

Integrative taxonomy analysis reveals the first record of the shrimp *Kishinouyepenaeopsis incisa* (Wang & Liu in Liu & Wang, 1987) (Decapoda, Penaeidae)

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Abstract. We document the first record of *Kishinouyepenaeopsis incisa* (Wang & Liu in Liu & Wang, 1987) (Decapoda, Penaeidae) from the west coast of Peninsular Malaysia. Five specimens were initially collected during a trawling survey in April 2014, followed by another 17 specimens collected during sampling sessions from February 2023 to August 2023. Previously, this species was known to occur only in South China and Bangladesh. We provide detailed morphometric and meristic data, along with brief diagnostic characters, supported by genetic analysis that corroborates the species identity and distribution.

Key words. Distribution, Indo-Pacific region, new record, penaeid shrimp

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INTRODUCTION

A traditional view holds that many marine species have large geographical ranges due to their high dispersal capability by pelagic larval stages or propagules and the lack of apparent dispersal barriers in the sea (Payo et al. 2013). Most species are characterized by sb-basinal distributions, being widespread in either the Indian or Pacific Ocean, but substantial fragmentation spans both oceans (Paulay and Meyer 2002). Shrimp species of the family Penaeidae Rafinesque, 1815 are widely recognized as the most economically important crustaceans (Chan 1998; Hurzaid et al. 2023). They inhabit tropical and subtropical shallow waters, with their greatest species diversity recorded in the Indo-West Pacific (IWP) region. Among the Penaeidae, the genus *Penaeus* Fabricius, 1798 holds the highest importance, followed by *Metapenaeus* Wood-Mason & Alcock, 1891 and *Parapenaeopsis* Alcock, 1901 sensu lato (s.l.) (Chan 1998; Hsu and Chan 2023).

Kishinouyepenaeopsis Sakai & Shinomiya, 2011 is an important genus within the Penaeidae, and it is particularly important both for its economic value and for its role in enhancing our understanding of the genetic, phylogenetic, and taxonomic complexities within the family (Cheng et al. 2018; Alam and Pálson 2021; Hurzaid et al. 2023). Sakai and Shinomiya (2011) redefined the broadly recognized *Parapenaeopsis* s.l., which was previously classified under the genus *Parapenaeopsis*, by dividing it into eight distinct genera. This reclassification resulted in the introduction of seven new genera, including *Kishinouyepenaeopsis*. While some studies have rejected the use of this new genus (Alam and Pálson 2021; Hsu and Chan 2023), we continue to adhere to this taxonomic classification as the previous molecular evidence supports the monophyly of this genus with high bootstrap support (Li et al. 2014; Hurzaid et al. 2020), and it aligns with the recent accepted taxonomic classification in World Register of Marine Species website (WoRMS 2024). Within the genus, there are four species: *K. amicus* (Nguyễn, 1971), *K. cornuta* (Kishinouye, 1900), *K. incisa* (Wang & Liu in Liu & Wang, 1987), and *K. maxillipedo* (Alcock, 1905). Among these, *K. cornuta* and *K. maxillipedo* have been reported from Malaysian coastal waters, but *K. amicus* and *K. incisa* have not. *Kishinouyepenaeopsis incisa* was originally described from South China (Li and Wang 1987), but since its description there have been no records indicating its presence in Malaysia. The current study constitutes the first documented occurrence of *K. incisa* along the coast of Peninsular Malaysia, contributing to the



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limited information available on the distribution of this lesser-known penaeid shrimp species in the Indo-Pacific region as well as in Malaysia.

METHODS

Our material was initially collected by direct trawling using research vessels in collaboration with the Fisheries Research Institute, Malaysia in April 2014. During this time, five specimens were collected from Sekinchan coast at a depth of 21 m. Our second encounter with the species occurred during a sampling session at local fish landing sites in Sekinchan, Selangor and Pantai Remis, Perak, in 2023. The specimens were fixed, photographed, and preserved following Hurzaid et al. (2020). Morphometrics and the terminology of morphological descriptions follow the guideline provided by Liu and Wang (1987), Parenrengi et al. (2022), and Hsu and Chan (2023). The specimens were measured to the nearest 0.01 mm using digital calipers. Species identification followed Liu and Wang (1987) and Pérez-Farfante and Kensley (1997). Voucher specimens from the 2014 sampling were deposited in the invertebrate collections at National Taiwan University Museum (NTUM_INV), Taipei, Taiwan. Voucher specimens from the sampling surveys in 2023 were deposited in the invertebrate collections at the Zoological Reference Laboratory, Universiti Sains Malaysia (USM_INV), Penang, Malaysia.

DNA-based identification was performed using mitochondrial cytochrome oxidase subunit I (COI) and 16S rRNA gene fragments, which were amplified with Penae_COIF and Penae_COIR (Hurzaid et al. 2020) for COI and 16Sar and 16Sbr (Palumbi et al. 1991) for 16S rRNA, respectively. Total genomic DNA was extracted from the pleopod of the shrimp specimens using CTAB (Cetyl trimethyl ammonium bromide) method (Nadia and Sadok 2017). PCR thermal profiles followed Hurzaid et al. (2020). Species confirmation was achieved by comparing generated sequences from the specimens with those available in GenBank, using a 99% similarity threshold for species assignment. The newly generated COI sequences from our specimens were submitted to GenBank under accession numbers, PP702991, PP703008, PP703010, PP703015, PP703165, PP708549, PP708549, PP703176, PP703182, PP700292, PP702603, PP700248, PP702606, PP702610, PP702611, PP711123, and PP702912. For the 16S rRNA gene, the accession number is PP859415. In addition, COI sequences from five specimens of *Kishinouyepenaeopsis incisa* (GenBank: MT178576 – MT178580; voucher number: NTUM_INV0004, NTUM_INV_0010) from the 2014 survey were also included in the molecular analysis. We also included the 16S rRNA sequence from Bangladesh (GenBank: ON264685; voucher number: DUZM_CR_107B) (Datta and Ahmed 2022) for comparison purposes, without examining their morphology.

RESULTS

Class Malacostraca Latreille, 1802
Order Decapoda Latreille, 1802
Family Penaeidae Rafinesque, 1815
Genus *Kishinouyepenaeopsis* Sakai & Shinomiya, 2011

Kishinouyepenaeopsis incisa (Wang & Liu in Liu & Wang, 1987)

Parapenaeopsis incisa Wang & Liu in Liu & Wang, 1987

Figure 1, Table 1

New records. MALAYSIA – SELANGOR • off Sekinchan coast; 03°18'19"N, 100°51'30"E; 21 m depth; 28.IV.2014; Hurzaid A leg.; bottom trawl; GenBank MT178576-MT178580; 5 ♀, NTUM_INV0004, NTUM_INV0010 • Sekinchan fish landing site; 03°29'56"N, 101°05'44"E; 8.VIII.2023; Fakhruddin NF leg.; GenBank (COI) PP700292, PP702603, PP700248; GenBank (16S rRNA) PP859415; 3 ♀, USM_INV0951, USM_INV0952, USM_INV1000 – PERAK • Pantai Remis fish landing site; 04°26'57"N, 100°37'19"E; 2.II.2023; Fakhruddin NF leg.; GenBank PP702991, PP703008, PP703010, PP703015, PP703165, PP708549, PP708550, PP703182, PP703176, PP702912, PP711123, PP702606, PP702610, PP702611; 14 ♀, USM_INV0647, USM_INV0650, USM_INV0651, USM_INV0652, USM_INV0654, USM_INV0655, USM_INV0656, USM_INV0686, USM_INV0658, USM_INV1017, USM_INV1016, USM_INV1013, USM_INV1014, USM_INV 1015.

Identification. The specimens were identified as *Kishinouyepenaeopsis incisa* based on the following combination of characters, which matched the diagnostic features given by Liu and Wang (1987): body robust, integument moderately thick, body length of adult 53.4–67.4 mm. Rostrum horizontal in proximal half, upturned distally, acute at tip, reaching end of second or middle of third segment of antennular peduncle, rarely to end of third segment; with 6–8 teeth (mostly 7) on upper border (excluding epigastric tooth), the first tooth posterior to orbital margin. Post-rostral carina reaches posterior margin of carapace, evenly broad throughout its length, with certain flatten area on posterior half. Pleon longitudinally carinated from somites 4–6. Telson without fixed or movable marginal teeth. Eyes rather large. Maxillar palp unsegmented.

Figure 1. *Kishinouyepenaeopsis incisa* (USM_INV1000), collected from Sekinchan, Selangor.



Table 1. Morphometric measurements of *Kishinouyepenaeopsis incisa* following the terminology as in Liu and Wang (1987), Parenrengi et al. (2022), and Hsu and Chan (2023).

Character	Measurements (mm)
Rostrum length (RL)	8.37–11.90
Carapace length (CL)	15.56–21.14
Carapace width (CW)	7.48–10.12
Carapace height (CH)	8.97–11.32
Body length (BL)	53.35–67.44
Segment length 1 (SL-1)	4.72–6.56
Segment length 2 (SL-2)	3.16–5.23
Segment length 3 (SL-3)	3.97–5.72
Segment length 4 (SL-4)	3.37–6.04
Segment length 5 (SL-5)	3.33–5.02
Segment length 6 (SL-6)	5.90–8.60
Segment height 6 (SH-6)	5.20–6.95

Maxilliped 1 with 5 segmented endopod, maxilliped 3 thin, reaches distal end of 1st segment of antennular peduncle, with ultimate segment surpassing distal end of carapocrite. Pereiopod 1 with at least distal half of dactylus surpassing pterygostomian angle. Pereiopod 2 with distal half or entire dactylus surpassing carapocrite. Basial spines and epipodites present on pereiopod 1 and 2. Pereiopod 3 longest, with propodus or even $\frac{1}{2}$ of merus surpassing carapocrite and without basal spine in both sexes. Pereiopod 5 with $\frac{3}{4}$ or whole dactylus (rarely $\frac{1}{3}$ propodus) surpassing pterygostomian angles.

Thelycum (female genital part). Anterior plate longer and comparatively narrower, anterior margin arcuated, lateral margins slightly concave at middle and produced laterally at base, forming a wing-like process, which is small in young individuals. Middle portion of ventral surface of anterior plate concave, slightly produced at its posterior end, behind it is the transversely produced posterior plate, with a sub-triangular plate on each side. Behind it is a tuft of long hairs, its posterior margin being straight.

This species is often misidentified as *K. cornuta* but can be differentiated by the shape of the petasma and thelycum, as well as the pattern of pubescence on the carapace. *Kishinouyepenaeopsis incisa* also differs from *K. cornuta* by having a posterior plate of the thelycum lacking a median boss (Hurzaid et al. 2020). The morphometric characters are detailed in Table 1.

DISCUSSION

The discovery of *Kishinouyepenaeopsis incisa* from Malaysian waters adds a new locality record and contributes to our understanding of the global range of commercial penaeid species. Our morphological identification of *K. incisa* was further validated by constructing a COI phylogenetic tree, where the specimens clustered together with those from the type locality of *K. incisa* from China, and a genetic distance of 0.5% suggested they are the same species (Figure 2). Previously, records of this species' distribution were limited to South China (Liu and Wang 1987) likely due to limited sampling efforts and a lack of taxonomic

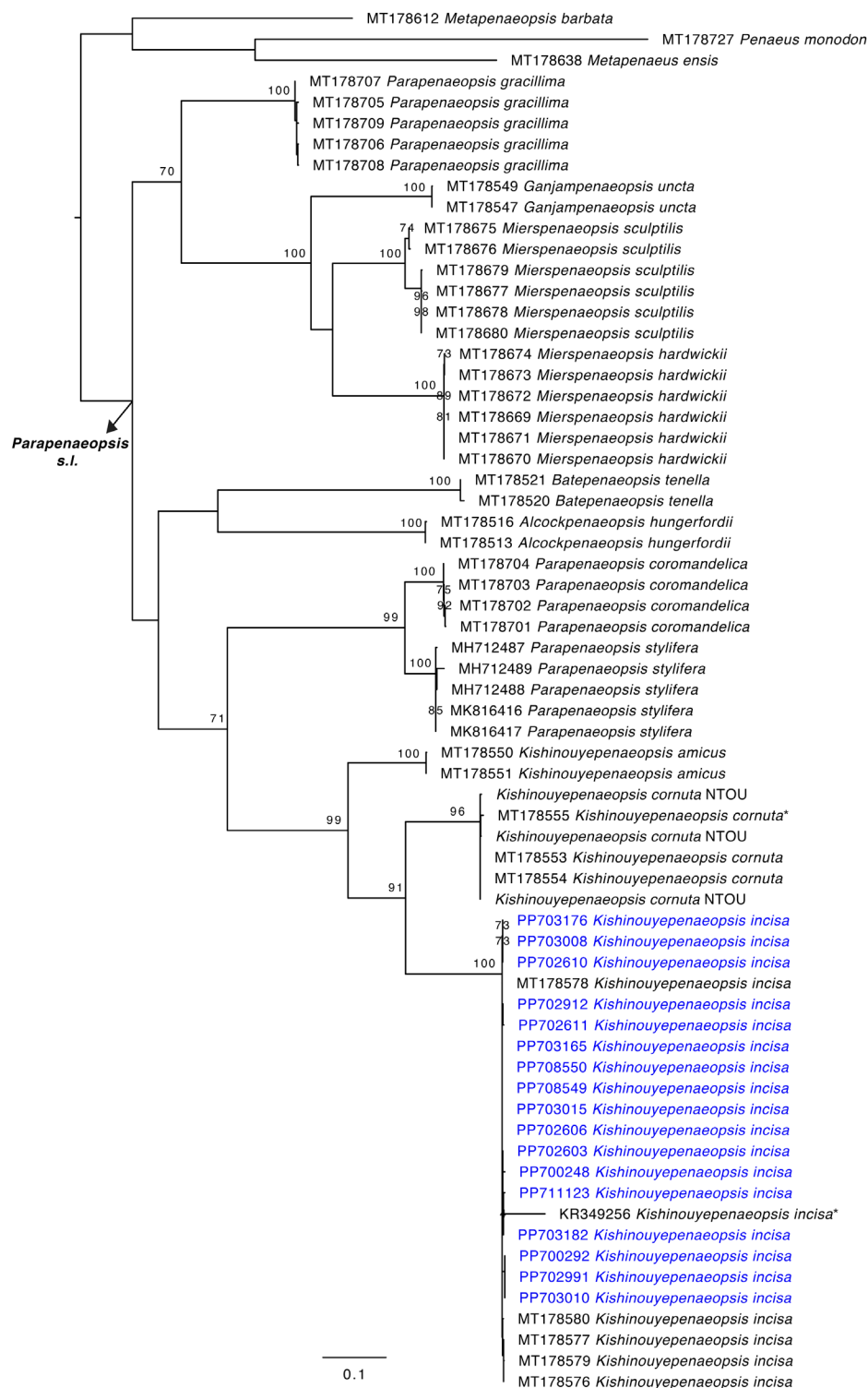


Figure 2. Phylogenetic tree of *Parapenaepsis* s.l. samples inferred by the maximum likelihood method with GTR + G nucleotide substitution model at COI gene. The *K. incisa* sequences generated in this study are shown in blue. Branch length is proportional to the inferred number of nucleotide substitutions. Numbers at nodes represent bootstrap values in percentages. Values <70% are not shown. * indicates the type locality. Tree was rooted using *Metapenaepsis barbata*, *Penaeus monodon* and *Metapenaepsis ensis*.

expertise across the region. Moreover, misidentification with *K. cornuta* may have contributed to perceived distributional gaps (Hurzaid et al. 2020). The recent discovery of *K. incisa* in Bangladesh (Datta and Ahmed 2022) fills some of these gaps and confirms a geographic range that extends towards the Bay of Bengal. Even though they did not publish their findings, the 16S rRNA sequence obtained from GenBank grouped together with *K. incisa* in our phylogenetic tree further corroborating its identification (Figure 3). It was previously unclear whether the species can naturally transverse the South China Sea and the Straits of Malacca to reach Bangladesh from Malaysia without evidence of its presence in the intervening waters. Our findings, together with those from Bangladesh, confirm that the pelagic larvae of this species can indeed transverse this area and be found in Bangladesh as well.

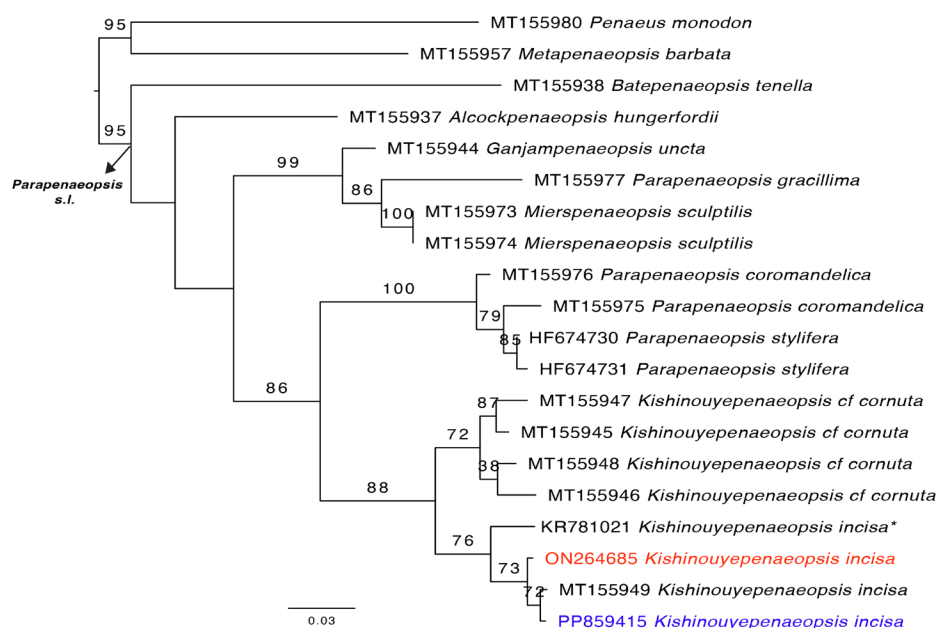
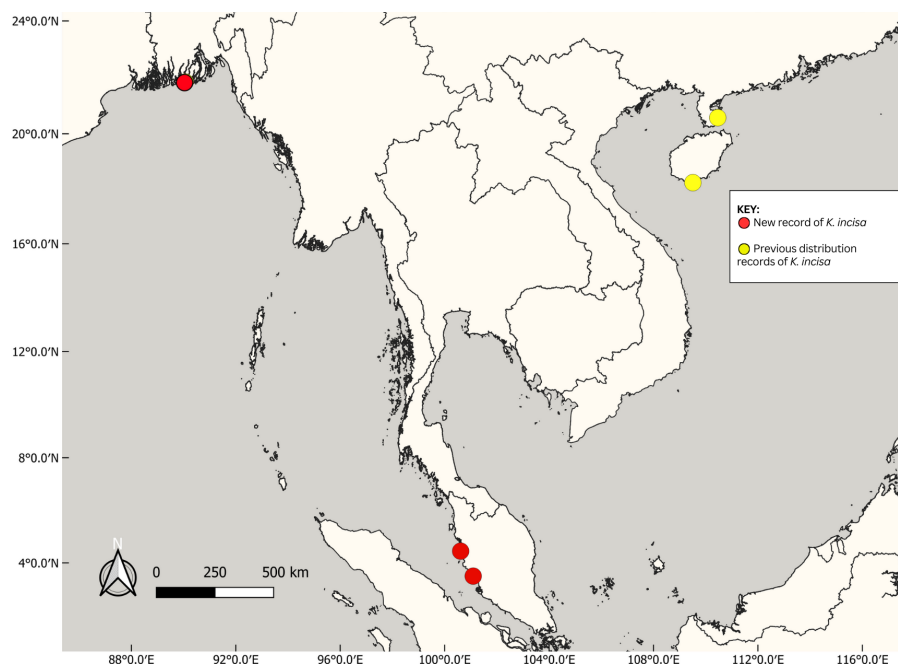


Figure 3. Phylogenetic tree of *Parapenaeopsis* s.l. samples inferred by the maximum likelihood method with GTR + G nucleotide substitution model at 16S rRNA gene. The *K. incisa* sequence generated in this study is shown in blue and *K. incisa* from Bangladesh is shown in red. Branch length is proportional to the inferred number of nucleotide substitutions. Numbers at nodes represent bootstrap values in percentages. Values <70% are not shown. * indicates the type locality. Tree was rooted using *Penaeus monodon* and *Metapenaeopsis barbata*.

Figure 4. Distribution map of *Kishinouyepenaeopsis incisa* (Wang & Liu in Liu & Wang, 1987). Yellow dots represent previous records based on Liu and Wang (1987). The red dots are the new records presented in this study and records by Datta and Ahmed (2022).



Disjunct distributions often result from limited sampling and taxonomic expertise rather than genuine population disjunction, particularly in cryptic species such as penaeid shrimps (Hurzaid et al. 2020; Abidin et al. 2024). Given their extended pelagic larval duration, population connectivity is expected for Penaeidae in the absence of physical barriers. Numerous studies have demonstrated substantial genetic homogeneity across ocean basins for this family (McMillen-Jackson and Bert 2004; Teodoro et al. 2015; Timm et al. 2021). The presence of *K. incisa* populations spanning the South China Sea and the Indian Ocean suggests a broad western Pacific range. Continued documentation of verified specimens will enhance our understanding of the biogeography and population structure of this species, which appears to be more widely distributed than previously acknowledged (Abidin et al. 2024).

Notably, our new record represents the first validated *K. incisa* occurrence from Malaysian waters, approximately 3500 km from the nearest documented population in Bangladesh (Datta and Ahmed 2022) (Figure 4). The presence of our specimens in the coastal waters of Peninsular Malaysia fills the distribution gaps between the records from South China and Bangladesh. The diverse ecosystems along the western coast of Peninsular Malaysia offer many suitable niches, particularly the mangrove estuaries (Hurzaid et al. 2023), which provide prime nursery areas rich in resources during the juvenile stage of this penaeid

species. Comprehensive surveys and detailed morphological examinations are needed to fully understand the distribution patterns and ecology of this species. Our findings underscore the importance of exploratory sampling in the biodiverse Indo Pacific region. Further expeditions in this globally significant marine region could reveal additional range extensions and previously undocumented populations of tropical marine fauna.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interest exist.

Ethical statement

No ethical statement is reported.

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Author's contributions

Conceptualization: NFF, AH. Methodology: NFF, AH. Investigation and validation: AH, SAMN. Funding acquisition: AH. Visualization: NFF, AH. Writing – original draft: NFF, SAMN, AH. Writing – review and editing: NFF, SAMN, AH.

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Data availability

Data that support the findings of this study are available in the main text. For COI, GenBank accession numbers: PP700292, PP702603, PP700248, PP702991, PP703008, PP703010, PP703015, PP703165, PP708549, PP708550, PP703182, PP703176, PP702912, PP711123, PP702606, PP702610, PP702611. For 16S rRNA, GenBank accession number: PP859415.

REFERENCES

- Abidin DHZ, Nor SAM, Seah YG, Ali MS, Latiff NAA, Jaafar TNAM** (2024) *Gymnothorax longinquus* (Whitley, 1948) (Anguilliformes: Muraenidae), Long Moray: a first record from Malaysia. *Check List* 20 (1): 126–131. <https://doi.org/10.15560/20.1.126>
- Alam MM, Pálsson S** (2021) Genetic variation of *Parapenaeopsis sculptilis* (Decapoda, Penaeidae) and reassessment of the phylogenetic relationships within the genus *Parapenaeopsis* based on mitochondrial DNA variation. *Aquatic Living Resources* 34: 1. <https://doi.org/10.1051/alr/2020027>
- Chan TY** (1998) Shrimps and prawns. In: Carpenter KE, Niem VH (Eds.) *The living marine resources of the Western Central Pacific*. Food and Agriculture Organization of the United Nations, Rome, Italy, 815–972.
- Cheng J, Chan TY, Zhang N, Sun S, Sha ZL** (2018) Mitochondrial phylogenomics reveals insights into taxonomy and evolution of Penaeoidea (Crustacea: Decapoda). *Zoologica Scripta* 47 (5): 582–594.
- Datta SK, Ahmed MS** (2022) *Kishinouyepenaeopsis incisa* isolate 11219 large subunit ribosomal RNA gene, partial sequence, mitochondrial. National Centre for Biotechnology Information, Maryland, USA. <https://www.ncbi.nlm.nih.gov/nucleotide/ON264685.1>. Accessed on: 2023-3-16.
- Hsu YC, Chan TY** (2023) On the penaeid shrimps of the genus *Parapenaeopsis* Alcock, 1901 (Crustacea, Decapoda) from Taiwan. *Zootaxa* 5361 (2): 221–236. <https://doi.org/10.11646/zootaxa.5361.2.4>
- Hurzaid A, Chan TY, Nor SAM, Muchlisin ZA, Chen WJ** (2020) Molecular phylogeny and diversity of penaeid shrimps (Crustacea: Decapoda) from South-East Asian waters. *Zoologica Scripta* 49 (5): 596–613. <https://doi.org/10.1111/zsc.12428>

- Hurzaid A, Jamaludin JAF, Nor SAM, Suhailan MAA** (2023) A preliminary checklist of commercial marine shrimps (Decapoda: Penaeidae) along Peninsular Malaysia coastal waters. In: IOP Conference Series: Earth and Environmental Science, Banda Aceh, Indonesia, 012003. <https://doi.org/10.1088/1755-1315/1221/1/012003>
- Li X, Xu Y, Kou Q** (2014) Molecular phylogeny of *Parapenaeopsis* Alcock, 1901 (Decapoda: Penaeidae) based on Chinese materials and 16S rDNA and COI sequence. Journal of Ocean University of China 13: 104–114. <https://doi.org/10.1007/s11802-014-2272-7>
- Liu R, Wang Y** (1987) Studies on Chinese species of the genus *Parapenaeopsis* (Decapoda, Crustacea). Oceanologia et Limnologia Sinica 18 (6): 523–539.
- McMillen-Jackson AL, Bert TM** (2004) Genetic diversity in the mtDNA control region and population structure in the pink shrimp *Farfantepenaeus duorarum*. Journal of Crustacean Biology 24 (1): 101–109. <https://doi.org/10.1651/C-2372>
- Nadia B, Sadok S** (2017) Comparison of DNA extraction methods suitable for PCR based applications to identify shrimp species in commercial products. Journal of FisheriesSciences. com 11 (4): 25–31. <https://doi.org/10.21767/1307-234X.1000138>
- Palumbi S, Martin A, Romano S, MacMillan WO, Stice L, Grabowski G** (1991) The simple fool's guide to PCR. Department of Zoology and Kewalo Marine Laboratory, University of Hawaii, Honolulu, USA, 45 pp.
- Parenrengi A, Tenriulo A, Suryanti E, Lante S, Nawang A, Rosmiati R** (2022) Morphological discrimination of tiger shrimp *Penaeus monodon* between female and male based on traditional and truss morphometric analyses. In: IOP Conference Series: Earth and Environmental Science, Makassar, Indonesia, 012055. <https://doi.org/10.1088/1755-1315/1119/1/012055>
- Paulay G, Meyer C** (2002) Diversification in the tropical Pacific: Comparisons between marine and terrestrial systems and the importance of founder speciation. Integrative and Comparative Biology 42 (5): 922–934. <https://doi.org/10.1093/icb/42.5.922>
- Payo DA, Leliaert F, Verbruggen H, D'hondt S, Calumpong HP, De Clerck O** (2013) Extensive cryptic species diversity and fine-scale endemism in the marine red alga *Portieria* in the Philippines. Proceedings of the Royal Society B: Biological Sciences 280 (1753): 20122660. <https://doi.org/10.1098/rspb.2012.2660>
- Pérez-Farfante I, Kensley B** (1997) Penaeoid and sergestoid shrimps and prawns of the world: keys and diagnoses for the families and genera. Éditions du Muséum, Paris, France, 233 pp.
- Sakai K, Shinomiya S** (2011) Preliminary report on eight new genera formerly attributed to *Parapenaeopsis* Alcock, 1901, sensu lato (Decapoda, Penaeidae). Crustaceana 84 (4): 491–504. <https://doi.org/10.1163/001121611X557037>
- Teodoro SSA, Terossi M, Costa RC, Mantelatto FL** (2015) Genetic homogeneity in the commercial pink shrimp *Farfantepenaeus paulensis* revealed by COI barcoding gene. Estuarine, Coastal and Shelf Science 166: 124–130. <https://doi.org/10.1016/j.ecss.2015.07.009>
- Timm LE, Jackson TL, Browder JA, Bracken-Grissom HD** (2021) Population genomics of the commercially important Gulf of Mexico pink shrimp *Farfantepenaeus duorarum* support models of juvenile transport around the Florida Peninsula. Frontiers in Ecology and Evolution 9: 659134. <https://doi.org/10.3389/fevo.2021.659134>
- WORMS** (World Register of Marine Species) (2024) *Kishinouyepenaeopsis* Sakai & Shinomiya, 2011. Flanders Marine Institute, Ostend, Belgium. <https://www.marinespecies.org/aphia.php?p=taxdetails&id=584971>. Accessed on: 2024-6-25.