *Population biology and feeding habits of the nephropid lobster Metanephrops thomsoni (Bate) was studied from a field survey sampled with bottom trawls in the East China Sea. The female/male ratio was 1.06:1. Three size-class groups were discriminated for both sexes, which may correspond to one to three year-old cohorts. The average stage fecundity was 471 in each brood. Larger than two-year-size-class females are multi broods during the breeding season. Gut analysis showed that this lobster is a common carnivore and mainly consume crustaceans and fishes, regardless of sex and carapace length size.*

Key words: *Metanephrops thomsoni, Population biology, Feeding habitats, East China Sea*
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Introduction

The nephropid lobster *Metanephrops thomsoni* (Bate, 1888) is distributed in the west pacific region of Korea, Japan, China, Taiwan and the Philippines (Kim, 1977; Baba, 1986; Holthuis, 1991; Chan and Yu, 1993). Although it is one of the economically important species in the region (Yamada *et al.*, 1986; Holthuis, 1991), little is known of its eco-biology. Its larval development is described by Uchida and Dotsu (1973). Yamada *et al.* (1986) briefly described the reproductive biology of the lobster without biological data. To date there have not been any studies which examine its population biology and feeding habits.

In recent years, large number of *M. thomsoni* has been captured by commercial fishing from the northern part of the East China Sea. In this area, the lobster is occasionally captured on sandy mud bottom along with several penaeid shrimps and commercial fishes by trawl net fishing (Yamada *et al.*, 1986; Cha *et al.*, 2001). The lobster lays relatively larger eggs and has small fecundity compared to other similar-habitat-patterned crustacean (Yamada *et al.*, 1986; Van Dover and Williams, 1991). This study examines the population structure, maturation and fecundity of *M. thomsoni*, based on the analysis of size distribution, the observation of gonadosomatic index, and the staging of ovarian and egg development. And, the feeding habitat of the lobster also is investigated using the foregut contents analysis.

Materials and Methods

Specimens of *M. thomsoni* were collected in December in 2003 by the research vessel *Tamgu 1* (2,159 tons), with a bottom trawl net (mesh size of the cod end 0.98 x 0.98 mm) in waters (32°58'-33°08'N 125°28'-128°00'E) known as the Korean fisheries blocks, 233, 240, 241 and 243 in the East China Sea (Fig. 1). The net with otter boards was towed 10 times during the daytime at depth 90-110 m for 60 min at 3.4 knot.

All the samples collected for this study were frozen on board shortly after capture and kept frozen (-80°C) until the analysis. Before the foregut contents analysis, the samples were thawed, sex was recorded and the carapace length (CL, the distance from the posterior edge of the eye socket to the middle hind margin of the carapace) was measured with a digital vernier caliper (CD-15C, Mitutoyo Corporation, Japan). To discriminate age cohort, the raw data were classified and length-frequency distributions were constructed using 1-mm intervals of CL. The cohorts were separated and fitted on the frequency distributions using a Bhattacharya's method (Bhattacharya, 1967) within ELEFAN computer analysis program.

To examine foregut contents, the foregut was removed and opened for the all specimens. The contents were washed and put into a glass dish, and examined under a dissecting microscope (M5-Wild, Heerbrugg, Switzerland). Differences in the diet of male and female *M. thomsoni* and between size classes were investigated.

To examine fecundity and egg volume of oviparous females, the egg was removed from pleopods, separated by egg stage and counted, and it's long and short diameters were measured under a microscope. Egg stage was separated by 5 stages: A, early spawned, early blastoderm; B, large blastoderm, gastulation; C, small eye visible; D, large eyes, outline of carapace and abdomen; E, pre-larval stage, eye large, abdomen long and separated from head. The female gonad maturation stage was described by gonadosomatic index (GSI). To examine GSI, the ovary was removed as above, dried (70°C) for 48 hr in dry oven and weighed.

Table - 1: Diet composition of *Metanephrops thomsoni* collected from the East China Sea in December 2003 as a function of size in males and females. Values are no. of each food item (%) in relation to the total no. of all food items in sample

Diet item	Size class midpoint (mm)					Male	Female
	17.5	22.5	27.5	32.5	37.5		
Crustacea						0	0
Shrimps	16.7	35.7	16.0	7.0	5.9	16.2	9.5
Crabs	50.0	50.0	36.0	43.9	58.8	48.5	42.9
Hermitcrabs	-	7.1	4.0	5.3	-	2.9	4.8
Amphipods	44.4	64.3	24.0	1.8	-	16.2	20.6
Stomatopods	-	-	-	3.5	5.9	4.4	-
Annelida							
Polychaetes	44.4	7.1	28.0	15.8	17.6	23.5	19.0
Chordata							
Fishes	22.2	14.3	28.0	26.3	23.5	26.5	22.2
Deterites	5.6	7.1	4.0	14.0	17.6	8.8	12.7
Unidentified	-	-	12.0	5.3	-	1.5	7.9

Statistical comparisons of dietary composition were performed with non-parametric tests. The Mann-Whitney U-test was used to detect differences between sexes in a particular prey item and the Kruskal-Wallis one-way analysis of variance was used to test the null hypothesis that there is no difference in the number of each prey type eaten by different size classes of the lobster. One-way analyses of variance followed by Tukey's Multiple Comparison Test at p=0.05 were made to test the significant difference of each egg stage and egg number.

Results and Discussion

Eighty-six males and 81 females of *M. thomsoni* were collected from the East China Sea during this investigation. Most of the numerous samples from several haul were captured in the above fisheries blocks, 240 and 241 at a depth around 100 m, with a bottom water temperature of 19.86°C and salinity of 34.53 psu. Many specimens seemed to occur around this location. The female/male ratio was found to be 1.06:1. The average CL of female and male was 28.48 mm and 29.81 mm, respectively.

Population structure: In this study three size-class groups were discriminated in both sexes in this study (Fig. 2), the mean length of each cohort was 20.0 mm, 31.5 mm and 39.3 mm CL. These groups showed different gaps of each cohort. The average length of male and female, CL was 29.81 mm and 28.48 mm, respectively. In case of CL there was no significant difference between the sexes (T = 1.42, p = 0.16, df = 163).

M. thomsoni had similar growth pattern with the nephropid lobster *Nephrops norvegicus* (Linne, 1758) as reported from Scotland (Tuck *et al.*, 1997). Discriminated each cohort appeared to correspond to year classes. In this study, however, we could not catch sufficient samples of small-sized individuals, apparently due to the mesh size selectivity or their burrowing behavior (Tokai *et al.*, 1990; Aguzzi *et al.*, 2004). Yamada *et al.* (1986) reported that ovigerous females of this species appeared from September to next April in the East China Sea. After hatching, the larvae passes through several, usually pelagic stages, before molting to the postlarvae which is most often benthic and spread several months before fishing recruitment in offshore area (Uchida and Dotsu, 1973; Yamada *et al.*, 1986). Thus, we can choose that the smallest cohort group of this study area is one-year-old one and the largest cohort is three-years-old.

Maturation and fecundity: Mean egg volume increased with the egg stages, the brood by 190% from 2.36 mm^3 in stage A to 4.50 mm^3 in stage E (Fig. 3). An one-way ANOVA revealed a significant difference between the egg stages ($p < 0.05$). The number of the eggs on pleopods ranged from 210 to over 880 per brood, showing a general increase with female size (Fig. 4). Relationship between the egg numbers and CL for females was equated by egg no = $0.06 \times CL^{2.57}$ ($R^2 = 0.31$, $p < 0.001$) (Fig. 5). The average number of each egg stage of brood was 471. There was no significant difference between the number of eggs and the egg stages ($p > 0.05$). The GSI value increased with the brood egg stage, the value by 3,186% from 0.50 in stage A to 15.93 in stage E (Fig. 6). The Kruskal-Wallis test showed a significant difference between each stage ($p < 0.05$).

Through this study, we identified two kinds of evidence of reproduction strategy in *M. thomsoni*. The first strategy is the low egg loss rate. The mean egg loss rate is smaller than 20% through the egg developing stages. This appears to be a rare feature in genus *Nephrops* and other crustaceans (Kuris, 1991; Mori *et al.*, 1998; Tuck *et al.*, 2000). Mori *et al.* (1998) estimated that mean monthly egg loss rate of *Nephrops norvegicus* was about 10% and the total egg loss rate was about 50% through the incubation period from the North Tyrrhenian Sea. The egg volume of stage E increased more than 100% of early stage in this study. Thus, we can suggest that *M. thomsoni* has opportunistic reproduction strategy during the early stages. The second strategy is multiple brood productions. During egg incubation in pleopods for hatching, the female developed the oocytes for the next spawning. Although we had one time sampling from spawning area, we come to realize that the female has several spawning times during the breeding season from September to next April. This study shows that *M. thomsoni* also has an ecological strategy for next generation.

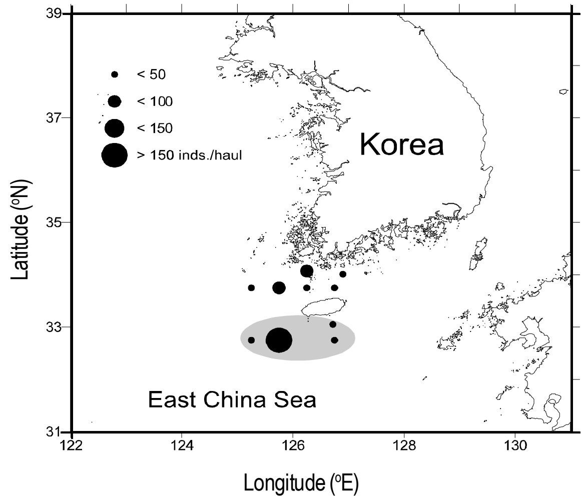

Fig. 1: Relative density of *Metanephrops thomsoni* at 4 sampling stations in the East China Sea

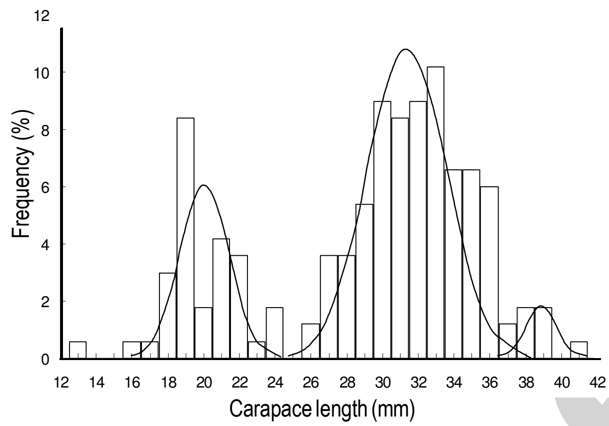

Fig. 2: Size distribution of *Metanephrops thomsoni* collected from the East China Sea in December 2003

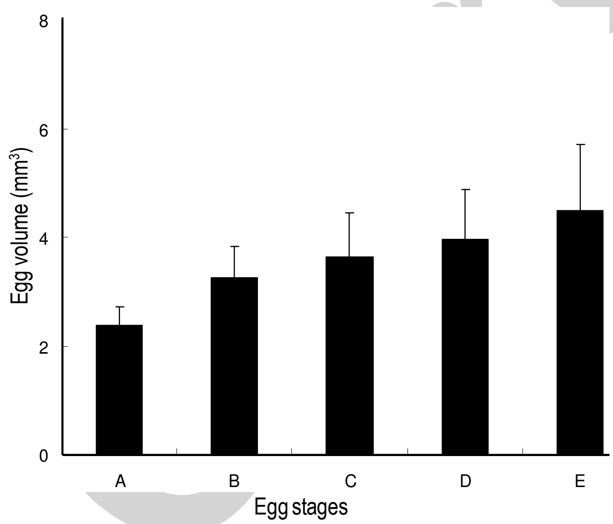

Fig. 3: Changes in the egg volume of *Metanephrops thomsoni* at different egg stages (A-E) collected from the East China Sea in December 2003

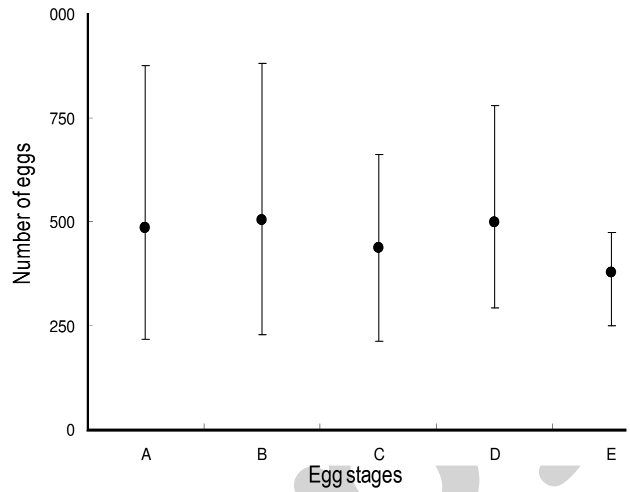

Fig. 4: Changes in the number of eggs of *Metanephrops thomsoni* in each egg stages (A-E) collected from the East China Sea in December 2003

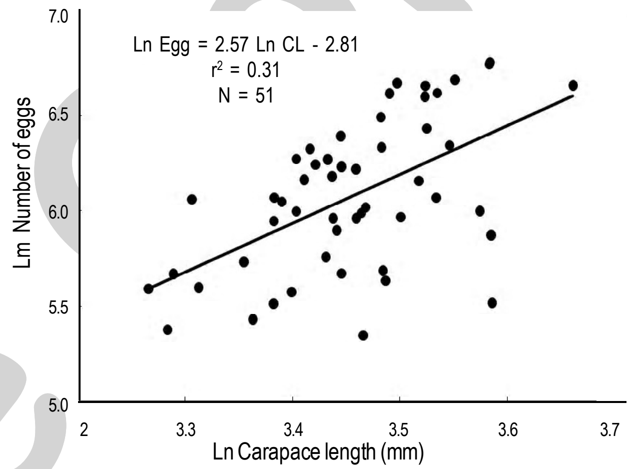

Fig. 5: Ln number of eggs per brood plotted against ln carapace length for the five incubation stages (A-E) of *Metanephrops thomsoni* collected from the East China Sea in December 2003

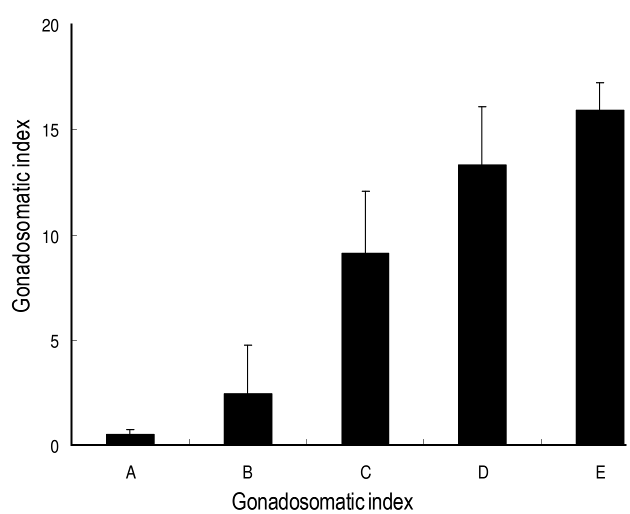

Fig. 6: Changes in gonadosomatic index of *Metanephrops thomsoni* in each egg stages (A-E) collected from the East China Sea in December 2003

Foregut contents: No difference was found in the diet between the sexes, but the occurrence of two prey items (polychaetes and fishes) was relatively greater in males than in females (Table 1). The frequency of occurrence of prey items didn't differ significantly among size classes of the lobster (Table 1). The frequency of occurrence of crustaceans increased with the size of the lobster. Crustaceans were comprised mainly of shrimps, crabs, hermitcrabs, amphipods, and stomatopods. The small size group of the lobster prefers amphipods to other crustacean dietary groups.

Dietary analysis shows that *M. thomsoni* is a predator of slow-moving or sessile benthic organisms. The major prey was crustaceans and polychaetes. Mobile prey such as fish is a minor component of their diet. Small percentage of fish prey item suggested that *M. thomsoni* is semi-mobile predator. Wassenberg and Hill (1989) reported that fish remains were quite common in lobsters collected from both scientific and commercial trawl. They suggested lobsters feed on fish discarded from commercial trawl or other discarded material. However, the small benthic fishes such as, goby and flat fish, frequently occurred in this study area (Yamada *et al.*, 1986). We found several fish back bones and fish scales in foregut contents of *M. thomsoni*. It can be suggested that the lobster feed on the small benthic fish. Since the lobster appears to consume carrion as it becomes available, there can be a suggestion that they are selective of active feeders.

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References

Aguzzi, J., A. Bozzano and F. Sarda: First observations on *Nephrops norvegicus* (L.) burrow densities on the continental shelf off the Catalan coast (western Mediterranean). *Crustaceana*, **77**, 299-310 (2004).

Baba, K.: The Anomura and Brachyura. *In*: Decapod crustacean from continental shelf and slope around Japan (*Eds.*: K. Baba, K. Hayashi and M. Toriyama). Japan Fisheries Resource Conservation, Tokyo. pp. 148-231(1986).

Bhattacharya, C.G.: A Simple method of resolution of a distribution into Gaussian components. *Biometics*, **23**, 115-135 (1967).

Cha, H.K., J.U. Lee, C.S. Park, C.I. Baik, S.Y. Hong, J.H. Park, D.W. Lee, Y.M. Choi, K. Hwang, Z.G. Kim, K.H. Choi, H. Sohn, M.H. Sohn, D.H. Kim and J.H. Choi: Shrimps of the Korean Waters. Nat'l. Fish. Res. Dev. Inst., Pusan (2001).

Chan, T.Y. and H.P. Yu: The Illustrated Lobsters of Taiwan. SMC Publishing Inc., Taipei (1993).

Holthuis, L.B.: FAO species catalogue. Vol. 13. Marine lobsters of the world. An annotated and illustrated catalogue of species of interest to fisheries known to date. FAO Fisheries Synopsis. No. 125, Vol. 13. Rome, FAO. p. 292 (1991).

Kim, H.S.: Macrura. Illustrated Flora and Fauna of Korea. Vol. 19. Samwha Publishing Co., Seoul (1977).

Kuris, A.M.: A review of patterns and cause of crustacean brood mortality. *In*: Crustancean egg production (*Eds.*: A. Wenner and A. Kuris). A.A. Balkema Publishers, Brookfield. pp. 117-141 (1991).

Mori, M., F. Biagi and S. De Ranieri: Fecundity and egg loss during incubation in Norway lobster (*Nephrops norvegicus*) in the North Tyrrhenian Sea. *J. Natural History*, **32**, 1641-1650 (1998).

Tokai, T., H. Ito, Y. Masaki and T. Kitahara: Mesh selectivity curves of a shrimp beam trawl for southern rough shrimp *Trachypenaeus curvirostris* and mantis shrimp *Oratosquilla oratoria*. *Nippon Suisan Gakkaishi*, **56**, 1231-1237 (1990).

Tuck, I.D., C.J. Chapman and R.J.A. Atkinson: Population biology of the Norway lobster, *Nephrops norvegicus* (L.) in the firth of clyde, Scotland -I: Growth and density. *ICES J. Marine Sci.*, **54**, 125-135 (1997).

Tuck, I.D., R.J.A. Atkinson and C.J. Chapman: Population biology of the Norway lobster, *Nephrops norvegicus* (L.) in the firth of clyde, Scotland II: Fecundity and size at onset of sexual maturity. *ICES J. Marine Sci.*, **57**, 1227-1239 (2000).

Uchida, T. and Y. Dotsu: On the larva hatching and larval development of the lobster, *Nephrops thomsoni*. Collection of the T.S. Nagasaki Maru of Nagasaki University. IV. *Bull. Faculty of Fisheries, Nagasaki University*, **36**, 23-35 (1973).

Van Dover, C.L. and A.B. Williams: Egg size in squat lobster (Galatheoidea): Constraint and freedom. *In*: Crustancean egg production (*Eds.*: A. Wenner and A. Kuris). A.A. Balkema Publishers, Brookfield. pp. 143-156 (1991).

Wassenberg, T.J. and B.J. Hill: Diets of four decapod crustaceans (*Linuparus trigonus*, *Metanephrops andamanicus*, *M. australiensis* and *M. boschmai*) from the continental shelf around Australia. *Marine Biology*, **103**, 161-167 (1989).

Yamada, U., M. Tagawa, S. Kishida and K. Honjo: Fishes of the East China Sea and the Yellow Sea. Seikai Regional Fisheries Research Laboratory, Nagasaki (1986).