

## Carapace colour morphs of the blue swimmer crab *Portunus pelagicus* population in Mandapam (Palk Bay and Gulf of Mannar) region

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Received 23 November 2017; revised 23 April 2018

The study analyzed the live colour pattern present on the carapace of *Portunus pelagicus*. Our results indicated that the occurrence of three major colour morphs in the population of *P. pelagicus* with an intraspecific variation among the female population in Mandapam (Palk Bay and Gulf of Mannar) region. The crab population was dominated by carapace colour morph Type 2 (51.27%) in Palk Bay and Type 3 (54.80%) in Gulf of Mannar. There was no evidence of a colour morph difference between ages in observed specimens. The colour morphotypes showed significant difference in the analysed population, among and between the sexes.

[**Keywords:** Manna crab; Carapace; Colour pattern; Palk Bay; Gulf of Mannar]

### Introduction

Carapace is a hard shell, made up of chitin, which protects the internal organs of crab. Carapace morphology is considered as one of the main keys for species identification of crabs. The colour morphs present on the carapace play an important role in the life cycle of many crab species<sup>1</sup>. In invertebrate taxa, crustaceans specially shrimps and isopod were taken as a model to study the polymorphism in colors and the role of chromatophores in coloration was well documented<sup>2,3,4,5,6,7,8,9,10,11,12</sup>. Among the crustaceans, many studies have been carried out in brachyuran crabs to understand the cause of colour variation due to polychromatism<sup>13,14</sup>, habitat, social and environmental factors<sup>12,15</sup>, colour pattern and predation<sup>9</sup>, background and predation<sup>16</sup>, behaviour and moult stages<sup>17,18</sup>, behaviour and mating<sup>19,20</sup>, and thermoregulation<sup>21,22</sup>. In the account of commercially important brachyuran crabs, major studies were focused on fishery, biology, morphometric variation, stock assessment and population diversity. Though the presence of colour morphs and patterns were noticed during the above said studies, documentation on colour morphs and patterns of carapace is scanty. The present study reports the details on live colour morphs of *P. pelagicus*, specifically the colour and patterns present on the carapace of the studied population of Mandapam (Palk Bay and Gulf of Mannar) region.

### Materials and Methods

Variation in colour morphs of carapace in *Portunus pelagicus* was observed during the collection of broodstock for seed production of crabs at the Mandapam Regional Centre of the ICAR- Central Marine Fisheries Research Institute(CMFRI). The observations were made in the commercial trawl landings at Mandapam in Palk Bay and Gulf of Mannar, the south-east coast of India during the period from August 2015 to July 2016. The samples were observed randomly from the trawl landings. A total of at least 50 crabs were scrutinized per sampling and a minimum of two to a maximum of four samplings were conducted per month. In the present study, the crab species were identified as per Fernando and Fernando (2002)<sup>23</sup> and FAO (2014)<sup>24</sup>. The carapace width (CW) measured to the nearest mm, sex, percentage of live colour morphs on the carapace among and between the sexes was recorded. Live colour morphs on the carapace were photographed using a digital camera (Canon, G12) for further study. Comparing the patterns present on the carapace in live specimens was difficult due to variation in pigmentation among the specimens. In order to clearly view the pattern present on the carapace, the carapace was exposed to sunlight for 3 to 5 days. This process bleached the pigments (particularly chlorophyll pigments) and hence the

pattern present on the carapace was clearly visible (Figs. 1-3).

### Results and Discussion

*Portunus pelagicus* is commonly known as blue swimmer crab although it does not always seem to be

particularly blue. It is characterised by transversely hexagonal carapace type, which is broad and flattened, rough in texture and the posterior third of the carapace granular. It has four spines on the frontal margin of the carapace, with nine teeth on each side and the last one very much pronounced as horns. Cheliped is slender and elongate with three spines on the anterior margin and has a postero-distal spine on the cheliped merus.

In general, males are dark blue (or) blue-green in colour with white dots on the carapace and females are characterised by dull green-brown coloured carapace. The colour variation between the sexes is recorded for sexual dimorphism in *Portunus sp.* and has already been well documented<sup>1,25</sup>. A total of 1963 specimens (both sex combined) were studied randomly from the commercial trawl landings at Mandapam in Palk Bay and Gulf of Mannar, Tamil Nadu, India. The size range of CW observed during the present investigation for males and females was 63 to 165 mm and 61 to 159 mm, respectively. The male and female sex percentage was 27.42 and 72.58, respectively. Among males, the sub-adult and adult percentage was 19.63 and 80.37, respectively and the same was 21.15 and 78.85, respectively among females.

In *P. pelagicus*, the adult male and female crabs exhibited typical colour patterns and about three live



Fig.1 — Male crab with Type 1 colour morph observed in A. Live carapace; B. Sun light exposed carapace.

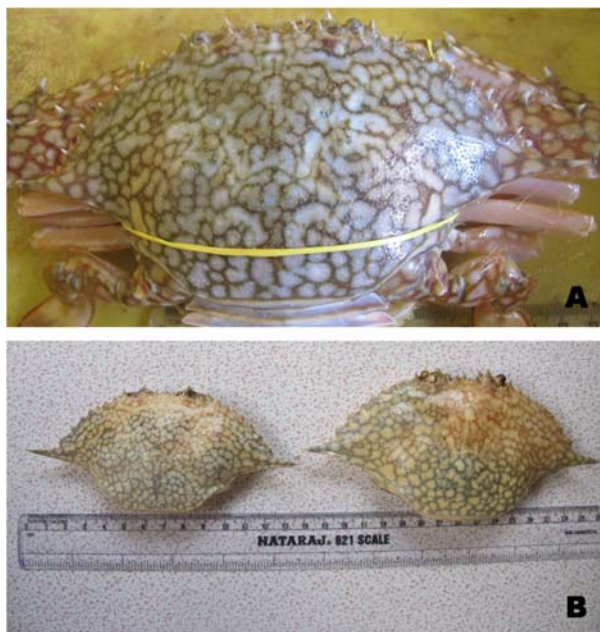


Fig. 2 — Female crab with Type 2 colour morph observed in A. Live carapace; B. Sun light exposed carapace.

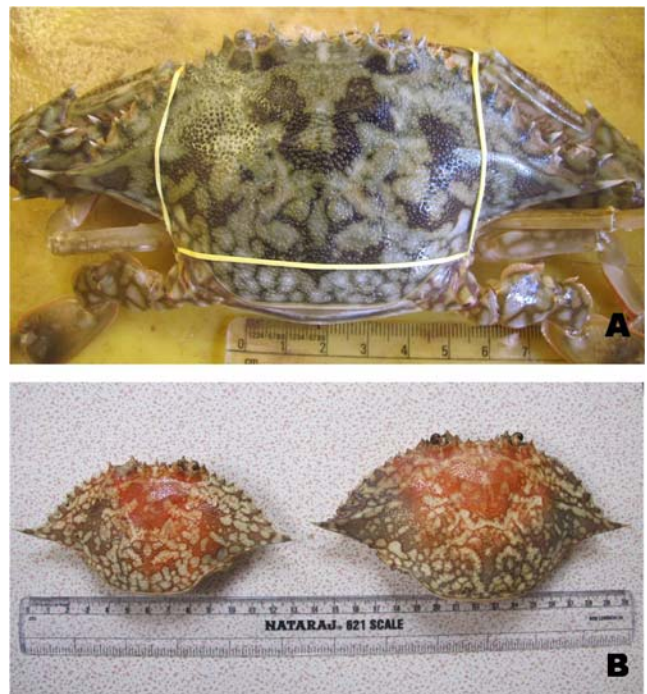


Fig. 3 — Female crab with Type 3 colour morph observed in A. Live carapace; B. Sun light exposed carapace.

colour morphs were recognized which are illustrated in Figures 1-3 and the details are described in Table 1. The crabs were found to have one or more solid colours on their carapace with a distinct pattern of spots or reticulations in another colour over and above. The colours in the sampled individuals were solid (green, blue, brown) as well as many shades of greenish blue or greenish brown. Often the carapace colour was a blend of two or three of these colours. The spots and reticulations were usually in white, grey or dull green, often with bluish green. The colour variation could be due to genetic, sex specific, environmental influence during or after development and/or age or molting stage of the crab<sup>6,22,26,27</sup>.

In the observation, the smaller sized crabs were bright in colour with more limited white spots and reticulations. But, it was reverse in larger crabs (Plate 1-3) which could be due to enlargement of individual carapace post-ecdysis along with white spots and reticulations. Hence, the background colour present on the carapace gets faded which results in change of colour with new molts, the carapace fades and the white spots present on the carapace are getting merged. All the three colour morphs crabs have

similar external morphological characteristics except for the colour and pattern present on the carapace.

The Type 1 colour morphs are present only in males and Type 2 and 3 only in females. The colour variation between the sexes is recorded as sexual dimorphism in *Portunus sp.* and it has already been well documented<sup>1,25</sup>. Overall, Type 2 colour morphs were dominant in Palk Bay region comprising 51.27%, the Type 3 colour morphs made up 20.87% and the Type 1 colour morphs were 27.86% of the studied population. But in Gulf of Mannar, Type 3 colour morphs made up to 54.80%, Type 2 colour morphs 17.59% and Type 1 colour morphs 27.61%. This difference can be attributed to ecological difference between the studied area (Palk Bay and Gulf of Mannar) and large representation of females than males in the studied population. This is the first report on the difference in carapace colour morphs within the female population of *P. pelagicus* from Indian water. In all the three colour morphs, size class 121-150mm showed maximum representation and the size class 60-90 mm showed minimum representation. This variation might be due to the number of samples collected for analyses based on carapace patterns.

Table 1 — Description on carapace live colour morphs reported in different studies and the present study in the wild *Portunus pelagicus*

Reference	Sub-adult	Adult	Sex
Svane & Hooper (2004) <sup>29</sup>	Pale-coloured carapace with pinkish hue	Bright blue with white spots Dull greenish-brown	Male Female
Lai <i>et al.</i> , (2010) <sup>25</sup>	Dark blue green carapace, pale background of blue green	Uniformly brownish green carapace; speckled with pale white spots, also possess spots and bands on the posterior and branchial regions of carapace	Male Female
Fujaya <i>et al.</i> , (2014)* <sup>30</sup>	Dark blue-green carapace, white spots on the whole carapace	Dark olive green blue, granulated carapace with many pale white spots on surface particularly posteriorly and anterolaterally; spots tend to merge to form reticulating bands, merging of pale white spots and network of white reticulations are more than the sub-adults	Male & Female
Type 1 (Present study, Fig. 1)	Bright greenish blue, granulated carapace with a variable network of white reticulations and spots, less reticulation and dense spots than adult	Dark olive green blue, granulated carapace with many pale white spots on surface particularly posteriorly and anterolaterally; spots tend to merge to form reticulating bands, merging of pale white spots and network of white reticulations are more than the sub-adults	Male
Type 2 (Present study, Fig. 2)	Greenish brown/olive colour and granulated carapace, pale green numerous dense spots that does not merge into broad net like bands, to sparsely spotted.no reticulations present	Greenish brown/olive colour and granulated carapace, large pale green spots that rarely merge into broad net like bands, to sparsely spotted, with thick reticulations and blotches	Female
Type 3 (Present study, Fig. 3)	Dark greenish brown carapace marked with numerous dense granulation, no spots and reticulations present	Greenish brown carapace with dark green blotches, “U” shaped dark green blotch present on gastric region (between left proto-gastric, meta-gastric and right proto-gastric region), large dark green blotches present on branchial and cardiac regions, thick reticulations, spots that merge into broad net like bands	Female

\*Crabs harvested from brackish water pond after 3-month rearing periods.



Unlike the size, the colour morphs did not correlate with age. Individuals were collected from 61 to 165 mm, presumably of different ages, with no evidence of a progression or trend in carapace colour morphs (Plates 1-3). There also seemed to be difference in the colours or patterns between males and females but no difference was found among sub-adult and adult males, as well as among sub-adult, adult and ovigerous females. Interestingly, a female specimen with U-shaped pattern and olive gray colour was noticed, instead of dark green colour usually observed in all Type 3 colour morphs (Plate 2B). Another female specimen with Type 3 colour morph was noticed with four spines on the anterior margin of left cheliped merus instead of three spines usually observed in all crab specimens (Plate 2C).

As the habitat is concerned, the *P. pelagicus* in Mandapam region live along rock, coral reef, macroalgal assemblages and sandy or muddy sea bottom<sup>28</sup> that are diversely coloured, which likely supports carapace colour variation. The variation in carapace colour morphs not only depends on the environment, habitat and diet, but also on the genetic causes<sup>1</sup> which must have some effect on the colour morphs and are likely to determine the pattern on the carapace, because different sex and different size class crabs kept the same pattern (Plates 1-3) even when their colour changed after several moult.

Ontogenic colour changes are common in many crustaceans, in response to the changing camouflage requirements associated with changes in habitat or behaviour<sup>6</sup>. CHI Da-li *et al.*, (2010)<sup>1</sup> reported that the carapace colour morphs change with environmental factors and make the crab invisible by means of protective colouring (camouflaged) which can help them survive the danger from predators or capture the prey easily. The carapace colour was shown to be associated with some physiological properties in some crab species<sup>22</sup> and the colour was often associated with the parts of a crab used in social interactions<sup>26</sup>. Alternatively, it is possible that ontogenetic shifts in colouration are not predation-related, but instead associated with intraspecific or intrageneric or for communication, *e.g.*, for crabs to signal their social status or breeding condition<sup>27</sup>.

The present study documented the occurrence of three major colour morphs in the population of *P. pelagicus*. Our observations revealed that an intraspecific variation among the females (Type 2 and Type 3 colour morphs) in Mandapam (Palk Bay and



Plate 1 — Different carapace live colour morphs observed in *Portunus pelagicus* landed at Mandapam coast. 1&2. Sub-adult and mature male with Type 1 colour morph carapace, 3&4. Sub-adult and ovigerous female with Type 2 colour morph carapace, 5&6. Sub-adult and ovigerous female with Type 3 colour morph carapace (For description refer Table 1).

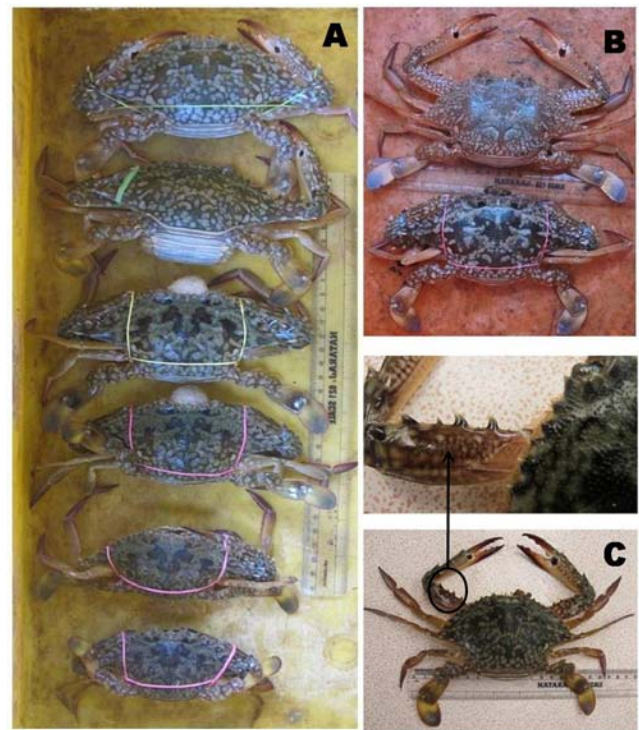


Plate 2 — A. Different size specimens with Type 3 colour morphs carapace observed in female crabs and unusual specimens (B and C); B. Female specimen with U-shaped pattern and olive gray colour; C. Female specimen with U-shaped pattern in dark green colour carapace was observed with four spines on the anterior margin of left cheliped merus.



Plate 3 — A. Different size specimens with Type 2 colour morph carapace observed in female crabs; B. Different size specimens with Type 1 colour morph carapace observed in male crabs.

Gulf of Mannar) region. Most likely, some combination of the above-described factors might influence the carapace colour morphs of *Portunus pelagicus* in this region; more extended interdisciplinary research in combination of ecological and molecular studies is necessary to unravel this mystery.

### Acknowledgment

We are thankful to Dr. A. Gopalakrishnan, Director, ICAR-CMFRI for his support and encouragement. We are grateful to the fishermen of Palk Bay and Gulf of Mannar for helping us in collecting the data and samples for the study. The authors also wish to acknowledge the funding support received from the Indian Council of Agricultural Research (ICAR) under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India.

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