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# *Emerita pangandaranensis* sp. nov., a new sand crab (Anomura, Hippidae) from South Coast of Java, Indonesia

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## Abstract

## Background

All previous reports of genus *Emerita* from Indonesia have only identified one species, namely *Emerita emeritus*, which were found on the west coast of Sumatera, and the south and northern coast of Java. Previous studies expected other species related to *Emerita emeritus* in southern Java.

## New information

We reported the new species of *Emerita*, which was found in Pangandaran Beach, in an intertidal area, within southern beach of Java, near Citonjong Estuary. We compare the specimen from a nearby location, that is Cilacap, and the collection of *Emerita emeritus* from Bengkulu. Here, we describe and illustrate the species.

## Keywords

intertidal, new *Emerita*, sand crab, southern Java

## Introduction

*Emerita* belongs to the family Hippidae, infraorder Anomura. In the Indo-Pacific, five species of *Emerita* have been well known, namely *Emerita emeritus* (west coast of India eastward to Vietnam and southward to Sumatera and Java, Indonesia), *E. austroafricana* (south Africa), *E. holthuisi* (Ratnagiri, India), *E. karachiensis* (Pakistan), and *E. taiwanensis* (Taiwan). In Indonesian waters, only one species of the genus *Emerita* has been reported (*Emerita emeritus*). It was reported from the west coast of Sumatera (Padang, Bengkulu), the south coast of Java (Cilacap, Kebumen, Bantul, Purworejo) (Wardiatno and Mashar 2013, Wardiatno et al. 2015, Nugaraha et al. 2018), and northern java (Bhagawati et al. 2020).

Hippidae inhabits sandy beaches, predominantly in tropical areas (Boyko and Harvey 1999). This condition is found in Indonesia, the second-longest beach globally, and tropical climate. For genus *Hippa*, several species have been reported in Indonesia, *H. adactyla*, *H. ovalis*, *H. marmorata*, *H. admirabilis*, and *H. celaeno* (Wardiatno et al. 2015). Unfortunately, reports regarding genus *Emerita* in Indonesia are almost from the ocean coast as *Emerita emeritus*.

In this study, we report a new *Emerita* from Indonesia that has a very close resemblance to *E. emeritus*. They are distinguished by the appearance of the anterior margin of the carapace. *Emerita emeritus* has a smooth anterior margin of carapace while crenulated in new *Emerita* species. At least two previous studies have suspected the existence of other species besides *Emerita emeritus* in southern Java (Butet et al. 2019, Nuryanto et al. 2020). This research aims to look for the important morphological character of *Emerita pangandaranensis* after they separated from *Emerita emeritus* based on the COI gene.

## Materials and methods

### Samples collection and documentation

Four specimens were captured by hand in the intertidal zone on the south coast of Java. The specimens were preserved in 70% alcohol for a day, then substituted in 96% alcohol for storage and deposited at the Museum Zoologicum Bogoriense (MZB), Research Center for Biology, Indonesian Institute of Sciences (LIPI), Cibinong, West Java, Indonesia. Specimens were photographed using a microscope (Leica Z6 APO) with a connector (Leica DMC 5400) belonging to the Indonesian Institute of Sciences (LIPI) and then illustrated using a Huion tablet (canvas Pro 13). Besides *Emerita pangandaranensis*, we described *Emerita emeritus* from Pangandaran and collection from Bengkulu (MZB Cru 4109).

## COI gene amplification, sequencing, and analysis

Muscle tissues were obtained from telson. The DNA from the muscle was extracted using GENE AID Genomic DNA Mini Kit (Tissue) according to manufacturer protocol. Amplification of gene fragment of COI was conducted using primer AF 215 (forward) 5'-TTC AAC AAA TCA TAA AGA TAT TGG-3' and AF 216 (reverse) 5'-TAA ACT TCA GGG TGA CCA AAA AAT CA3' [6] with GoTaq Green Mastermix. The Sanger sequencing was applied for PCR product.

The sequence of COI gene fragments was aligned to obtain homolog sequence using ClustalW, which was embedded in MEGA 7 (Kumar et al. 2016). Nucleotide variation, were calculated using DNASP 5 (Rozas et al. 2003). The statistical method used to construct the phylogenetic tree is the Neighbor-Joining method with nucleotide substitution model of Kimura-2 Parameter with 1000 bootstrap using MEGA7. Genetic distance was performed using MEGA7 and the Kimura-2 parameter as a model. Four novel sequences from the new taxon (*Emerita* sp. 6, 7, 8, and P2), three sequences of *E. emeritus*, together with reference sequences obtained from GenBank (Table 1), were used to construct the phylogenetic tree and performed genetic distance.

## Taxon treatment

### *Emerita pangandaranensis* Hanim, 2022, sp. n.

#### Materials

##### *Holotype:*

- a. scientificName: *Emerita pangandaranensis* Hanim; kingdom: Animalia; phylum: Arthropoda; class: Malacostraca; order: Decapoda; family: Hippidae; taxonRank: species; genus: *Emerita*; country: Indonesia; countryCode: IDN; stateProvince: West Java; county: Pangandaran Regency; locality: Pangandaran Beach; verbatimElevation: 0 m a.s.l.; verbatimLatitude: 7°42'11.1"S; verbatimLongitude: 108°39'22.5"E; eventDate: 2020-10-07; individualCount: 1; sex: male; lifeStage: juvenile; catalogNumber: MZB Cru 5338; recordedBy: Nisfa Hanim; disposition: in collection; associatedSequences: MZ571198; identifiedBy: Nisfa Hanim; Vinna Windy Putri; type: PhysicalObject; institutionCode: MZB; collectionCode: MZB Cru; basisOfRecord: Preserved Specimen

##### *Paratypes:*

- a. scientificName: *Emerita pangandaranensis* Hanim; kingdom: Animalia; phylum: Arthropoda; class: Malacostraca; order: Decapoda; family: Hippidae; taxonRank: species; genus: *Emerita*; country: Indonesia; countryCode: IDN; stateProvince: West Java; county: Pangandaran Regency; locality: Pangandaran Beach; verbatimElevation: 0 m a.s.l.; verbatimLatitude: 7°42'11.1"S; verbatimLongitude: 108°39'22.5"E; eventDate: 2019-08-22; individualCount: 1; sex: female; lifeStage: adult; catalogNumber: MZB Cru 5339; recordedBy: Achmad Farajallah; Nisfa Hanim; disposition: in collection; identifiedBy: Nisfa Hanim; type: Physical Object; institutionCode: MZB; collectionCode: MZB Cru; basisOfRecord: Preserved Specimen

- b. scientificName: *Emerita pangandaranensis* Hanim; kingdom: Animalia; phylum: Arthropoda; class: Malacostraca; order: Decapoda; family: Hippidae; taxonRank: species; genus: Emerita; country: Indonesia; countryCode: IDN; stateProvince: West Java; county: Pangandaran Regency; locality: Pangandaran Beach; verbatimElevation: 0 m a.s.l.; verbatimLatitude: 7°41'38.8356"S; verbatimLongitude: 109°11'18.1572"E; eventDate: 2020-10-04; individualCount: 5; sex: female; lifeStage: adult; catalogNumber: MZB Cru 5340; recordedBy: Achmad Farajallah; disposition: in collection; identifiedBy: Nisfa Hanim; type: Physical Object; institutionCode: MZB; collectionCode: MZB cru; basisOfRecord: Preserved Specimen

## Description

Body almost cylindrical; frontal margin of carapace tridentate (with three lobes). All three lobes sharply triangular (horny tips), median lobe shorter than lateral lobes, separated by a U-shaped sinus. The U-shaped sinus on each side greater in width than breadth of median lobe at base. Anterior margin carapace sinuated. Dorsal surface of carapace covered with quite prominent transverse rugae, in area between cardiac region and frontal lobes (Fig. 1, Suppl. materials 2, 3). Lateral border of carapace serrulate in its anterior half. The serrulate appearance formed by minutely setose pit. Posterolateral carapace margin rounded.

Eyes with slender, elongated peduncles, length (including cornea) exceeding tip of longest horny spine on second antennal segment (Fig. 2). Antennular flagellum with 27 articles in specimen from Pangandaran and about more than 40 articles in individual from Cilacap. Second antennal segment with three large spines distally, all with horny tips, median spine longest (Fig. 3).

Merus of third maxilliped rectangular, length about 1.63 times as long as greatest width. Outer anterolateral angle of merus of third maxilliped rectangular, and not produced. Antero-internal lobe smooth, distally rounded (Fig. 4).

Dactylus of first pereopod elongated, 1.85 times as long as greatest width, distally with one spine, lower margin with four distinct horny spines, spine on the terminal or apical spine and the last spine is relatively shorter than three others, no spine on upper margin (Fig. 5).

## Diagnosis

Anterior margin of carapace sinuated. Spines in dactyls of first pereopod contain five distinct spines on the inner margin. Spine on terminal or apical spine and the last spine relatively shorter than the three others, with none on the upper margin.

## Etymology

The name of the new species has been taken from the name of the area where the holotype was found.

## Distribution

Pangandaran and Cilacap (south coast of Java, Indonesia)

***Emerita emeritus* (Linnaeus, 1767):** Body almost cylindrical; frontal margin of carapace tridentate (with three lobes). All three lobes sharply triangular (horny tips), median lobe shorter than lateral lobes (Fig. 6). Anterior margin denticulated, almost smooth in some individuals (Suppl. materials 4, 5). Dorsal surface of carapace covered with quite prominent transverse rugae, in area between cardiac region and frontal lobes. Lateral border of carapace serrulate in its anterior half. The serrulate appearance formed by minutely setose pit. Posterolateral carapace margin rounded.

Eyes with slender, elongated peduncles, length (including cornea) exceeding tip of longest horny spine on second antennal segment. Antennular flagellum with 26 articles in specimen from Pangandaran and about 42 articles in individual from Bengkulu. Second antennal segment with three large spines distally, all with horny tips, median spine longest.

Merus of third maxilliped rectangular, length approximately 1.5 times as long as greatest width. Outer anterolateral angle of merus of third maxilliped tooth-like produced. Antero-internal lobe low triangular, but prominent (Fig. 7).

Dactylus of first pereopod elongated, length more than twice its greatest width, but in specimen from Pangandaran, length about 1.8 times as long as greatest width (it could be due to the difference of their measurement or age), distally with one spine, upper margin with 1-2 spines, some times broken or missing, lower margin with 3-4 spines (Fig. 8).

## Analysis

Identification based on the COI gene revealed that the samples were not *Emerita emeritus*. The nucleotide comparison between the samples (*Emerita* sp.) and *Emerita emeritus* showed differences of 97 nucleotides in COI sequences data, which supported them to be different species (Table 2).

The analyzed dataset comprised 15 taxa where *Emerita emeritus* and *Emerita* sp. were our data and the other species retrieved from GenBank (Table 1). The phylogenetic tree demonstrated that the new taxon (*Emerita* sp.) formed a distinct clade. Moreover, this species appeared closely related to *Emerita emeritus* (Fig. 9).

Genetic distances (Kimura 2 parameter) based on COI gene show that *Emerita pangandaranensis* (*Emerita* sp.) having an average distance of 0,153 from *Emerita emeritus* (Suppl. material 1). In the genus *Emerita*, species' genetic distance ranges from 0,141 for COI and 0,058 for 16S rRNA data (Haye et al. 2002).

## Discussion

The discovery of new species or records in a country initiated by DNA barcoding has increased (Ibrahim et al. 2021, Mesias and Weigand 2021). In the Arthropod group, the redescription of the Hemiptera group increased rapidly since the application of DNA barcodes using a universal priming site for that group (Sousa et al. 2021, Ferreira et al. 2021).

This was also the case with our study. The molecular data showed that our species is entirely different with the already reported species, *Emerita emeritus*. The nucleotide variation, the phylogenetic tree and genetic distance all shows the same result. The morphological data also concur with the molecular data.

Based on morphological data, the character that was consistently observed in each individual that could differentiate between *Emerita pangandaranensis* and *Emerita emeritus* was the anterolateral margin of the carapace. In *Emerita pangandaranensis* the anterolateral margin is sinuated, while in *Emerita emeritus* the anterolateral margin of the carapace is almost smooth.

For another several character, such as the spines in dactyls of the first legs, this species is most similar to *E. karachiensis* and *E. holthuisi* that have spines from four up to six on the inner margin of dactyls of the first pereiopod and have no spines on the outer margin. With the merus of the third maxilliped, this species has a close resemblance to *E. holthuisi*, which both have the outer anterolateral angle of the outer margin of the merus of the third maxilliped rectangular and not produced (Table 3). *Emerita holthuisi* originated from India, and *E. karachiensis* from Pakistan.

In both *Emerita emeritus* and *Emerita pangandaranensis*, several characters vary within a species, such as the number of spines on the dactylus of the first pereiopod and the number of septa on the antennula. *Emerita emeritus* originating from Bengkulu has no spine on the outer margin, and there are only two spines on the inner margin (perhaps another spine broken). In contrast, the dactylus on *Emerita Pangandaranensis* from Cilacap has three spines on the inner margin (perhaps another spine broken).

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Figure 1.  
*Emerita pangadaranensis* sp. nov.

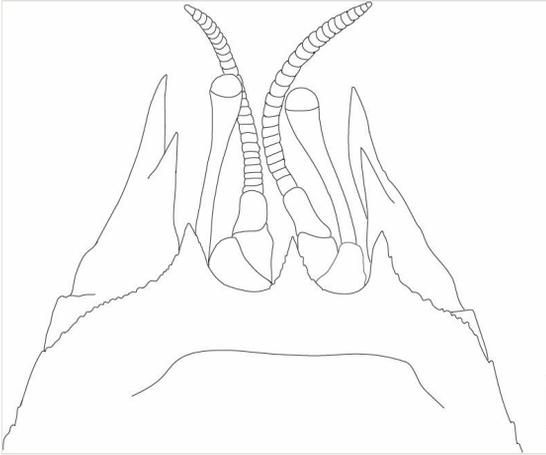


Figure 2.  
*Emerita pangadaranensis*, frontal lobes. Scale of 1 mm

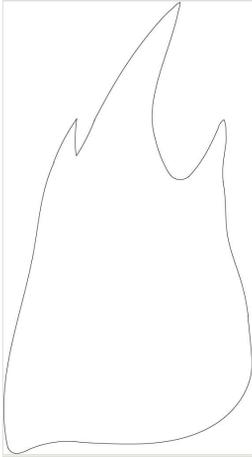


Figure 3.

*Emerita pangadaranensis*, the second antennal segment. Scale of 1 mm.

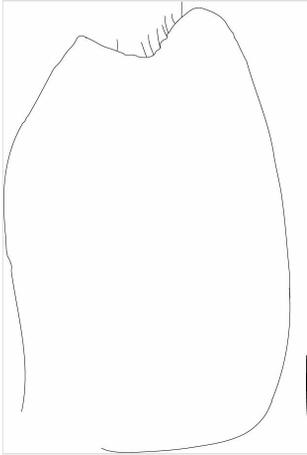


Figure 4.

*Emerita pangadaranensis*, Merus of the third maxilliped. Scale of 1 m.

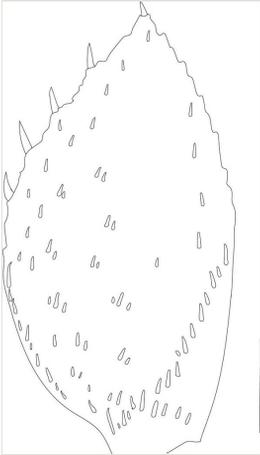


Figure 5.

*Emerita pangadaranensis*, dactylus of first pereopod. Scale of 1 mm.

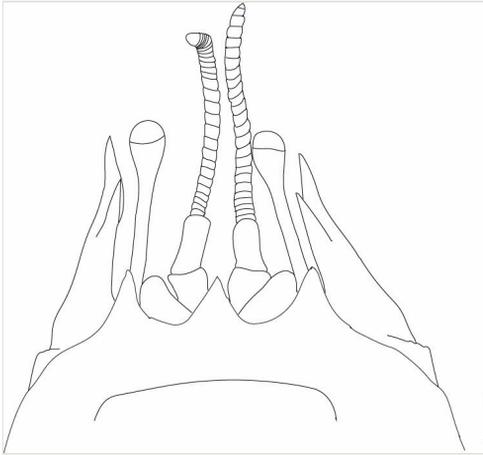


Figure 6.

*Emerita emeritus* (from Pangandaran), frontal lobes. Scale of 1 mm.

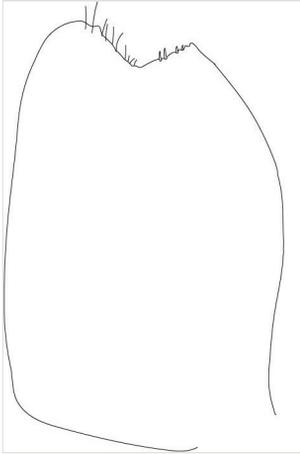


Figure 7.

*Emerita emeritus*, Merus of the third maxilliped. Scale of 1 mm.

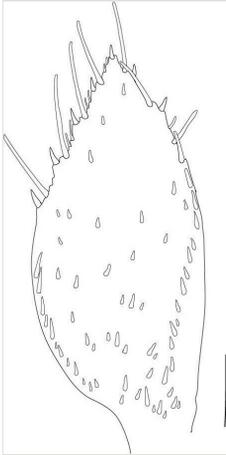


Figure 8.

*Emerita emeritus*, dactylus of first pereiopod. Scale of 1 m.

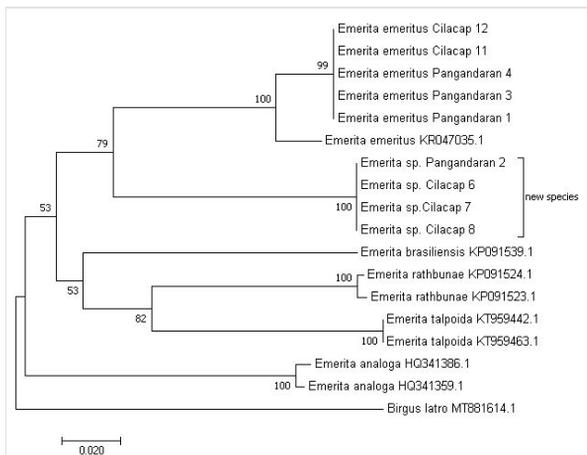


Figure 9.

Phylogenetic tree inferred from a Neighbor Joining analysis, based on a concatenated alignment of the COI sequence data. Nonhippid anomurans were declared as outgroup taxa.

Table 1.

Taxa used in this study and their GenBank accession numbers.

Taxon	Collection Locality	Voucher/Catalog Number	GenBank Accession Number
<i>Emerita emeritus</i> 1	Pangandaran		
<i>Emerita emeritus</i> 3	Pangandaran		
<i>Emerita emeritus</i> 4	Pangandaran		
<i>Emerita emeritus</i> 11	Cilacap		
<i>Emerita emeritus</i> 12	Cilacap		
<i>Emerita emeritus</i>	Bengkulu		KR047035.1
<i>Emerita</i> sp. 6	Cilacap		
<i>Emerita</i> sp. 7	Cilacap		
<i>Emerita</i> sp. 8	Cilacap	MZB Cru 5340	
<i>Emerita</i> sp. P2	Pangandaran	MZB Cru 5338	MZ571198
<i>Emerita rathbunae</i>			KP091524.1
<i>Emerita rathbunae</i>			KP091523.1
<i>Emerita talpoida</i>			KT959442.1
<i>Emerita talpoida</i>			KT959463.1
<i>Emerita analoga</i>			HQ341386.1
<i>Emerita analoga</i>			HQ341359.1
<i>Emerita brasiliensis</i>			KP091539.1
<i>Birgus latro</i>			MT881614.1

Table 2.

The specific base differences between *E. pangandaranensis* and *E. emeritus* in COI. Different base pairs have been marked on specific sites, and the same base is omitted.

Site	1	3	5	6	7	8	13	18	24	39
<i>E. emeritus</i>	A	C	A	A	T	C	T	T	T	T
<i>E. pangandaraensis</i>	G	T	T	T	G	G	C	C	C	C
Site	42	45	54	58	63	87	90	120	129	135
<i>E. emeritus</i>	G	A	C	T	C	A	G	T	T	T
<i>E. pangandaraensis</i>	C	G	A	C	A	T	A	C	C	A
Site	141	144	159	171	186	189	192	195	201	205
<i>E. emeritus</i>	T	C	C	T	C	C	T	C	C	C
<i>E. pangandaraensis</i>	C	T	T	A	T	T	A	T	T	T
Site	210	214	228	231	240	243	246	249	255	261
<i>E. emeritus</i>	A	C	T	T	T	C	C	T	C	A
<i>E. pangandaraensis</i>	C	T	C	A	C	T	T	A	T	G
Site	264	267	271	273	274	276	279	285	291	292
<i>E. emeritus</i>	A	T	C	T	C	A	T	T	C	C
<i>E. pangandaraensis</i>	C	C	T	A	T	G	G	C	T	T
Site	295	309	324	330	339	348	354	366	375	390
<i>E. emeritus</i>	C	G	A	G	G	C	A	C	T	A
<i>E. pangandaraensis</i>	T	A	T	A	A	T	T	T	C	G
Site	393	399	408	411	415	417	420	465	480	486
<i>E. emeritus</i>	C	G	C	T	T	A	G	C	C	C
<i>E. pangandaraensis</i>	T	T	A	A	C	C	A	T	T	T
Site	492	516	522	525	528	540	541	543	547	565
<i>E. emeritus</i>	C	A	C	G	C	C	C	C	T	C
<i>E. pangandaraensis</i>	T	T	T	A	T	T	T	A	C	T

Site	<b>570</b>	<b>582</b>	<b>585</b>	<b>588</b>	<b>594</b>	<b>597</b>	<b>600</b>	<b>603</b>	<b>604</b>	<b>606</b>
<i>E. emeritus</i>	<b>G</b>	<b>T</b>	<b>A</b>	<b>C</b>	<b>C</b>	<b>T</b>	<b>T</b>	<b>C</b>	<b>C</b>	<b>G</b>
<i>E. pangandaraensis</i>	<b>A</b>	<b>G</b>	<b>G</b>	<b>A</b>	<b>T</b>	<b>C</b>	<b>A</b>	<b>T</b>	<b>T</b>	<b>A</b>
Site	<b>609</b>	<b>633</b>	<b>642</b>	<b>648</b>	<b>649</b>	<b>657</b>	<b>660</b>			
<i>E. emeritus</i>	<b>C</b>	<b>A</b>	<b>C</b>	<b>A</b>	<b>C</b>	<b>G</b>	<b>C</b>			
<i>E. pangandaraensis</i>	<b>T</b>	<b>G</b>	<b>T</b>	<b>C</b>	<b>T</b>	<b>A</b>	<b>T</b>			

Table 3.

Morphological differences between *Emerita* spp.

Characters	<i>E. austroafricana</i>	<i>E. taiwanensis</i>	<i>E. karachiensis</i>	<i>E. holthuisi</i>	<i>E. emeritus</i>	<i>E. pangandaranensis</i> sp. nov
References	Schmitt 1937	Hsueh 2015	Niazi and Haqub 1974	Sankolli 1962	This study	This study
Spines in dactylus of first legs	Two spines on the upper or outer margin and four on the inner or lower margin	One to three spines on the inner margin. No spine on the upper margin	Five to nine but usually 6 distinct spines on the lower margin	Generally four distinct spines on the inner or lower margin. No spine on the upper margin	Generally four spines in the lower margin, and two spines are placed on the upper margin, near the tip.	Five distinct spines on the inner margin. No spine on the upper margin
Dactyls of first legs	Length less than twice its greatest width and, not counting the terminal or apical tooth or spine	Length 2.78 times as long as greatest width, distally subacute with one spine	Length is more than double of its breadth and usually terminates in a distal spine	Length is more than twice its width and terminates in a spine distally.	Length more than twice its greatest width. It terminates in a spine	The dactylus is more length than width, 1.85 times as long as the greatest width. It terminates in a spine.
Three of frontal lobes	In shape, acuteness, and relative length the three projections of the front are much like those of <i>E. emeritus</i> (L.)	Approximately equal in length. They separated on either side by a U-shaped sinus, median lobe sharply triangular, distally acute, lateral lobes subacute	The median lobe is less acute, blunt, and triangulate, separated on either side by a U-shaped sinus from the submedian teeth.	Lobes are relatively short and wide. The median lobe is triangular and sub-acute and is separated from the lateral lobes by a distance greater than its own breadth at the base	Lobes sharply triangular, the median lobe is shorter than the lateral lobes, and it separated with lateral lobes by a distance much greater than its own breadth separated at the base	Lobes sharply triangular (horny tips), the median lobe is shorter than the lateral lobes, separated on either side by a U-shaped sinus

Merus of the third maxilliped	The lobe at the Antero-inner angle of the large and operculiform joint of the third or outer maxilliped is low-triangular, broad at the base, and distally rounded	Length approximately 1.8 times as long as greatest width Anterolateral angle of outer margin rectangular, not produced, antero-internal lobe high, triangular, distally rounded	The outer anterolateral angle possesses a produced tooth-like horny tip, which is sometimes broken or missing. The antero-internal lobe is blunt, rounded distally, having developed and raised triangle	The outer anterolateral angle of the external margin is rectangular and not produced; the antero-internal lobe is low triangular, distally rounded, and little prominent	The outer anterolateral angle is tooth-like produced with a horny tip, which is sometimes broken or missing; the antero-internal lobe is low triangular but prominent	Maximum length to maximum width ratio about 1.63. The outer anterolateral is rectangular, not produced. The antero-internal lobe is blunt, distally rounded, and prominent
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## Supplementary materials

### Suppl. material 1: Genetic distances (Kimura 2 parameter) for COI sequences of *Emerita* spp.

**Authors:** Nisfa Hanim, Achmad Farajallah, Vinna Windy Putri, Yusli Wardiatno, Dyah Perwitasari, Ali Suman

**Data type:** phylogenetic

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### Suppl. material 2: *Emerita pangandaranensis* (Holotype), frontal lobes

**Authors:** Nisfa Hanim, Achmad Farajallah, Vinna Windy Putri, Yusli Wardiatno, Dyah Perwitasari, Ali Suman

**Data type:** Morphology

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### Suppl. material 3: *Emerita pangandaranensis* (Paratype, Cilacap), frontal lobes

**Authors:** Nisfa Hanim, Achmad Farajallah, Vinna Windy Putri, Yusli Wardiatno, Dyah Perwitasari, Ali Suman

**Data type:** morphological

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### Suppl. material 4: *Emerita emeritus* from Pangandaran, frontal lobes

**Authors:** Nisfa Hanim, Achmad Farajallah, Vinna Windy Putri, Yusli Wardiatno, Dyah Perwitasari, Ali Suman

**Data type:** morphological

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### Suppl. material 5: *Emerita emeritus* from Bengkulu, frontal lobes

**Authors:** Nisfa Hanim, Achmad Farajallah, Vinna Windy Putri, Yusli Wardiatno, Dyah Perwitasari, Ali Suman

**Data type:** morphological

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