Goswami, U., S.G. Dalal and S.C. Goswami 1986. Preliminary studies on prawn, *Peneaus merguiensis,* for selection of broodstock in genetic improvement programmes. *Aquaculture,* **53** : 41-58.

Hallerman, E.M. 1994. Toward coordination and funding of long term genetic improvement programs for striped and hybrid bass *Marone* sp. *World Aquacul. Soc.,* **25** (3) : 360-365.

Lester, L.J. 1983. Developing a selective breeding program for penaeid shrimp mariculture. *Aquaculture,* **33** : 41-50.

Shultz, F.T. 1986. Developing a commercial breeding program. *Aquaculture,* **57** : 65-76.

Snedecor, G.W. and W.G. Cochran 1967. *Statistical Methods.* 6th Edn., Iowa State Univ. Press, Iowa, 593 pp.

variance explained by regression equation reached its maximum of 99 %; with the increment due to carapace width being only 3 % (Table 5).

The present study has shown that the tail weight has high coefficient of variation in *P. monodon,* suggesting the possibility of improvement by genetic selection. The data have also indicated the use of morphometric traits in predicting the tail weight with high degree of accuracy. Therefore the morphometric traits such as PCL and CW which are highly correlated with the tail weight and easily measurable without actually sacrificing the animals, could be used while selecting the broodstock of *P. monodon* for producing seed with faster growth potential. In juveniles, AAC and SAD give an indication about the future growth potential of the animal. This is an important factor in the captive broodstock development as it would help the breeders to cull the animals even at the early stages of life cycle. However, further study is warranted, with larger data on broodstock animals to arrive at the population means of the morphometric traits so as to select the broodstock of *P. monodon* based on their individuals merit over the population means.

TABLE 5. *Prediction equations for tail weight in different weight groups — stepwise regression*

Weight group	Prediction equation	R^2 (%)	F value
A	TW =-3.69 + 0.23 AAC	88	459.43*
	TW =-3.83 + 0.24 SAD + 0.16 AAC	91	333.81*
	Full model regression	94	93.66*
B	TW = -8.78 + 1.1 SSL	65	103.39*
	TW = -13.77 + 0.40 PCL + 0.69 SSL	78	98.12*
	Full model regression	89	42.94*
C	TW = 1.02 + 0.82 CW	45	15.31*
	TW = -8.62 + 0.21 AAC + 0.71 CW	70	20.72*
	Full model regression	85	6.96*
D	TW = -86.35 + 2.67 PCL	96	489.21*
	TW = -87.97 + 1.95 CW + 1.66 PCL	99	559.58*
	Full model regression	99	135.01*

* Significant at 1% level.

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References

Alagarswami, K. 1993. Planning for augmenting shrimp seed production. *Fishing Chimes,* **13**(1) : 27-31.

Gjedrem, T. 1983. Genetic variation in quantitative traits and selective breeding in fish and shellfish. *Aquaculture,* **33** : 51-72.

TABLE 3. *Matrix of correlation coefficients among the morphometric traits. Weight group C values are given above the diagonal and weight group B values are given below the diagonal*

		Weight group C									
		PCL	CW	FSL	AAC	SAD	FLF	SSL	PAC	SSD	TW
	PCL	1.00	0.48	0.09	0.29	0.20	−0.07	0.41	0.34	0.19	0.60
	CW	0.63	1.00	0.45	0.17	0.38	0.02	0.30	0.52	0.13	0.67
	FSL	0.69	0.70	1.00	−0.24	0.17	0.31	0.35	0.22	0.28	0.17
	AAC	0.52	0.59	0.48	1.00	0.40	0.04	0.34	0.31	0.13	0.61
Weight	SAD	0.50	0.57	0.68	0.53	1.00	0.34	0.01	0.33	0.07	0.42
group B	FLF	0.46	0.60	0.67	0.57	0.63	1.00	0.22	0.06	0.33	−0.06
	SSL	0.63	0.64	0.64	0.66	0.59	0.60	1.00	0.19	0.41	0.61
	PAC	0.62	0.59	0.51	0.75	0.55	0.52	0.68	1.00	−0.07	0.52
	SSD	0.63	0.66	0.68	0.59	0.63	0.64	0.69	0.66	1.00	0.25
	TW	0.80	0.78	0.74	0.74	0.68	0.61	0.80	0.76	0.79	1.00

the reason for the lower correlations in weight groups B and C is to be further ascertained through adequate data.

The stepwise regression analysis was done with tail weight as the dependent variable and all the other morphometric traits as independent variables. The results have revealed that various morphometric traits entered the regression euqation in different orders (Table 4). In all the weight groups, regression is highly significant indicating that the tail weight is highly influenced by the morphometric traits. In the weight groups A and D, the coeffficient of determination, R^2 values are high when compared to weight groups B and C, indicating a higher degree of relationship in the former weight groups. This is in accordance with the observation made regarding the correlation coefficients. In the weight group A; 88 % of the total variance of the tail weight could be explained by anterior abodmen circumference (AAC) alone. The addition of two more variables raised the R^2 value to its maximum (94 %); after which the further addition of variables could not contribute in explaining the variance in tail weight. In case of broodstock (weight group D) partial carapace length (PCL) alone explained 96 % of the total variance of the tail weight. With the addition of one more variable (carapace width, CW) to the equation, the total

TABLE 4. *The order in which different morphometric traits entered the regression equation in different weight groups stepwise regression*

	Weight groups			
	A	B	C	D
	AAC	SSL	CW	PCL
	SAD	PCL	AAC	CW
	PAC	AAC	SSL	SSL
	SSL	CW	FLF	SAD
	PCL	SSD	SAD	SSD
	FSL	SAD	PCL	FLF
	FLF	FLF	PAC	FSL
	SSD	PAC	SSD	AAC
	CW	FSL	FSL	PAC
R^2 (%)	94	89	85	99

The data were subjected to stepwise regression analysis by using computer software – Microstat and the statistical significance of relationships was estimated (Snedecor and Cochran, 1967). The influence due to geographical location was removed by collecting the animals from the same agro-climatic zone. While analysing the data, influence of sex was not considered as it was reported earlier that sex has no significant effect in the regression analysis (Goswami *et al.,* 1986).

Results and discussion

The means along with coefficients of variation of different morphometric traits in various weight groups are presented in the Table 1. Coefficients of variation for different morphometric traits are higher in the weight group A when compared to the other weight groups. Coefficient of variation of tail weight are found to be almost twice that of their respective linear measures except in weight group C. Lester (1983) also observed a similar pattern in *P. vannamei* and *P. stylirostris.* This implies that the tail weight is highly variable and so can be exploited by selection depending upon the amount of additive genetic variance of the total variance.

Correlation matrices have shown that most of the morphometric traits are having significant relationship with tail weight in different weight groups studied. Lester (1983) and Goswami *et al.* (1986) also reported high correlations. It is important to note that the correlations are higher in weight groups A and D (Table 2) and relatively low in weight groups B and C (Table 3). In weight group A, TW showed the highest correlation of 0.93 with AAC, PAC and SSL. Lester (1983) reported the highest correlation of 0.90 between TW and PCL in *P. stylirostris* and 0.95 between TW and SSD in *P. vannamei;* in the same weight group. These variations may be due to the species differences. So the present study revealed that in *P. monodon,* tail weight is highly correlated with the morphometric traits both in juveniles (A) and in the broodstock (D). However,

TABLE. 2 *Matrix of correlation coefficients among the morphometric traits. Weight group D values are given above the diagonal and weight group A values are given below the diagonal*

		Weight group D									
		PCL	CW	FSL	AAC	SAD	FLF	SSL	PAC	SSD	TW
	PCL	1.00	0.93	0.83	0.92	0.86	0.76	0.86	0.93	0.91	0.98
	CW	0.91	1.00	0.81	0.91	0.87	0.80	0.92	0.90	0.84	0.97
	FSL	0.88	0.84	1.00	0.75	0.81	0.72	0.78	0.80	0.78	0.85
	AAC	0.86	0.80	0.84	1.00	0.86	0.75	0.88	0.91	0.91	0.94
Weight	SAD	0.86	0.86	0.84	0.85	1.00	0.79	0.76	0.80	0.78	0.89
group A	FLF	0.80	0.76	0.82	0.87	0.83	1.00	0.68	0.80	0.67	0.80
	SSL	0.88	0.84	0.88	0.92	0.87	0.88	1.00	0.84	0.80	0.91
	PAC	0.89	0.83	0.84	0.93	0.84	0.83	0.92	1.00	0.88	0.93
	SSD	0.86	0.87	0.84	0.90	0.86	0.82	0.90	0.92	1.00	0.91
	TW	0.90	0.85	0.88	0.93	0.90	0.85	0.93	0.93	0.90	1.00

tion of the key economic trait (Hallerman, 1994) and its correlation with easily measurable morphometric traits. Earlier Lester (1983) and Goswami *et al.* (1986) have studied the morphometric traits in *Peneaus stylirostris, P. vannamei* and *P. merguiensis* and derived prediction equations for tail weight. In the present study, preliminary information on the level and organisation of variation in tail weight and its correlation with different morphometric traits of *P. monodon* has been analysed and the possible use of these traits in selecting the broodstock is suggested.

Materials and methods

A total of 165 *P. monodon* of different sizes collected from Chennai coast formed the material for the study. These shrimps were divided into four different weight groups based on the total weight.

The weight groups considered were: A. 0 - 10 g, B. 10 - 20 g, C. 20 - 30 g and D > 60g (broodstock). Nine morphometric traits (which could be measured without bruising the animal) showing a possible correlation with tail weight, were identified (Lester, 1983) and are listed in Table 1.

TABLE 1. *Means of morphometric traits along with coefficients of variation in different weight groups of* P. monodon

Morphometric traits (mm)	Weight group A N=67		Weight group B N=57		Weight group C N=21		Weight group D N=20	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Partial carapace length (PCL)	18.42	0.23	29.21	0.08	34.05	0.04	58.05	0.13
Carapace width (CW)	10.43	0.18	15.68	0.09	18.52	0.09	30.90	0.13
First segment length (FSL)	7.63	0.21	13.00	0.12	15.43	0.07	25.70	0.10
Anterior abdomen circumference (AAC)	26.79	0.25	45.61	0.09	54.90	0.08	83.85	0.09
Second abdominal segment depth (SAD)	9.28	0.28	15.77	0.10	18.81	0.11	34.95	0.10
Fifth segment length, flexed (FLF)	6.40	0.21	10.61	0.10	12.81	0.15	20.80	0.10
Sixth segment length (SSL)	10.61	0.19	16.86	0.09	20.24	0.07	30.90	0.10
Posterior abdomen circumference (PAC)	20.18	0.26	34.44	0.08	38.81	0.21	60.80	0.09
Sixth segment depth (SSD)	7.97	0.21	13.16	0.09	16.19	0.07	26.60	0.08
Tail weight (TW) (g)	2.57	0.65	9.68	0.21	16.16	0.12	68.80	0.29

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Reliable criteria for the selection of broodstock of *Penaeus monodon* Fabricius in genetic improvement programmes

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ABSTRACT

Level of variation in tail weight and its degree of dependence on different morphometric traits were estimated in *Penaeus monodon.* The data on morphometric traits of a total of 165 *P. monodon* of four different weight groups, were subjected to stepwise regression analysis. The coefficient of variation of tail weight in all the groups was found to be higher. Correlation matrices revealed a significant relationship between the morphometric traits and tail weight, particularly in the broodstock animals. The order in which different morphometric traits entered the regression equation differed among the wieght groups. In broodstock animals, partial carapace length and carapace width determine the tail weight with high degree of accuracy (R^2= 99%). Therefore, these easily measurable traits can be used as criteria in the selection of *P. monodon* broodstock.

Introduction

Penaeid shrimp culture has attained a commercial status in India and hence there is great demand for seed. Large scale seed production depends on the availability of wild broodstock. However, wild spawners are in high demand in all shrimp farming countries. The problem is more acute with *Penaeus monodon* as compared to the other species. As of now, pond reared broodstock play a minor role in the spawning programmes of hatcheries (Alagarswami, 1993). So the captive broodstock development and selective breeding are the major areas through which genetic improvement and assured supply of good quality seed could be achieved.

Growth rate is a primary trait for selection in most organisms (Shultz, 1986). In general, body weight shows a very high phenotypic variation in all species of fish and shellfish. Due to their high fecundity it is possible to apply a very high selection intensity (Gjedrem, 1983). Therefore, even at low heritabilities the potential for genetic improvement of growth rate through selection is promising in aquatic organisms. Further the success of a selection programme depends on the knowledge of base line data on quantitative varia-