Bull. Inst. Zool., Academia Sinica 29(2): 71-80 (1990)

TAGGING EXPERIMENT ON THE GRASS PRAWN, *PENAEUS MONODON* IN SOUTHWESTERN COAST OF TAIWAN[1]

SUN-CHIO FONG, YUN-YUAN TING,[2]
HAU-SHEN LU and SEN-CHANG CHOW

Institute of Marine Biology, National Sun Yat-sen University, Kaohsiung, Taiwan 80424, Republic of China
and
Tainan Branch, Taiwan Fisheries Research Institute, Tainan, Taiwan 72401, Republic of China[2]

(Accepted September 15, 1989)

Sun-Chio Fong, Yun-Yuan Ting, Hau-Sen Lu and Sen-Chang Chow (1990) Tagging experiment on grass prawn, *Penaeus monodon* in southwestern coast of Taiwan. *Bull. Inst. Zool., Academia Sinica* 29(2): 71-80. Adult grass prawns (*Penaeus monodon* Fabricius) cultivated within earthern ponds were released into the natural fishing ground at the southwestern coast of Taiwan. Streamer tags were attached to a portion of the released prawns of stock assessment. From the locations of the re-discovered tags, prawns appeared to move to shallow water during the spawning season, and move to deep water during the cold months. Instantaneous total and fishing mortality rates during the fishing season were estimated with discussions on possible reasons of bias. Technical suggestions were also given for better tagging and releasing of grass prawns.

Key words: Grass prawn, Monodon, Tagging, Taiwan.

Grass prawn (*Penaeus monodon* Fabricius) is a major marine food source in Taiwan. It was known that they aggregated near a depth greater than 30 meters of salt and brackish waters (Huang, 1980; Su, 1989a). Although they were routinely appeard in the catch of baby trawler throughout the year, greater amount has been found between June and November. Larval prawns appeared from August to October along the coastal area (Huang, 1980), providing stock for the prawn farms. However, supply of larval prawn fluctuates seasonally and does not meet the increasing demand of the prawn farmer. Since the successfulness of induced spawning of naturally matured breeder (Liao and Huang, 1970; Chen, 1977), there has been great demand of of matured prawn from commercial hatcheries.

Although grass prawn of adult size from natural water can be manipulated artificially to become fully mature and spawn with various degrees of success, until 1984 (Lin and Ting, 1984; 1985; 1986) there has no report of success on the case of prawns raised in captivity. In 1981, a typhoon destroyed many prawn

1. This project was funded by the Committee of Agriculture, ROC in 1983 (Grant No. 72NC-4.1-C-223).

farms near the coastal area, stocks were flooded to the sea. According to the observation of local fishermen, the yield of breeders at the following season was extraordinarily high. Although the increase may have been due to changes in environment, it seemed logical to assume that the stock that had lost by prawn ponds survived in the marine environment and were reclaimed. Based on the above assumption, the possibility of increasing the supply of breeders through stocking with adult prawns that were raised within ponds was proposed and studied. The life history and emigration of grass prawn near the coastal waters of southwest Taiwan were reported by Su and Liao (1987) and Su *et al.* (1989a, 1989b). This study, conducted on the same line, expected to expose the preliminary ecological and fishery behavior of grass parwns through tagging-recapturing as well as catch data analysis.

MATERIALS AND METHODS

The areas chosen for the experiments were Putai and Masago (Fig. 1). Both areas have a local fishery for prawn breeders. The fishermen in Putai used baby trawler (less than 10 tons) on water with depth from 7 to 28 meters (average 20 meters). The boat was regularly operated with 1 to 2 presons from 5-6 A.M. to 3 P.M. daily. The fishing ground was less than 60 minutes of sailing from dock. This distance was quite convenient for the prawns to be kept alive and be sold after the boats returned. There was a total of 3 agents in Putai who operated as middleman for the market of prawn breeders. Reward were given to all the local agents to provide us with daily information of the yield of breeders and to collect the returning tags.

The fishing boats in Masago were operated in an area different from the fishermen of Putai. Their fishing ground was located further from the coast (Fig. 1) whereas the water was deeper (ranging between 40–70 meters). Most fishing boats were bigger and operates from 9 P.M. to 3 A.M.. Prawn breeders were not the major target for fishing but were caught simultaneously with other fishes. They were sold openly at the pier to retailers. We hired a part-time employee at the local fishermen association for recording the daily catch and collecting the returning tags.

To estimate the effects of prawn release, streamer tags were manufactured following Marulle *et al.* (1976). The tags were 10 cm long and made with plastic textile fabrics. Each tag was inserted through the prawn body between the 5th and the 6th abdominal segment (during the third tagging trip, the prawns were tagged between the 1st and the 2nd abdominal segments). The effects of tagging upon the prawn were estimated by cultivating prawns (averaged weight 22.57 gm) within in-doored concrete tank of 10 m×5 m×2 m (depth) for 12 weeks and their mortality were estimated.

Two tagging trips were made to Putai (one on August 8, 1983 and the other on August 19, 1983 respectively). One trip was made to Masago on March 19, 1984. Each trip lasted for 2–3 days and a total of approximately twenty thousand adult grass prawns (averaging seven to ten thousand individuals per working day) were released. All prawns were raised in earthern ponds for approximately five months (individual weight between 33 and 40 grams). They were first seined out from the cultivation pond early in the morning and were held in ice water and transported to the pier where tagging were to be performed. A total of approximate one thousand prawns (equal numbers for the male and female prawns) were tagged each day. With approximate fifteen men employed, the operation takes about one hour. The water was being aerated and maintained at low

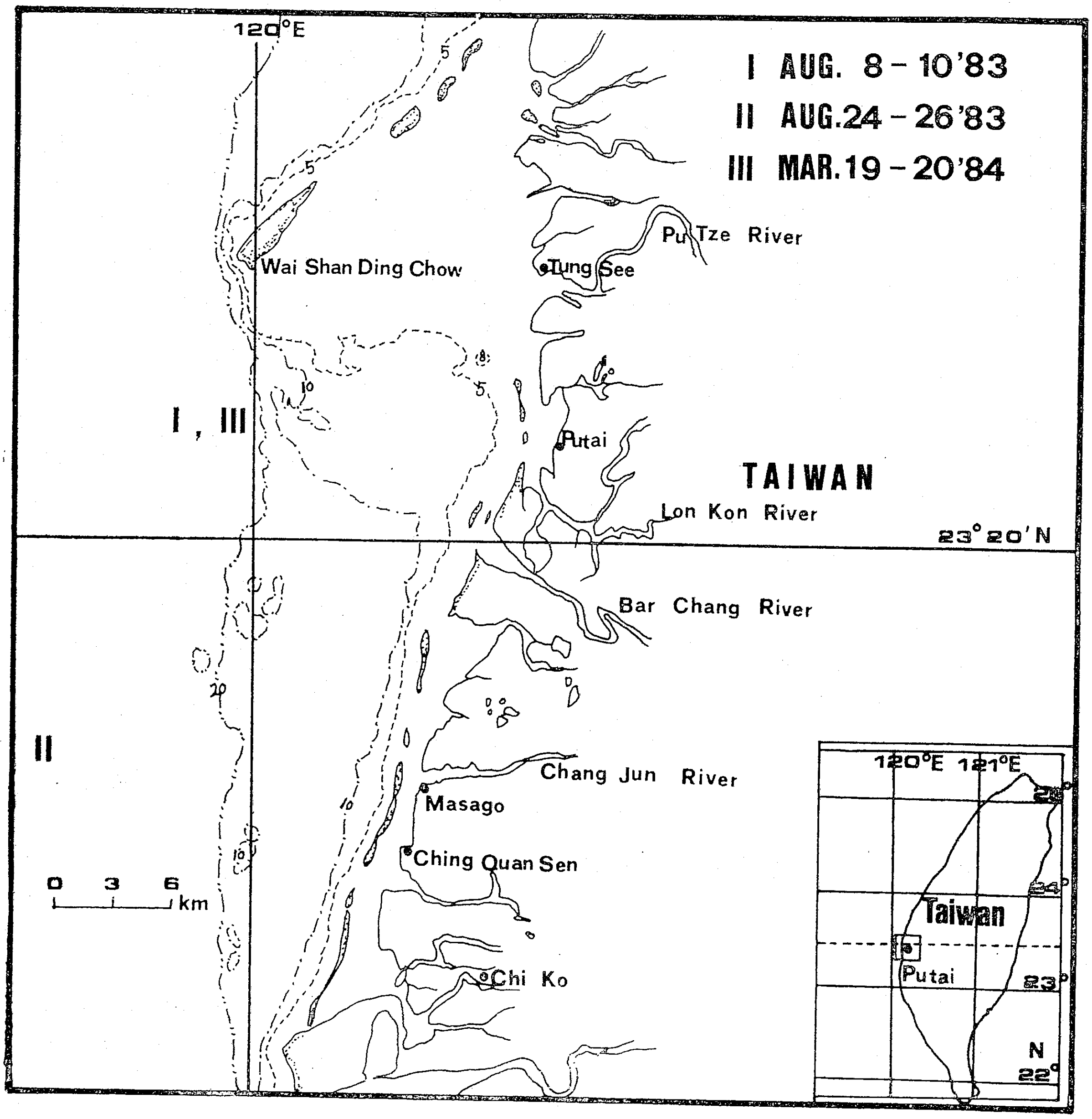

Fig. 1. Locations of releasing site for each tagging trip.

temperature with ice at all times. Nevertheless, death of prawns still occurred. All prawns were shipped and released near the fishing ground before noon. Number of prawns released was estimated by the total weight times the estimated number of individual per kilogram. Before the release of prawns, the mortality in each separated tank was roughly estimated as a weighing factor for the estimation of actual number of tagging and/or release.

RESULTS

Estimation of tagging mortality

The 12-week-in-door experiment in the concrete tank showed the accumulated mortality rates of different treatments (Fig. 2). Final mortality rates were equal

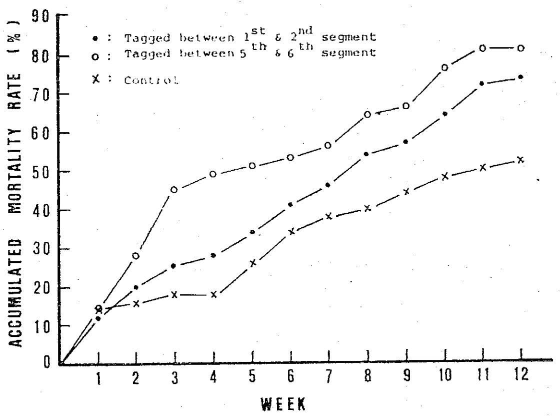

Fig. 2. Accumulated mortality rates of grass prawns in captivity of concrete tanks for 12 weeks.

to 81% and 73% for two tagging position respectively. The controlled groups resulted in 54% of mortality. All these values are significantly higher than that of prawn culture within earthern pounds. However, assumming that the effect of tagging is additive to the effect of the "natural" mortality rate within tank, theoretical values of daily mortality due solely to tagging were estimated as follows:

$$1.0-0.54=e^{-82M}$$
$$1.0-0.81=e^{-(M+M')82}$$
$$1.0-0.73=e^{-(M+M'')82}$$

Where M stand for the instaneous mortality of the controlled,

M' is the mortality due to tagging between 4th and 5th segment, and

M'' is the mortality due to tagging between 1st and 2nd segment. Solving the three equations gives $M'=0.0108$ and $M''=0.0065$. Obviously tagging between 1st and 2nd segment caused less death than tagging between 4th and 5th segment.

The rate of tag lost through moulting was equal to 0.04% per day if tagged between 5th and 6th segment. This value is considered negligible if tagged between 1st and 2nd segment.

Although the tank experiment had showed that prawns were better adapted to tag between 1st and 2nd segments, tagging had begun before this experiment was completed. Thus, during the first and the second trips, prawns were chosen to be tagged between 4th and 5th segment.

Spatial and temporal distributions of prawns

Table 1 shows the figures for each tagging trip. The returning of each individual tag is recorded in Table 2. Between August 1983 and May 1984, a total of 51 tags had returned. Most of the returned tags were found approximately two months after the first trip.

Table 1
Recordings of tagging and recapturing of grass prawn

Trip No.	Location	Tagging Date	Weight kg	Number per kg	Survival*	Estimated Release	No. Tagged	Estimated Tagged	Recapture
I	Putai	Aug. 8, '83	406.2	25.00	0.60	6,093	1,106	664	5
	Putai	Aug. 9, '83	379.8	25.00	0.90	8,546	1,035	932	8
	Putai	Aug. 10, '83	415.2	28.33	1.00	11,763	998	998	5
II	Masago	Aug. 24, '83	417.6	25.00	0.70	7,308	1,027	719	9
	Masago	Aug. 25, '83	412.2	25.00	0.40	4,122	1,021	408	2
	Masago	Aug. 26, '83	397.8	25.00	0.75	7,459	1,029	772	14
III	Putai	Mar. 19, '84	351.6	33.33	0.90	10,547	998	898	7
	Putai	Mar. 20, '84	257.4	33.33	0.95	8,150	1,000	950	1
	Sum		3,037.8			63,987	8,214	6,340	51

*: Weighted rate of survival before release.

Table 2
Recordings of numbers of rediscovered tags. Even and odd numbers stand for male and female prawns respectively

	Tag number	Released site	Trip No.*	Date of recapture	Recaptured site
1	A00164	Putai	I	Aug. 9, 1983	Putai
2	X00016	Putai	I	Aug. 9, 1983	Putai
3	W00016	Putai	I	Aug. 9, 1983	Putai
4	L00187	Putai	I	Aug. 14, 1983	Putai
5	A00188	Putai	I	Aug. 14, 1983	Putai
6	C00002	Putai	I	Aug. 18, 1983	Putai
7	J00160	Putai	I	Aug. 20, 1983	Putai
8	T00189	Putai	I	Aug. 21, 1983	Putai
9	K00080	Putai	I	Aug. 21, 1983	Putai
10	L10180	Masago	II	Aug. 28, 1983	Putai
11	G10085	Masago	II	Ang. 28, 1983	Putai
12	T00093	Putai	I	Aug. 28, 1983	Putai
13	B10165	Masago	II	Aug. 30, 1983	Putai
14	V10090	Masago	II	Aug. 30, 1983	Putai
15	T10034	Masago	II	Aug. 30, 1983	Putai
16	R00072	Putai	I	Aug. 31, 1983	Putai
17	M10194	Masago	II	Aug. 31, 1983	Putai
18	V10056	Masago	II	Sept. 1, 1983	Putai
19	C10091	Masago	II	Sept. 1, 1983	Putai
20	U00004	Putai	I	Sept. 1, 1983	Putai
21	F10167	Masago	II	Sept. 1, 1983	Masago
22	W00100	Putai	I	Sept. 1, 1983	Masago
23	B00002	Putai	I	Sept. 2, 1983	Putai
24	S10056	Masago	II	Sept. 2, 1983	Putai
25	D10088	Masago	II	Sept. 2, 1983	Masago
26	S10031	Masago	II	Sept. 2, 1983	Masago
27	P10040	Masago	II	Sept. 6, 1983	Putai
28	F10119	Masago	II	Sept. 11, 1983	Masago
29	H10174	Masago	II	Sept. 13, 1983	Putai
30	S10102	Masago	II	Sept. 15, 1983	Putai
31	D00154	Putai	I	Sept. 15, 1983	Putai
32	F10164	Masago	II	Sept. 16, 1983	Putai
33	G10189	Masago	II	Sept. 17, 1983	Putai
34	B10114	Masago	II	Sept. 17, 1983	Putai
35	N10196	Masago	II	Sept. 17, 1983	Putai
36	O00194	Putai	I	Sept. 17, 1983	Putai
37	J10040	Masago	II	Sept. 18, 1983	Putai
38	P10002	Masago	II	Sept. 30, 1983	Putai
39	Y00128	Putai	I	Oct. 2, 1983	Putai
40	K10195	Masago	II	Oct. 3, 1983	Putai
41	V10199	Masago	II	Oct. 5, 1983	Putai
42	V00124	Putai	I	Oct. 20, 1983	Putai
43	M10173	Masago	II	Mar. 4, 1984	Putai
44	H00831	Putai	III	Apr. 10, 1984	Putai
45	C00661	Putai	III	Apr. 10, 1984	Putai
46	F00930	Putai	III	Apr. 11, 1984	Putai
47	V00022	Putai	III	Apr. 13, 1984	Putai
48	J01492	Putai	III	Apr. 13, 1984	Putai
49	X00362	Putai	III	Apr. 13, 1984	Putai
50	X00327	Putai	III	Apr. 14, 1984	Putai
51	N00014	Putai	III	Apr. 15, 1984	Putai

*I: Aug. 8-10, '83, II: Aug. 24-26, '83, III: Mar. 19-20, '84

Table 3
Contingency table for tagging and recapturing grass prawns at Putai and Masago during the first two trips

Recaptured site	Released site		
	Putai	Masago	Sum
Putai	17	21	38
Masago	1	4	5
Sum	18	25	43

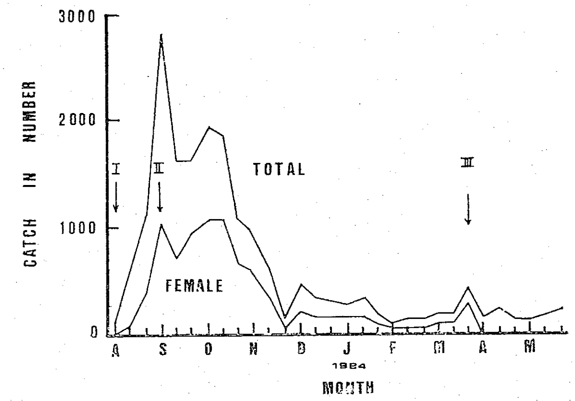

Fig. 3. Variation of total yield of prawn breeder in Putai and Masago areas. I, II and III stand for each tagging trips respectively.

Much less returning were found in Masago than in Putai. Out of the 38 tags found in Putai, 21 were released from Masago (with deeper water of fishing ground). A McNemar test resulted in significant change (Conover, 1980) for the prawn to have the tendency to move from Masago to Putai during that period (Table 3).

All tags returned were found on the living body of the adult prawns by the dealers in Putai or from the pier market in Masago. Only the tags with known number were accepted. Some tags were reported with unknown tag numbers, they were not included in the data analyses.

The supply of breeders from Putai and Masago areas was ploted in Fig. 3. The catch was significantly high between August and October, but the percentage of female breeder had maintained a steady rate through the whole period. It was possible that the prawn fishing ground was closed by the spawning ground and that the rise in prawn catch between August and October was due mainly to the aggregation of the spawners.

Although most breeders were caught at Putai area, the relative rate of production for matured prawn was higher in Masago area (overall percentage value of 24.35 versus 8.31 in Putai) (Table 4). Also, the peak for the yield of female prawns as well as that of the egg-carrying prawns appeared at a later period lasted longer in Masago area. Combining these facts, we concluded that prawns tended to stay in the shallow area during the warm months, as the temperature became low, more female prawn moved to the deep water area.

Estimation of recapture rate

Table 2 shown that most of the rediscovered tags were found within 100 days after release. The average rate of recapture for the first and second trip combined was estimated as follows. The total number of tags before releasing was equal to 6,216, after weighted with *in situ* mortality rates, the number comes to 4,493. Assuming an average returning preiod of 50 days, we can write

$$4493 \times e^{-(M+M'+r)50}$$

where M is the unknown value of instantaneus natural mortality rate of prawn in the natural environment; M' is the instantaneous mortality rate due solely to tagging which was equal to 0.018; and $r=0.0004$ was the instantaneous rate of tag lost due to molting (both values based on the experiment in the concrete tank).

Table 4
Estimation of percentage of matured female prawn in Putai and Masago areas

Period (1983)	Putai				Masago		
	Total female catch	Subset* from 2 dealers	No. of matured female	Percentage %	Total female catch	No. of matured female	Percentage %
Aug. 1-10	9	9	9	100.0	0	0	
Aug. 11-20	88	19	4	21.1	0	0	
Aug. 21-31	316	118	27	22.9	78	10	12.8
Sept. 1-10	1,010	154	40	26.0	2	0	0.0
Sept. 11-20	695	382	90	23.6	20	6	30.0
Sept. 21-30	888	402	42	10.5	63	11	17.5
Oct. 1-10	1,011	460	25	5.4	50	13	26.0
Oct. 11-20	875	687	29	4.2	170	62	36.5
Oct. 21-31	480	313	7	2.2	183	64	35.0
Nov. 1-10	350	209	0	0.0	203	45	22.2
Nov. 11-20	342	172	3	1.7	39	7	18.0
Nov. 21-30	57	12	0	0.0	13	2	15.4
Dec. 1-10	152	66	0	0.0	61	13	21.3
Dec. 11-20	84	19	0	0.0	80	21	26.3
Dec. 21-31	86	65	0	0.0	77	18	23.4
Jan. 1-10	90	76	0	0.0	66	12	18.2
Jan. 11-20	109	82	0	0.0	51	5	9.8
Jan. 21-31	72	47	0	0.0	9	0	0.0
Feb. 1-10	32	16	0	0.0	0	0	
Feb. 11-20	41	2	0	0.0	17	0	0.0
Feb. 21-30	24	2	0	0.0	17	3	17.7
Mar. 1-10	98	5	0	0.0	0	0	
Mar. 11-20	82	3	0	0.0	0	0	
Mar. 21-31	265	3	0	0.0	0	0	
Sum	7,256	3,323	276		1,199	292	
Overall				8.3			24.4

*: Data from one dealer was not available.

Substituting the known figures into the equation above, the number of effective tags would be equal to

$$2{,}566\times e^{-50M}$$

Also, according to Table 1, the total effective release was equal to 45,291 individuals, after weighted with 50 days of natural mortality in the sea the number became

$$45{,}291\times e^{-50M}$$

Since the total number of recapture from the two tagging trips was equal to 43, we can write

$$\frac{43}{2{,}566\times e^{-50M}}=\frac{R}{45{,}291\times e^{-50M}}$$

Where R stands for the number of prawn (including those that were not tagged) released and recaptured. The value of R in the equation above was equal to 759 individuals, giving 2.69 percent of recapture rate.

The recapture for the third tagging trip was calculated at a similiar way with values of $M'=0.0065$ and $r=0$. The resulted value is equal to 88, much lower than the combined result of the first two trips.

Estimation of fishing mortality rate

It is possible, following Gulland (1969), to estimate the total and fishing prawn mortality rates of the tagged from the data in Table 2. Grouping the recovered tags by a successive 10-day period, begining at the first day after the tagging trip, the frequency of recovered tags of trip 1 and 2 was shown in Table 5. Using the coded time interval (r') as the independent variable, and the natural logarithm of total recoveries for the respective time interval

Table 5
Number of tagged and recovered prawns, grouped according to a 10-days time period after releasing

Period*	Recover from trip I	Recover from trip II	Total
0	7	12	19
1	4	3	7
2	3	6	9
3	2	2	4
4	0	1	1
5	1	0	1
6	1	0	1
Sum	18	24	42

*: The first time period at large is coded 0, the following periods 1, 2, etc.

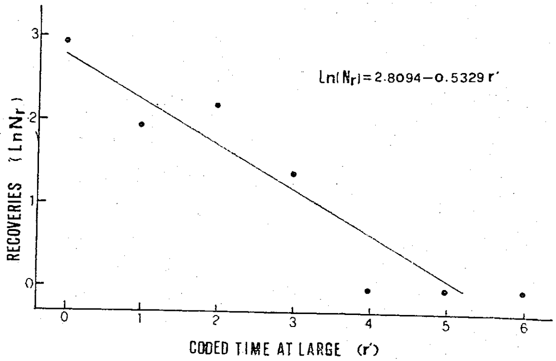

Fig. 4. Analysis of tag return for grass prawn from the first two trips.

(Nr) as dependent variable. Regression analysis (Fig. 4) has shown that

$$\ln Nr = a + Zr'$$
$$= 2.8094 - 0.5329r', \quad p > 0.01$$

Whereas $Z = -0.5329$ is the instantanous total mortality coefficient for the 10-day period, which is comparable to a mortality rate of 58.69%.

The value of instantanous fishing mortality coefficient (F) can be calculated as

$$F = \frac{e^a Z}{N_0(1 - e^{-Z})}$$
$$= 0.0048$$

Whereas $N_0 = 4{,}493$ is the total number of tagged prawn on two trips.

DISCUSSIONS

The fact that more prawn released from Masago fishing area were recovered in the Putai area (Table 3) was taken as the result that prawn tended to move from deep water (60 m) to the shallow water area (20 m). This phenomenon follows the condition reported by Huang (1980) and Su (1989a) that grass prawn tended to aggregate between 10 to 40 meter depth near the estury during spawning season.

The estimated value of total mortaliIy coefficient (Z) gave rise to a survival rate less than 1% within 100 days. This value is abnormally high and should not be taken as accurate estimate of the natural population. Also, the estimated fishing mortality rate is quite low ($F=$ 0.0048, equal to 95% of survival due solely to fishing within 100 days). Possible reasons responsible for the bias are:

(1) Only the prawns which were ripen to some extent can get a good price on the market. The death ones and those in poor condition were likely to be used for family foods by the fisherman, thus some of the recovered

tags were not reported. This seems to be the major cause for the low estimate of fishing mortality.

(2) Extra death caused by tagging upon the prawns were highly significant.

(3) The lose of tags on molting was higher than expected.

(4) Estimated values of mortality during the shipping were lower than the true values.

The combined effect of the above may be responsible for the high value of natural mortality rate estimated.

The sex ratio of the tagged prawns was maintained at 1:1, but the sex ratio of the recaptured in the first two trips combined was equal to 14 males versus 29 females. The number of female prawn was significantly higher. Although such phenomenon may be ascribed to a possible higher natural mortality rate of the male prawn but we have no evidence to the existance of such a condition. Liao (1977) pointed out that female grass prawn over 28.5 gm grows faster than male. Su *et al.* (1989b) reported that the growth potential was 9.37 g/week for female subadults and 3.52 g/week for male subadults. It is logical to assume that the fishermen tended to collect more female prawns because of the higher prices being offered for them. This seemed to be the reason for the appearance of a higher number of female prawns within catch.

Possible reasons for the low value of recapture rate of the third trip were:

(1) Data collection on the third trip was terminatd only 26 days after the releasing due to lack of fund.

(2) Body size of the prawns used for the third trip was comparatively small, some of them might not reach an accepatble condition for the hatchery, and were not accepted by the dealers.

(3) The density of the population was lower than that of Autumn and the fishing intensity was lighter by that time.

The exact condition of maturity of most recovered prawns were unfortunately not identified (they were transported to the hatcheries immediately and the prices were confidential). Nevertheless, Lu (one of the authors) had managed to witness one recaptured prawn with fully riped ovaries. Since all prawns sold by the dealers should ripen to some extent, else they would not be accepted by the buyer, we thought that at least some of thereleased prawns were able to become sexually matured in the natural environment. The released pond-raised female prawn being recaptured in the maturing stage was also reported by Su *et al.* (1989b). In this study, the earliest for the recaptured prawn to ripe was found approximately three weeks after release.

Following are some suggestions for improving tagging operation:

(1) Maintain stable but low water temperature and saturated dissolved oxygen during shipping and handing.

(2) Allow for minimum time on shipping and handling, tag the prawns beforehand if possible.

(3) Use a longer streamer tag. A tag of 15-20 cm long would work better than a 10 cm one.

(4) Use female prawns solely for stocking, the impact of returning would be stronger.

(5) Temporarily ban fishing activity on the nearby area for some period immediately after stocking such that the prawn will have better chance to scatter.

Ackmowledgements: We would like to thank the employees of Tainan Station, Taiwan Fisheries Research Institute, for their invaluable assistance during each tagging trip. Many fishermen had provided information concerning the returned tags, and the Fishermen's Associations of Putai and of Masago areas had arranged the shipping facilities; without their help the experiments would not be completed.

REFERENCES

Chen, W. P. (1977) Report on maturation of *Penaeus monodon* Fabricius in captivity by eye-stalk ablation with subsequent spawning and production of juveniles. *China Fisheries Monthly* **294**: 173-177 (in Chinese).

Conover, W. J. (1980) *Practical nonparametric statistics*. 2nd ed. John Wiley and Sons Inc. New York. 439 p.

Gulland, J. A. (1969) Manual of methods for fish stock assesment. Part 1. Fish population analysis. *FAO Man. Fish. Sci.* **4**: 1-154.

Huang, T. L. (1980) Aquaculture in Taiwan. *Bank of Taiwan Quarterly* **25**: 140-236 (in Chinese).

Liao, I. C. and T. L. Huang (1970) Experiments on propagation and culture of prawns in Taiwan. Indopacific Fisheries Council, 14th Session, (1970).

Liao, I. C. (1977) A culture study on grass prawn, *Penaeus monodon*, in Taiwan—the patterns, the prospects. *J. Fish. Soc. Taiwan* **5**: 11-29.

Lin, M. N. and Y. Y. Ting (1984) Studies of reproductive organ and artificial fertilization by spermatophore transplantation of grass prawn. *Special Report Taiwan Fisheries Research Institute*. Keelung. 130 p. (in Chinese).

Lin, M. N. and Y. Y. Ting (1985) Observations of poor hatching in the unilateral eyestock-ablated females of *Penaeus monodon* Fabricius. *Bull. Japan Soc. Sci. Fish.* **52**: 355.

Lin, M. N. and Y. Y. Ting (1986) Spermatophore transplantation and artificial fertilization in grass prawn. *Bull. Japan Soc. Sci. Fish.* **52**: 585-589.

Marullo, F., D. A. Emillioni, C. W. Caillouet and S. H. Clark (1976) A vinyl streamer tag for shrimp (*Penaeus* spp.). *Trans. Amer. Fish. Soc.* **6**: 658-663.

Su, M. S. and I. C. Liao (1987) Ecological studies on commercially important prawns from the coastal waters of southwest Taiwan—I. Emigration of *Penaeus monodon* from Dapong Bay. *J. Fish. Soc. Taiwan* **14**: 36-48.

Su, M. S., I. C. Liao and R. Hirano (1989a) Life history of grass prawn, *Penaeus monodon*, in the coastal waters of southwest Taiwan. Presented in The Second Asian Fisheries Forum, Apr. 17-22, Tokyo, Japan.

Su, M. S., I. C. Liao and R. Hirano (1989b) Re-stocking of subadult grass prawn, *Penaeus monodon*, in the coastal waters of southwest Taiwan. Presented in The Second Asian Fisheries Forum, Apr. 17-22, Tokyo, Japan.

臺灣西海岸草蝦 (*Penaeus monodon*) 之標識放流研究

方新疇　丁雲源　盧浩森　周賢鏘

利用本省魚塭養殖，已達成體大小之草蝦，在布袋及馬沙溝兩地放流。並利用流式標籤 (streamer tag) 對部份草蝦予以標記，以探討成熟草蝦回收之可行性。由回收標籤之移動情形顯示草蝦在產卵季節有向淺水區移動，而在冬季則向深水區移動之跡像。又所得資料推算全死之率及漁獲死亡率結果顯示回收資料有若干誤差。有關如何改進放流技術之方法亦在文中予以討論。