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澎湖岐頭灣潮間帶出現之對蝦類稚蝦

張崑雄•陳章波•謝蕙蓮
蘇偉成•胡興華•李錫珍

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OCCURRENCE OF JUVENILE PENAEID SHRIMPS IN THE INTERTIDAL AREA OF CHITO BAY, PENGHU, TAIWAN¹

KUN-HSIUNG CHANG*, CHANG-PO CHEN*, HWEY-LIAN HSIEH*,
WEI-CHENG SU**, SING-HAW HU** and SEE-CHENG LEE**

* Institute of Zoology, Academia Sinica, Taipei, Taiwan, 115
Republic of China

** Division of Penghu, Taiwan Fisheries Research Institute,
Penghu 800, Taiwan, R. O. C.

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Kun-Hsiung Chang, Chang-Po Chen, Hwey-Lian Hsieh, Wei-Cheng Su, Sing-Hwa Hu and See-Cheng Lee (1981) Occurrence of Juvenile Penaeid Shrimps in the Intertidal Area of Chito Bay, Penghu, Taiwan. *Bull. Inst. Zool., Academia Sinica*, 20(2): 1-9 (1981) In the intertidal area of Chito Bay, Penghu, 2,455 individuals of juvenile penaeid shrimps, belonging to four species, were collected by hand trawling from August 1979 to September 1980. *Penaeus latisulcatus* Kishinouye was dominant, 2080 individuals were caught, comprising 85% of the total catch. *Metapenaeus ensis* (de Hann), rank in second, 319 individuals were caught (13%), peak numbers occurred in spring and autumn. Of *P. japonicus* Bate, only 39 individuals were caught in winter, whereas 17 *P. semisulcatus* de Haan were caught in summer. The relationship between seasonal abundance of juvenile shrimps, reproductive periods and environmental factors are discussed.

Penghu, often called the Pescadores, consists of islands with an extended serrated coastline and many shallow bays with an abundance of marine life. The Tropic of Cancer passes through the islands the water is warm and non-polluted, and the conditions appear very favorable for the development of aquaculture. With this goal in view, an ecological survey was conducted in Penghu from the intertidal region down to 10 meters sublittoral.

Knowledge of the composition and occurrence of juvenile shrimps in the intertidal zones is necessary for pond-cultivation and for a program involving release of juvenile prawns into the sea. To obtain the necessary information, a program of hand-trawling was carried out to sample the shrimp population in Chito Bay. In this work, four kinds of penaeid

juveniles were collected. All of them now have high-commercial values and this survey area, Chito Bay, as a nursery ground for prawns, is important and deserving conservation.

The occurrences of these juvenile shrimps varied seasonally, but the numerical patterns did not coincide well with the reported spawning seasons in some species. A very common prawn, *Metapenaeopsis barbara* (de Haan), fished offshore from Penghu, does not appear in this survey. These factors are of some importance and deserve discussion.

MATERIALS AND METHODS

From August 1979 to September 1980, the juvenile shrimps were collected monthly by two men pulling a small trawl net through the shallow water of the intertidal area of Chito Bay (Fig. 1), during low tide after dark. The

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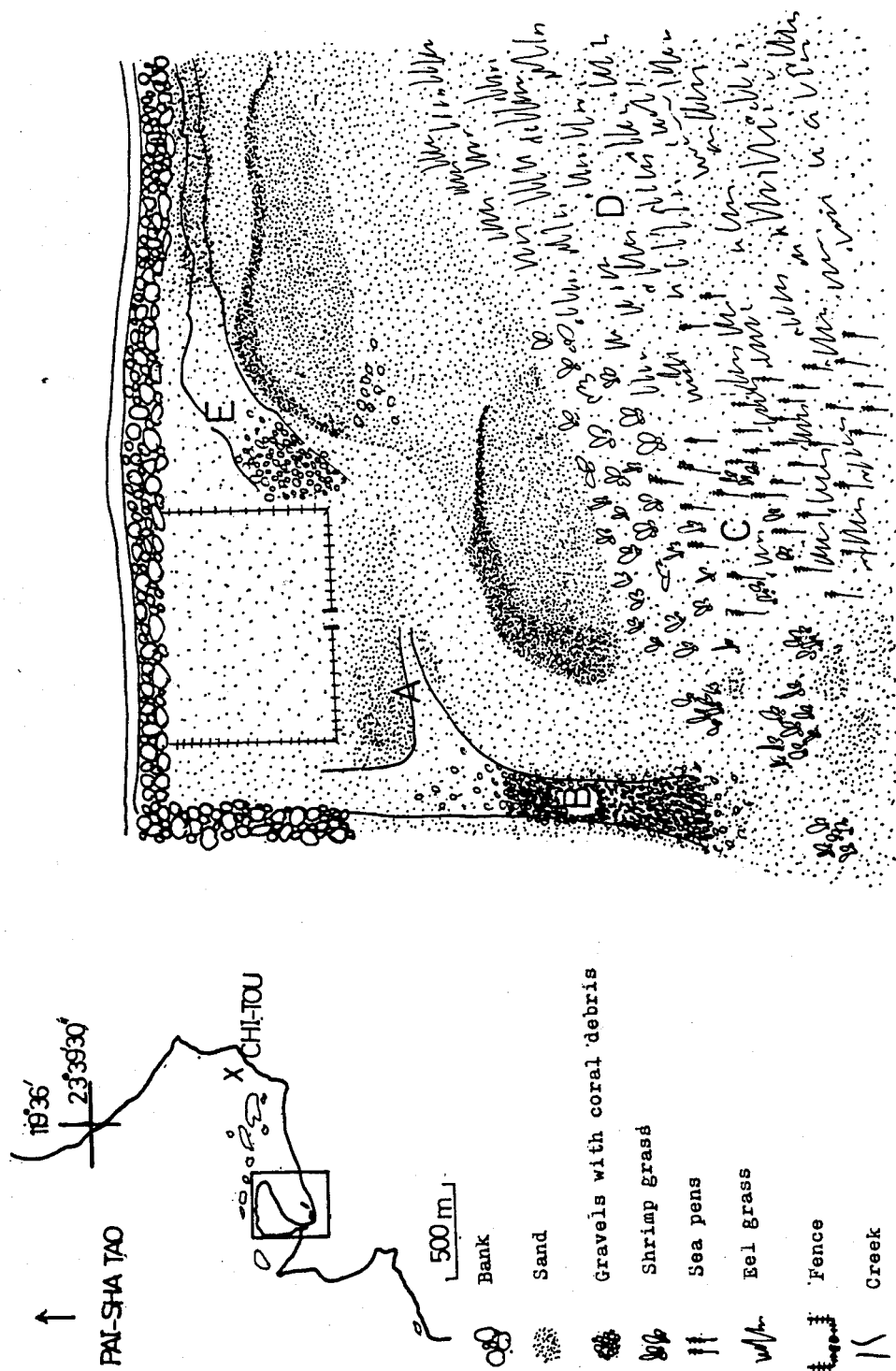


Fig. 1. Location and habitats of Chito Bay, Penghu.

net (Fig. 2) was pulled for about 10–30 meters, and the shrimps that had been caught were removed. This procedure was repeated again and again for two hours in order to collect a large number of shrimps.

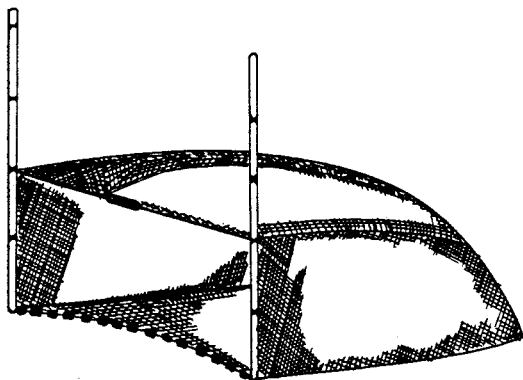


Fig. 2. Sampling gear: upper margin 140 mm, lower margin 200 mm, net height 62 mm, mesh size 2 mm.

In this survey area, five habitats at tide ebb were distinguished. On Area A, the bottom was composed of fine sand, and the water was less than 10 cm deep. A creek, 10–15 meters width, 20–30 cm deep, ran through Area B, where the major components of the bottom were gravels and coral debris; both sides of the creek were sandy. Area C lay at average low tide level, where most of the bottom was covered with shrimp grass (*Halophila ovalis* (R. Br.) Hook) or eel grass (*Thalassia* sp.), and an abundance of sea pen (*Virgularia* sp.) was noteworthy there. The sampling Area C was 20–30 cm in depth. The major differences between Area D and C were that the former was covered with less shrimp grass than eel grass, and was shallower in depth (5–10 cm). In addition, Area D was more sandy. At Area E, there was a creek, about 5 meters wide and 20 cm in depth, where the bottom was composed of fine sand upstream, but coral debris downstream. In comparing the habitat preference of juvenile shrimps, the net was pulled a distance of 10 meters twice in each area.

The shrimps were identified and sexed after Lee and Yu⁽⁴⁾, and Chen⁽¹⁾. Among the

juvenile shrimps collected, there are some difficulties in identifying male *P. japonicus* and *P. latisulcatus* when the carapace length is less than 10 mm. However, the development of female genitalia is quite different in these two species, and the identification was therefore made easy. In *P. japonicus*, it starts with a U-shape, whereas *P. latisulcatus* it has a V-shaped genitalia.

The specimen were fixed in 70% alcohol in the field, then weighed in the wet state to 0.01 g in laboratory. The size of shrimps was measured as carapace length (CL), defined as the linear distance between the post-orbital margin and the median posterior end of the carapace; and a slide caliper accurate to 0.1 mm was used.

RESULTS

A total of 2,455 individuals of juvenile shrimps was collected in this study. Four species of penaeid shrimps were present, viz., *Penaeus latisulcatus* Kishinouye, *P. japonicus* Bate, *P. semisulcatus* de Haan, and *Metapenaeus ensis* (de Haan). The number of each species collected monthly is listed in Table 1.

P. latisulcatus dominated other shrimps, forming about 85% of the total catch, it occurred throughout the year and was most abundant in summer. *M. ensis*, ranked second, comprising 13% of the total catch, it appeared twice a year in spring and summer-autumn, the latter being the major season. *P. japonicus* occurred only in winter; 39 individuals were caught. On the other hand, 17 *P. semisulcatus* were collected during a short period in summer.

The monthly distribution patterns of the carapace length (CL) of the four kinds of shrimps are shown in Fig. 3. In *P. latisulcatus*, small individuals 3–10 mm in CL, occurred in two peak periods during a year, one from May to June, the other in September. Moreover, the body size of *P. latisulcatus* in June was smaller than in May. Generally, juveniles of *P. latisulcatus* were smaller than 18 mm in CL in summer, but in winter some up to 22 mm in CL were encountered.

TABLE 1.
Juvenile penaeid shrimps collected from the intertidal regions of
Chito Bay of Penghu, Taiwan

Dates of sampling	<i>Penaeus latisulcatus</i>	<i>Metapenaeus ensis</i>	<i>P. japonicus</i>	<i>P. semisulcatus</i>
Aug. 27 '79	47	97	0	13
Sep. 23 '79	36	42	0	0
Nov. 6 '79	126	20	0	0
Dec. 8 '79	192	6	0	0
Jan. 6 '80	48	2	0	0
Feb. 4 '80	11	0	8	0
Mar. 5 '80	34	10	10	0
Apr. 2 '80	2	8	15	0
May 4 '80	403	15	6	0
Jun. 2 '80	432	0	0	0
Jul. 15 '80	274	17	0	1
Aug. 14 '80	131	55	0	3
Sep. 13 '80	344	47	0	0
Total	2080	319	39	17
Percentage (%)	84.7	13.0	1.6	0.7

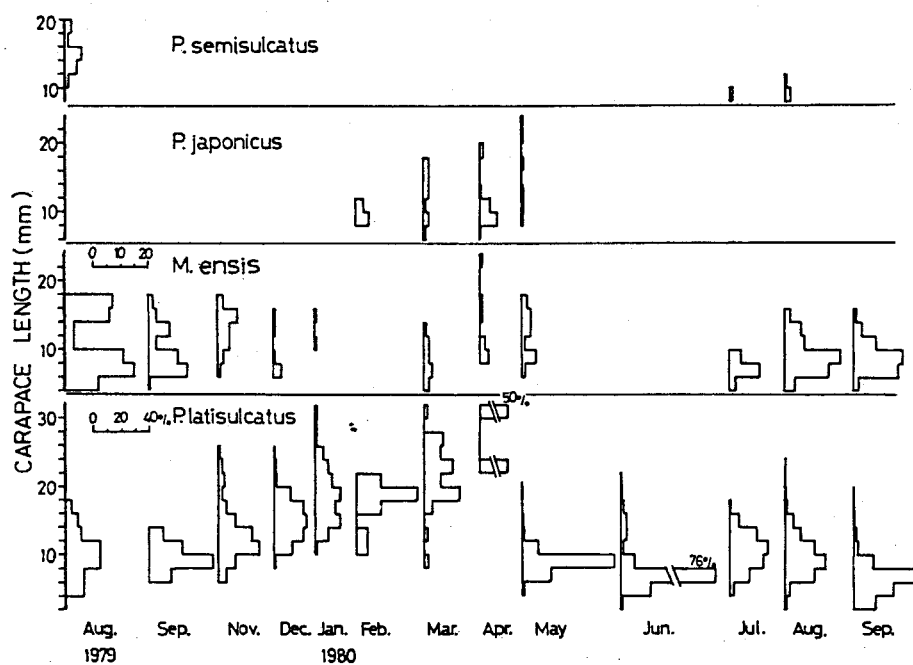


Fig. 3. The body size of juvenile shrimps collected monthly in the intertidal area of Chito Bay, presented as relative frequency for *P. latisulcatus*, and as individuals for the other species.

Small juveniles, 4 to 10 mm in CL, of *M. ensis* also appeared twice a year, once in March and again from August to September. Except for one individual 23 mm CL, *M. ensis* were less than 18 mm in CL. The body size of *P. japonicus* and *P. semisulcatus* ranged from 7 to 22 mm and 8 to 19 mm in CL, respectively, the initial sizes were larger than those of *P. latisulcatus* and *M. ensis*.

The relationship between body weight and carapace length of the four species of juvenile shrimps are shown in Table 2, and Figs. 4-7. Only *P. semisulcatus* shows a linear relationship, the other have exponential curves, i.e., $W = aCL^b$, where W is body weight. As shown in the figures, there is no difference in this relationship between males and females of all four kinds of juvenile shrimps.

TABLE 2.
Relationships between wet body weight (g) and carapace length (mm) of four kinds of juvenile shrimps collected from the intertidal Chito Bay.
The equation for *P. semisulcatus* is $W = a + bCL$, others $W = aCL^b$.

Species	Range of carapace length (CL)	a	b
<i>P. latisulcatus</i> ¹	4.3-30.1	1.6376×10^{-4}	3.3887
<i>P. japonicus</i> ^{2,3}	7.1-22.5	4.4689×10^{-4}	
<i>P. semisulcatus</i> ²	8.0-18.8	2.7253	0.3334
<i>M. ensis</i> ⁴	5.0-17.5	3.8410×10^{-4}	3.1805

- 1: specimens collected in August, 1979 and January, 1980;
2: all specimens collected in this study;
3: in Japan, the equation $a = 3.71 \times 10^{-4}$; $b = 2.935$, after Hachiyang and Maekawa⁽²⁾;
4: only specimens collected in August, 1979.

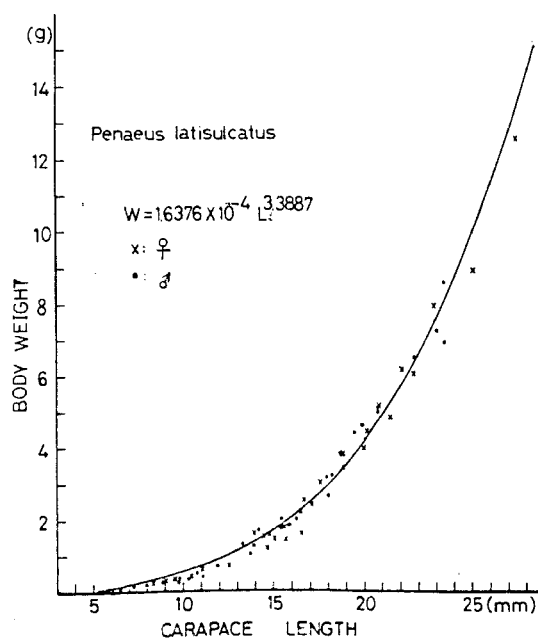


Fig. 4. The relationship between body weight and carapace length of *P. latisulcatus*.

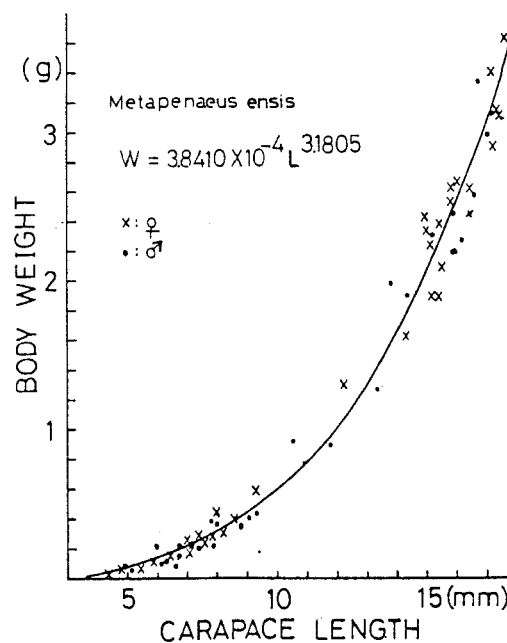


Fig. 5. The relationship between body weight and carapace length of *M. ensis*.

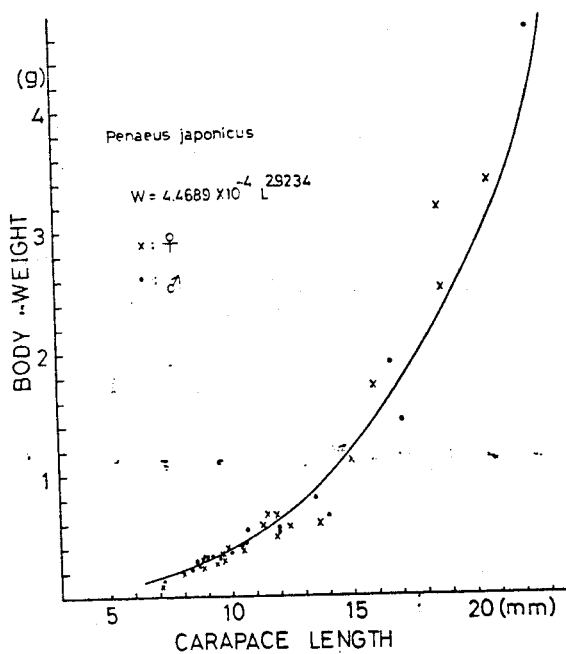


Fig. 6 The relationship between body weight and carapace length of *P. japonicus*.

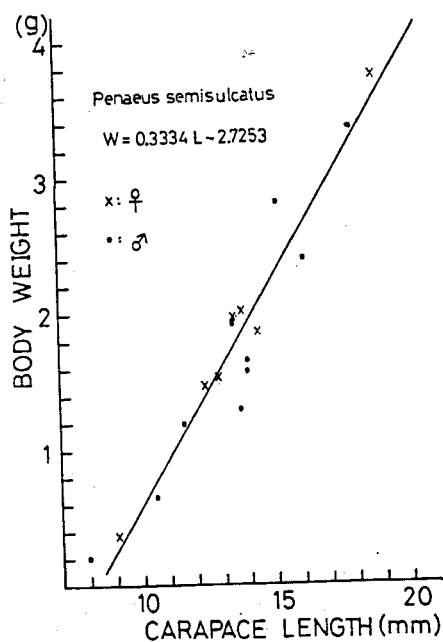


Fig. 7. The relationship between body weight and carapace length of *P. semisulcatus*

The habitat preferences of juvenile shrimps are shown in Table 3. The preferences of *P. latisulcatus* and *M. ensis* differ by the former appearing mostly in the Area A and E, whereas the latter confined mostly in the Area D and E.

TABLE 3.
Habitat preferences of *P. latisulcatus* and *M. ensis* within the intertidal area of Chito Bay

Species	Individuals ^(b)	Area ^(a)				
		A	B	C	D	E
<i>P. latisulcatus</i>	96	79	33	54	104	
<i>M. ensis</i>	4	1	1	10	7	

(a): general descriptions of area in MATERIALS AND METHODS;

(b): total of individuals collected by trawling to 10-meter distance from May to September 1980.

DISCUSSION

P. latisulcatus is a wide-ranging species, and was recorded from Japan, Korea, the Philippines, and the Australian coastline⁽⁴⁾. Although there is no commercial fishery for this prawn in Penghu, it is an important species in West Australian where a series of researches on its distribution, survival, growth, spawning and fecundity were conducted⁽⁹⁻¹²⁾. For mariculture purposes, an attempt has been made in Okinawa to induce spawning and culture the larvae⁽¹³⁾. As a dominant species in the intertidal region of Chito Bay, Penghu, its commercial potential calls for a more detailed investigation.

Penn pointed out that in the Australian waters, the southern population (32°S) of *P. latisulcatus* spawns only in summer whereas the northern population (21-26°S) spawns almost year round and has two peaks: one in autumn, the other in spring⁽¹²⁾. Juvenile *P. latisulcatus* in Penghu (23°N) have two peaks of abundance, which match well with the spawning peaks of the northern population of West Australia. The body size of *P. latisulcatus* collected at Penghu

in June was smaller than that in May, also revealing that this prawn is a multispawner⁽¹²⁾.

The temperature of the inshore nursery ground in northern West Australia falls to about 15°C in winter, retarding the growth of juvenile *P. latisulcatus*⁽¹²⁾. In Penghu, it drops to nearly 15°C in winter also (Table 4) and this factor may be responsible for the presence of only a few individuals in winter.

TABLE 4.
Air temperature and water temperature
and rainfall in Penghu

Month	Air temp. (°C)	Water temp. (°C)	Prec. (mm)
Aug. '79	29.4	28.7	28.6
Sep. '79	28.6	28.1	27.9
Oct. '79	25.5	22.8	24.3
Nov. '79	22.1	20.7	21.3
Dec. '79	20.2	18.9	19.3
Jan. '80	17.2	16.8	27.6
Feb. '80	15.3	15.3	47.6
Mar. '80	20.7	19.7	11.2
Apr. '80	23.7	22.6	69.7
May '80	26.0	25.0	63.1
Jun. '80	29.9	28.6	13.6
Jul. '80	30.1	28.9	67.2
Aug. '80	29.8	28.5	156.1
Sep. '80	29.0	27.3	17.3

In contrast to *P. latisulcatus*, *P. japonicus* is an important prawn of commercial value in Penghu, but only a few juveniles were caught in this survey. In Taiwan, the mature spawners of *P. japonicus* can be found in two periods, one from the middle of February to late May, the other from September to December^(3,5). However, the juveniles occurred in Penghu only during one period, from February to May, in this survey. The minimum body size of juvenile *P. japonicus* collected was about 7 mm in CL (0.1 g); it required at least 30 days to reach this size under experimental conditions (20–22°C)⁽³⁾. In Penghu the water temperature falls far lower than this. Therefore, the juvenile *P. japonicus* occurring February may have been spawned in November–December of the previous year, whereas, the juveniles in April could have

been spawned in late February. These are matters for future work.

In Japan, the spawning season of *P. japonicus* occurred from May to September and the juveniles (3–40 mm in CL) could be caught in intertidal area all year round. The juveniles originating from the early spawning season could migrate offshore in the same year, whereas those coming from the late spawning season would live in the intertidal area until next late-spring before they moved out⁽²⁾. The temperature of the substratum, 5 cm deep, ranged from 7 to 35°C in Japan; it showed about same temperature range in summer but was warmer in Penghu (unpublished data). Under these circumstances it is not clear why the juvenile *P. japonicus* was not found in Penghu at other seasons during this study.

Metapenaeus ensis is widely distributed in eastern waters of the Malayan Peninsula/Sumatra Land Mass, and extends north to Japan and south to Australia⁽¹⁾. This is a pond-reared shrimp in southern Taiwan, after the artificial propagation was successfully conducted in 1969⁽⁶⁾. Mature spawners of *M. ensis* occur from March to October in southern Taiwan⁽⁵⁾, but the juveniles occurring in Chito Bay fall into two periods: a smaller component occurring in March–May and a major one in August–September, and these coincided with the change of rainfall which dropped drastically from 63.1 mm in May to 13.6 mm in June and then increased to 67.2 mm in July (Table 4). This suggests that the occurrence of juvenile *M. ensis* may be related to the rainfall. In penaeid shrimps, this phenomenon is quite common, for example, post-larvae of *Metapenaeus* spp. in Jepara, Indonesia, showed two peaks in July and in October, which coincided with the end and beginning of rainy season, respectively⁽¹³⁾.

The presence of juveniles of *P. semisulcatus* in July and August at Penghu, correlated well with the spawning of prawns from February to May in Taiwan⁽⁵⁾. In Jepara, Indonesia, post-larvae of *P. semisulcatus* (8.0–8.5 mm of total length) were present from April to December, with

maximum numbers in July-August⁽¹³⁾. In Pulicat Lake, about 13°N latitude on India's East coast, juvenile *P. semisulcatus* were found twice a year from August to October and from March to June⁽¹⁴⁾. Therefore, over this wide geographical area, juvenile *P. semisulcatus* are found at different time but still show a peak of abundance in August. Although there was a little difference in habitat preferences between *P. latisulcatus* and *M. ensis*; most of the juveniles were collected from sandy areas such as Area A, D, and E. This may be related to the penaeid shrimps' preferences for hiding in sandy bottoms⁽⁶⁾. In West Australia, the nursery ground of *P. latisulcatus* was found in shallow sand banks near shore⁽¹²⁾.

The occurrences of juvenile shrimps in coastal water depends not only on the spawners, but also on environmental conditions prevailing in the area, such as salinity, temperature, currents, habitats, etc.⁽⁷⁾ In addition the migratory habits during the early developing stages are also important⁽¹⁰⁾. The absence of juvenile *Metapenaeopsis barbata* (de Haan), of which adults are very common on Penghu offshore, from the intertidal area of Chito Bay might be explained as the juvenile of this species is less migratory, since many small individuals about 3 cm in total length were caught along with adults from an offshore fishing ground in another survey on March 8th, 1980.

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澎湖岐頭灣潮間帶出現之對蝦類稚蝦

張崑雄 陳章波 謝蕙蓮

蘇偉成 胡興華 李錫珍

由民國 68 年 8 月至 69 年 9 月，每月在澎湖岐頭灣潮間帶，以小型拖網作夜間採集一次，採集時間約二小時。共計採得對蝦類 (Penaeid) 2455 尾，分為二屬四種。竹節蝦 (*Penaeus latisulcatus*) 2080 尾 (佔 85%)；沙蝦 (*Metapenaeus ensis*) 319 尾 (佔 13%)；斑節蝦 (*P. japonicus*) 39 尾 (佔 2%)；熊蝦 (*P. semisulcatus*) 17 尾。

竹節蝦全年都有，但冬季數量減少；沙蝦一年出現二期，分別在春季及夏秋；斑節蝦只冬季出現；熊蝦則只在夏季出現。這顯示澎湖岐頭灣為天然稚蝦孵育場。