A preliminary biodiversity survey of mudflats around Pulau Ubin, Singapore revealed 20 amphipod species in 16 genera from 12 families and two suborders. A checklist of the amphipods of Pulau Ubin mudflats is provided. Distribution of each species in the South China Sea is discussed. This study reports new locality records for 17 species, with only three of the collected species having been previously reported from Singapore. Four species collected during this survey have not been previously reported from the South China Sea.

Key words. Amphipoda, Pulau Ubin, checklist, biodiversity, South China Sea, Singapore

INTRODUCTION

Marine biodiversity studies around Singapore are lacking. Most of what is known of amphipods inhabiting this area is reported in scattered literature from adjacent areas. Lowry (2000) created a checklist of the Amphipoda recorded from the South China Sea (153 spp.), but noted that most reports are from Hong Kong, Vietnam, and the Philippines. Singapore’s location in the highly diverse Indo-Pacific region suggests that it should have high diversity, yet few studies have focused on this area. As part of the Biodiversity initiative of the National University of Singapore, amphipods were examined during a preliminary survey of mudflat habitats around Pulau Ubin. Amphipods collected from Pulau Ubin belong to two suborders: Gammaridea Latreille, 1802 and Senticaudata Lowry & Myers, 2013.

MATERIAL AND METHODS

Specimens were collected around Pulau Ubin by hand, mud combing, dredges, seines, otter trawls, and shrimp traps. Stations that yielded amphipods are listed in Table 1 and mapped in Fig. 1. In the laboratory, specimens were sorted, photographed, and preserved in 2% saltwater buffered formalin or in 70% ethanol. Identification of amphipods to family level was done using the Amphipoda Family Key (Lowry, 1999). Identification to genus and species level was done using literature based on adjacent areas in the Indo-Pacific region.

CHECKLIST

AMPHIPODA FROM PULAU UBIN MUDFLATS

(Listed alphabetically by family. Numbers in parentheses represent number of specimens collected.)

GAMMARIDEA

Ampeliscidae (1 genus, 3 species)
Ampelisca bocki Dahl, 1944
CMBS-M02 (1), CMBS-M24 (4), CMBS-D07 (1)
Ampelisca chinensis Imbach, 1967
CMBS-D06 (1), CMBS-D07 (1)
Ampelisca cyclops iyoensis Imbach, 1967
CMBS-D23 (1)

Leucothoidae (1 genus, 1 species)
Leucothoe cf furina Savigny, 1816
CMBS-D07 (1), CMBS-H17 (1)

Lysianassidae (1 genus, 1 species)
Waldeckia nudum (Imbach, 1967)
CMBS-D15 (1)

Stenothoidae (1 genus, 1 species)
Stenothoe gallensis Walker, 1904
CMBS-D07 (1)

SENTICAUDATA

Ampithoidae (1 genus, 1 species)
Cymadusa vadosa Imbach, 1967
CMBS-M13 (1), CMBS-S16 (1), CMBS-H17 (1)
Table 1. Samples that yielded amphipods

<table>
<thead>
<tr>
<th>Station</th>
<th>Date</th>
<th>Location</th>
<th>Sampling Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMBS-M02</td>
<td>6 March 2012</td>
<td>Sungei Puaka</td>
<td>Mud Combing</td>
</tr>
<tr>
<td>CMBS-D06</td>
<td>6 March 2012</td>
<td>Between Ubin and Tekong</td>
<td>Dredge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Between mouth of Sungei Maman to Kelong</td>
<td></td>
</tr>
<tr>
<td>CMBS-D07</td>
<td>6 March 2012</td>
<td>FC72E</td>
<td>Hand dredge</td>
</tr>
<tr>
<td>CMBS-D10</td>
<td>7 March 2012</td>
<td>Ketam Deep</td>
<td>Dredge</td>
</tr>
<tr>
<td>CMBS-M13</td>
<td>7 March 2012</td>
<td>Outward Bound Singapore</td>
<td>Mud Combing</td>
</tr>
<tr>
<td>CMBS-D15</td>
<td>7 March 2012</td>
<td>Sekudu/Malang Papan beacon</td>
<td>Dredge</td>
</tr>
<tr>
<td>CMBS-S16</td>
<td>7 March 2012</td>
<td>Chek Jawa</td>
<td>Seining</td>
</tr>
<tr>
<td>CMBS-H17</td>
<td>7 March 2012</td>
<td>Chek Jawa</td>
<td>Beach combing / hand collection</td>
</tr>
<tr>
<td>CMBS-N19</td>
<td>8 March 2012</td>
<td>Sungei Puaka</td>
<td>Shrimp trap, left overnight</td>
</tr>
<tr>
<td>CMBS-T20</td>
<td>8 March 2012</td>
<td>Ketam Channel</td>
<td>Otter trawl</td>
</tr>
<tr>
<td>CMBS-D23</td>
<td>8 March 2012</td>
<td>North of Outward Bound Singapore</td>
<td>Dredge</td>
</tr>
</tbody>
</table>
Aoridae (2 genera, 2 species)
Bemlos sp.
CMBS-D07 (1)
Lembos sp.
CMBS-D06 (1)

Caprellidae (1 genus, 1 species)
Caprella equilibra Say, 1818
CMBS-D06 (1), CMBS-D07 (2)

Corophiidae (1 genus, 1 species)
Cheiriphotis megacheles (Giles, 1885)
CMBS-D23 (2)

Ischyroceridae (2 genera, 2 species)
Cerapus sp.
CMBS-D10 (~25)
Ericthonius pugnax (Dana, 1853)
CMBS-T20 (6)

Maeridae (2 genera, 3 species)
Ceradocus hawaiensis Barnard, 1955
CMBS-D07 (1)
Ceradocus laevis Olerod, 1970
CMBS-S16 (1)
Meximaera sp.
CMBS-H17 (12)

Melitidae (2 genera, 2 species)
Melita koreana Stephenson, 1944
CMBS-M02 (1)
Dulichiella pacifica Lowry & Springthorpe, 2005
CMBS-T20 (16)

Podoceridae (1 genus, 2 species)
Podocerus sandroruffoi Ortiz & Lalana, 2003
CMBS-H17 (~30)
Podocerus sp.
CMBS-S16 (11), CMBS-T20 (27), CMBS-N19 (2)

DISCUSSION
The preliminary biodiversity survey at Pulau Ubin revealed 20 amphipod species in 16 genera from 12 families. This survey greatly increased the number of amphipods known from Singapore. Two species of Aoridae, one species of Ischyroceridae, one species of Maeridae, and one species of Podoceridae were only identified to genus level due to the lack of literature available from the area. These may represent new species, but further research is necessary to determine this.

With the exception of four species (Cerapus sp., Meximaera sp., Podocerus sandroruffoi, and Podocerus sp.), all species collected during this survey have been previously reported from the South China Sea. Cerapus sp. was collected in large numbers with tubes and resembles Cerapus tubularis Say, 1817. Cerapus tubularis has been previously reported from Japan by Morino (1976) and Hirayama (1995). However, the type locality for this species is Long Island Sound, New York, U.S.A, suggesting that if these specimens represent C. tubularis, this species is introduced to Singapore. Meximaera sp. is most likely a new species. This genus has typically been reported from the Atlantic and eastern Pacific oceans, although it is not unlikely that the genus is more widespread than is currently known. Podocerus sandroruffoi has been previously reported from Indonesia (Ortiz & Lalana, 2003). Podocerus sp. closely resembles Podocerus inconspicuus (Stebbing, 1888), although Hughes (2012) considered this species to be confined to south-eastern Australia. This suggests that the specimens collected here represent a new closely related species or an introduced species to Singapore.

Waldeckia nudum, Caprella equilibra, and Dulichiella pacifica are the only species collected here that have been previously reported from Singapore (Arimoto, 1976; Lowry, 2000; Lowry & Springthorpe, 2007). Leucthoe furina, Stenothoe gallensis, Cymadusa vadosa, and Ericthonius pugnax have been reported from Malaysia (Azman & Othman, 2013), while the other species have been reported from Vietnam, Hong Kong, and the Philippines (Imbach, 1967; Huang, 1994; Lowry, 2000).

Ampeliscid amphipods are common soft bottom inhabitants worldwide, yet only three species were collected here (A. bocki, A. chinensis, and A. cyclops). Leucothoe furina is a circumtropical species that is typically an endocommensal associate of sponges, but is often collected individually in dredge samples. Epimeron 3 in the Pulau Ubin specimens does not match the illustrations in the literature for L. furina, but all other characters match well, so for now it is considered L. cf. furina.

Amphitoid and aorid amphipods are common algal inhabitants. Among these, Bemlos sp. and Lembos sp. were collected via dredge in this survey. These genera are widespread, but the species have yet to be determined. Caprella equilibra is nearly cosmopolitan, reported worldwide. Takeuchi & Sawamoto (1998) reported the Pacific distribution of this species to be limited to temperate regions based on planktonic material. However, according to Arimoto (1976), this species has been reported from Hawaii, Philippine Islands, Malaysia and Singapore (Arimoto, 1976).

All together, this survey has yielded 17 species with new locality records in Singapore and four species newly reported in the South China Sea. Future biodiversity surveys around Singapore will undoubtedly reveal a much higher diversity of Amphipoda than is currently known.
ACKNOWLEDGEMENTS

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