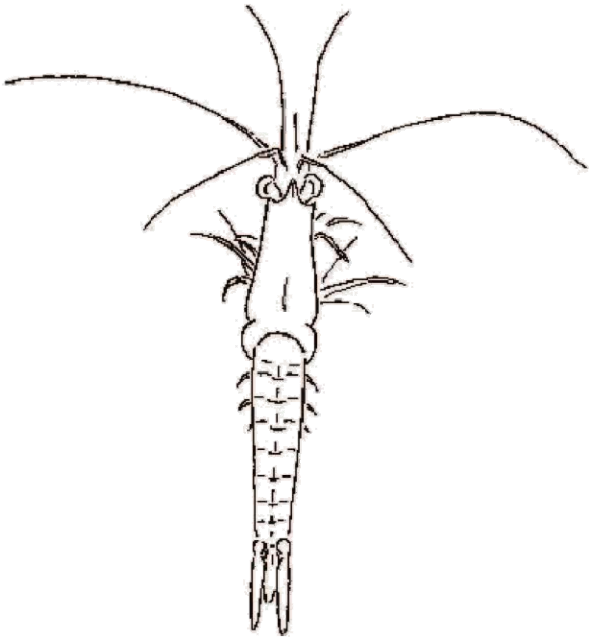
A KEY TO THE MYSIDACEA OF THE UPPER SAN FRANCISCO ESTUARY



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INTRODUCTION

Mysidaceans, otherwise know as opossum shrimp, are an important component of coastal and oceanic ecosystems, as well as in lakes around the world (Tattersall 1951). Some species, however, are restricted to cave systems (Bowman 1977). Regarded as an important food source for trout, mysids have been introduced into many large lakes in North America and Europe to provide fish forage. In spite of their importance, mysids tend to be poorly studied because of the sampling difficulties presented by their epibenthic daytime distribution. Fortunately, they enter the water column during low light levels and at night, and become more vulnerable to capture. Another potential difficulty is that the different mysid species are not easily distinguishable. To facilitate correct identification, this key to mysids in the upper San Francisco Estuary documents the criteria for identification used by the California Department of Fish and Game (CDFG) Zooplankton Project.

Nine species of mysid shrimp have been reported in the San Francisco Estuary, but only 7 have been collected by the CDFG's Zooplankton Project. Six native species have been identified from the estuary and include: *Neomysis mercedis* (Holmes 1897); *N. kadiakensis* (Ortman 1908); *N. costata* (Holmes 1900) (now *Holmsimysis costata* [Holmquist 1979]); *N. macropsis* (Tattersall 1932) (now *Alienacanthomysis macropsis* [Holmquist 1981]); *Deltamysis holmquistae* (Bowman and Orsi 1992); and *N. rayi* (Murdoch 1885). *N. rayi* is a large coastal marine species that may only occasionally enter San Francisco Bay and has never been taken by the CDFG Zooplankton Project. *Deltamysis holmquistae* is extremely rare and has not been found anywhere else in the world since its discovery in the upper San Francisco Estuary in 1976 (Bowman and Orsi 1992): only a few specimens are taken each year. Two Chinese species, *Acanthomysis bowmani* (Modlin and Orsi 1997) and *A. aspera* (Ii 1964), were introduced in 1992 (Modlin and Orsi 1997), and a Korean species, *Acanthomysis hwanhaiensis* (Ii 1964), was found in a 1998 pilot study of San Francisco Bay (Modlin and Orsi 2000). The Zooplankton Project identifies and counts only seven of the species: *N. mercedis*, *N. kadiakensis*, *A. macropsis*, *D. holmquistae*, *A. bowmani*, *A. aspera*, and *A. hwanhaiensis*.

Recent information indicates a 10th mysid species inhabits the San Francisco Estuary. Mysids identified as *Neomysis kadiakensis*, taken in and upstream from San Pablo Bay, may actually be *Neomysis japonica*, an introduced species (John Chapman 2004, personal communication). These two species are very difficult to distinguish morphometrically, but differ in salinity requirement: *N. kadiakensis* is a marine species and *N. japonica* a fresh to brackish water species.

Released from their brood pouch at about 2-millimeters (mm) total length, mysid young grow to a maximum length of about 19 mm in the San Francisco Estuary, although few individuals of the larger species surpass 17 mm. The larval stages are passed in the brood pouch and the newly released young, or neonates, resemble the adults, simplifying their identification. However, juveniles shorter than 5 mm may not be well distinguished by this key because their features sometimes differ slightly from the adults.

The mysid community of the San Francisco Estuary will likely evolve beyond the current scope of this key. Presently, 3 of the 7 species described were introduced (4 of 8 including *N. japonica*) and more introductions are possible in the future. For this reason, any adult mysid(s) with eyes/eyestalks, rostrums, and/or telsons that do not match those shown in the plates should be considered suspect and retained for positive identification.

This report (key) documents the CDFG Zooplankton Project's mysid identification criteria, which have undergone outside review (see Acknowledgements on page 12). It includes only the seven species collected by the Project as of 2005; *Neomysis kadiakensis* and *N. japonica* are herein treated as one due to the current lack of definitive morphometric characters to distinguish between them. The key focuses on

variations in eyestalks, eyes, rostrum, and telson to determine the correct species identification. Enhanced photographs of these body parts (composites from different focal distances) from each species provide clear views of distinguishing features and complement descriptions in the key.

METHODS

The specimens used to develop this key were taken from the CDFG's Zooplankton Project monitoring samples. These samples were collected in a 0.505-mm mesh plankton net (1.48 meters long and a 29-centimeter mouth diameter) affixed to a ski-mounted frame, which allowed the targeting of mysids close to the bottom during daytime sampling. Year-round sampling currently takes place on a monthly basis at fixed stations in the upper San Francisco Estuary. These stations are located from San Pablo Bay, through Suisun Bay and Marsh, and upstream to the eastern edge of the Sacramento San Joaquin Delta. See Knutson and Orsi (1983) for a more detailed description of the methods used.

To help narrow down and support species identification, current information is provided on each species' salinity range, the most commonly occupied salinities, and the peak abundance period. The species' salinity information was calculated from bottom electro-conductivity measurements taken during monitoring surveys from 1996 to 2003. During this period, and in general, bottom salinities measured within the project sampling area only rarely exceeded 29 practical salinity units (psu), which is lower than adjacent marine waters. Thus, salinity ranges provided probably underestimate those of species commonly found in marine waters. The most commonly occupied salinities are defined as those where the species' abundance was higher than its mean abundance across all salinities where it was collected.

KEY TO SPECIES AND DEFINITION OF TERMS

Cornea - the eye, the pigmented region at the distal end of the eyestalk.

Eyestalk - the movable appendage attached to the anterior end of the head with the eye at its distal end.

- Eyestalk width - the width at the mid-point of the eyestalk (i.e., midway between edge of the head and the distal edge of the cornea).
- Eyestalk length - the length from the head to the distal edge of the cornea.

Rostrum - beaklike protrusion.

Keel on rostrum - a ridge running along the ventral side of the rostrum of some mysids.

Uropods - the last pair of abdominal appendages.

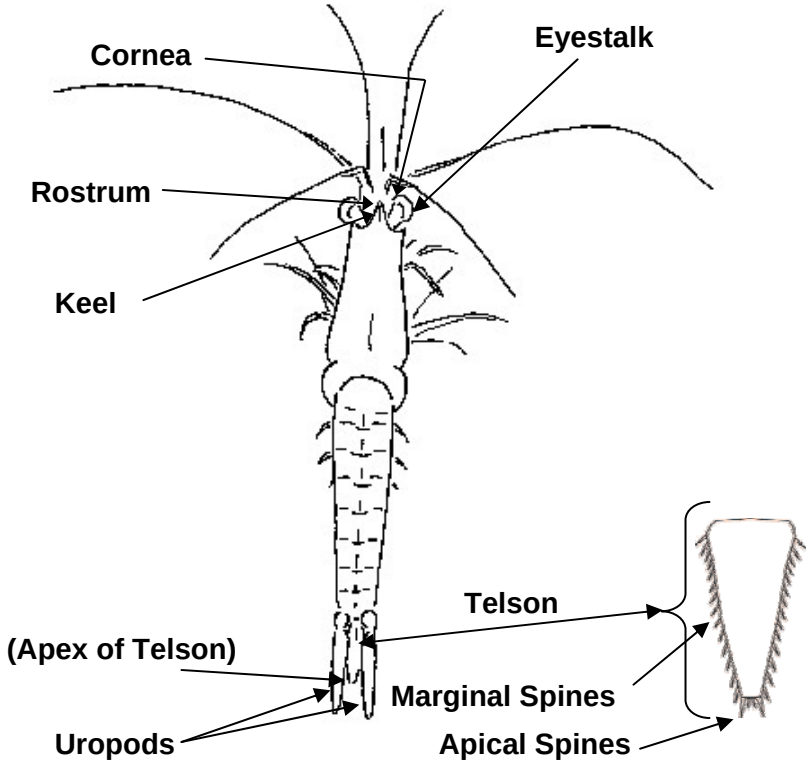
Telson - the flat appendage attached to the posterior end of the body and flanked by the uropods.

- Telson width – the width at the widest point of the base of the telson.
- Telson length – the length along the longitudinal axis from the posterior edge of the abdomen to the distal-most point of the telson not including the spines.

Marginal Spines - spines along the lateral margins of the telson not oriented parallel to the longitudinal axis.

Apical Spines - the spines at the posterior end of the telson oriented parallel to the longitudinal axis

- Inner apical spines: the two apical spines adjacent the longitudinal axis.
- Outer apical spines: the two apical spines closest to the marginal spines.



KEY TO SPECIES

1a Eyestalks, length greater than 4 times width.....*Alienacanthomysis macropsis (Page 5)*

1b Eyestalks, length less than 4 times width..... 2

2a Eyestalks, length 1.9–3 times width 6

2b Eyestalks, length less than 1.9 times width,..... 3

3a Telson broad, length approximately 1.2–1.3 times width..... *Deltamysis holmquistae (Page 6)*

3b Telson narrow, length greater than 1.3 times width..... 4

4a Corneas kidney-shaped in dorsal view..... *Acanthomysis hwanhaiensis (Page 7)*

4b Corneas not kidney-shaped 5

5a Telson, marginal spines adjacent to the apical spines approximately half as long as apical spines.....*A. aspera (Page 8)*

5b Telson, marginal spines adjacent to the apical spines less than 0.4 times as long as apical spines.....*A. bowmani (Page 9)*

6a Telson, inner apical spines less than 0.4 times the length of outer apical spines with marginal spines few and widely spaced.....*Neomysis mercedis (Page 10)*

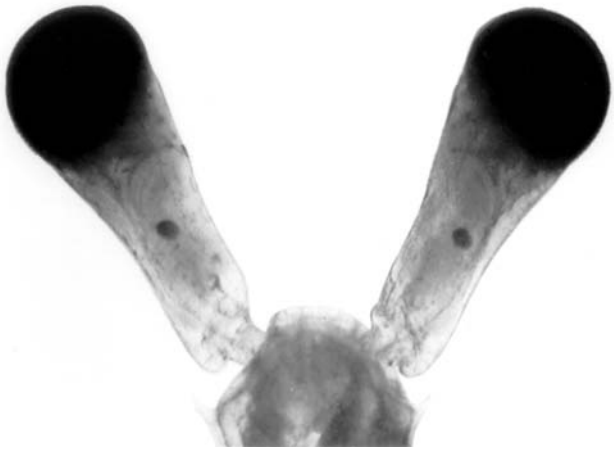
6b Telson, length of inner apical spines approximately half the length of outer apical spines with marginal spines numerous and closely spaced..... *Neomysis kadiakensis/japonica*[*] *(Page 11)*

[*] *Note: Recent information indicates that mysids identified as Neomysis kadiakensis taken in, and upstream from, San Pablo Bay may actually be Neomysis japonica, an introduced species. These species are currently indistinguishable morphometrically*

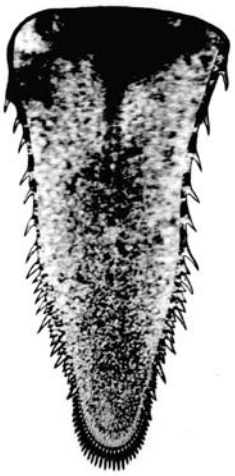
Plate 1. Dorsal View of *Alienacanthomysis macropsis*

Origin: Native
Salinity range: 6–30 psu (EC 10 - 47 mS/cm)
Most abundant between: 10–30 psu (EC 17–47 mS/cm)
Peak abundance months: December–March
Length from base of eyestalks to base of telson: to 13 mm

a. Eyes and Rostrum



b. Telson



Distinguishing characteristics:

Rostrum: Rounded and very short in dorsal view. Keel present (not shown in dorsal view).

Eyestalks: Greater than 4 times as long as wide. Cornea at apex.

Telson: Apex rounded, length approximately 1.9–2.1 times width at base, many apical spines that are shorter than the marginal spines. Marginal spines vary in length and are more robust than the apical spines.

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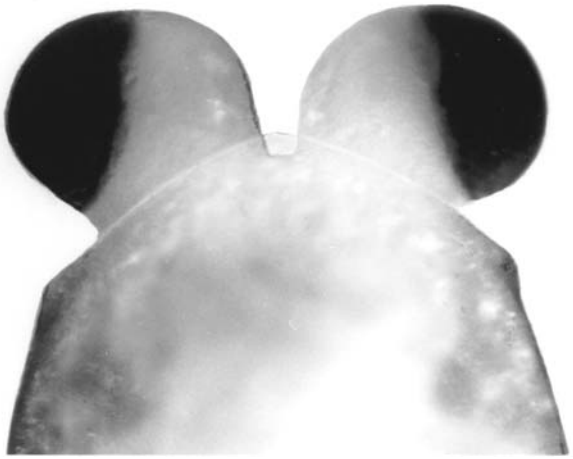
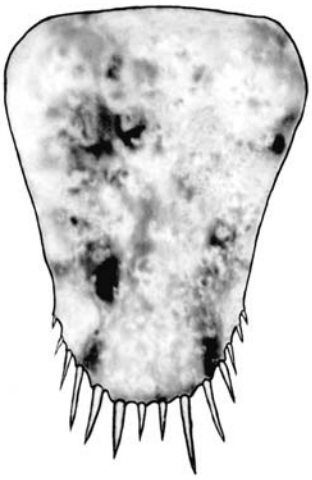
Plate 2. Dorsal View of *Deltamysis holmquistae*

Origin: Cryptic; described from DFG samples
Salinity range: Fresh water - 6 (EC 0.1–10 mS/cm)
Most abundant between: Very rare so salinity and abundance months are tentative
Peak abundance months: December–January
Length from base of eyestalks to base of telson: to 6 mm

a. Eyes and Rostrum



b. Telson



Distinguishing characteristics:

Rostrum: Slightly pointed in dorsal view. Ventral keel absent.
Eyestalks: 1.1 times as long as wide. Cornea is located more on the lateral margin than on the apex.
Telson: Apex broadly truncate, length 1.2–1.3 times width at base, width at base approximately 1.5–1.6 times width at apex; 2 long subapical spine pairs, and 1 apical spine pair less than half the length of the subapical spines.

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Plate 3. Dorsal View of *Acanthomysis hwanhaiensis*

Origin: Korea
Salinity range: 9–28 psu (EC 15–44 mS/cm)
Most abundant between: 20–28 psu (EC 32–44 mS/cm)
Peak abundance months: April–May
Length from base of eyestalks to base of telson: to 12 mm

a. Eyes and Rostrum

b. Telson

Distinguishing characteristics:

Rostrum: Rounded. Ventral keel present (not shown in dorsal view).
Eyestalks: 1.4–1.7 times as long as wide. Cornea at apex, kidney shaped.
Telson: Apex rounded, length approximately 2.4–2.5 times width at base, width at base approximately 6 times width at apex; 4 apical spines, outer 2 shorter than inner 2. Marginal spines vary in length.

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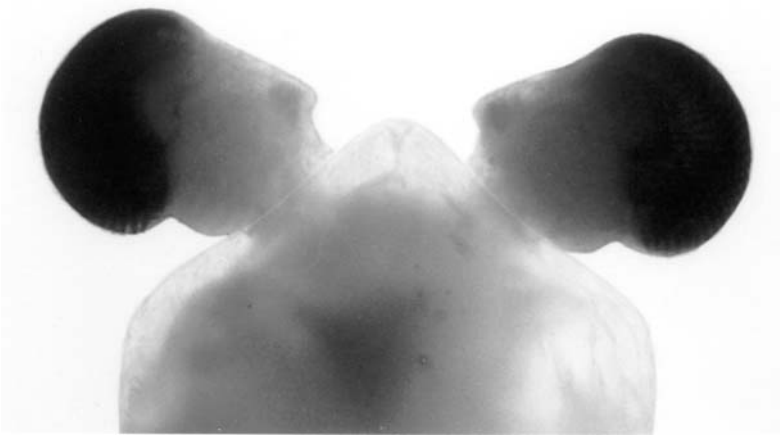
Plate 4. Dorsal View of *Acanthomysis aspera*

Origin: Japan
Salinity range: Fresh water - 30 psu (EC 0.5–47 mS/cm)
Most abundant between: 20–28 psu (EC 29–43 mS/cm)
Peak abundance months: November–December
Length from base of eyestalks to base of telson: to 11 mm

a. Eyes and Rostrum



b. Telson

Distinguishing characteristics:

Rostrum: Pointed, but not sharply so. Ventral keel present (not distinct in dorsal view).
Eyestalks: 1.4–1.8 times as long as wide. Cornea at apex.
Telson: Apex broadly truncate, length 2.1–2.2 times width at base, width at base approximately 4 times as long as width at apex; 4 apical spines about equal in length and approximately 2 times the length of the marginal spines.

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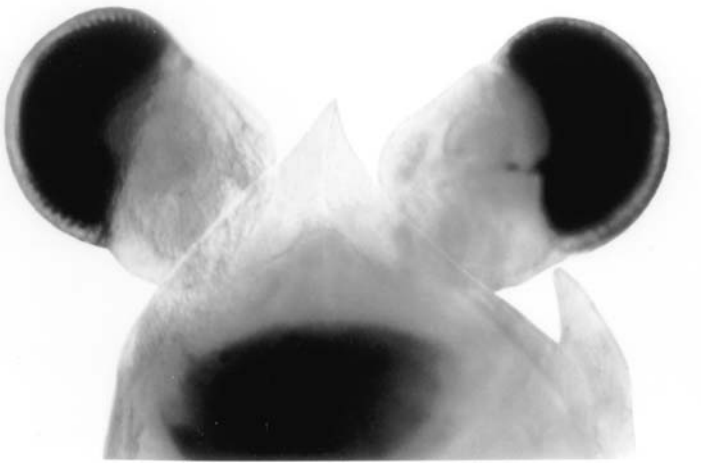
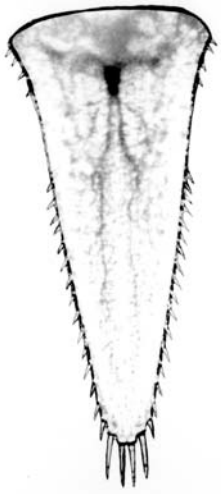
Plate 5. Dorsal View of *Acanthomysis bowmani*

Origin: probably China
Salinity range: Fresh water - 28 psu (EC 0.5–44 mS/cm)
Most abundant between: 0.6–10 psu (EC 1–17 mS/cm)
Peak abundance months: May–August
Length from base of eyestalks to base of telson: to 13 mm

a. Eyes and Rostrum



b. Telson



Distinguishing characteristics:

Rostrum: Sharply pointed. Ventral keel present (not distinct in dorsal view).
Eyestalks: 1.4–1.6 times as long as wide. Cornea at apex.
Telson: Apex narrowly truncate with length approximately 2.2 times width at base, width at base 10–11 times as wide as width at apex; 4 apical spines approximately equal in length.

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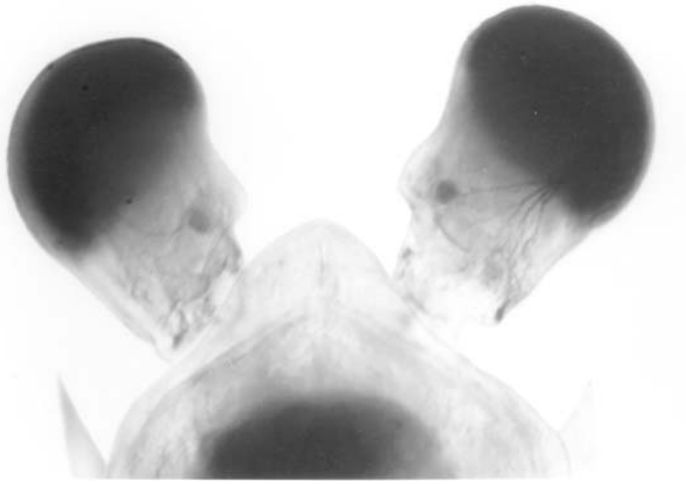
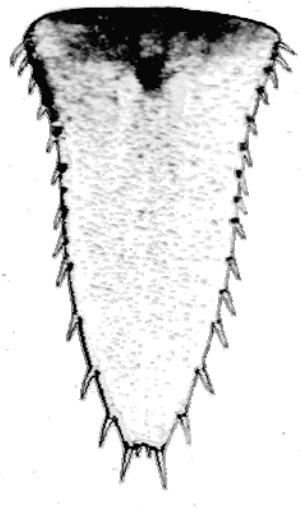
Plate 6. Dorsal View of *Neomysis mercedis*

Origin: Native
Salinity range: Fresh water - 26 psu (EC 0.1–41 mS/cm)
Most abundant between: 0.6–9.0 psu (EC 1–15 mS/cm)
Peak abundance months: April–June
Length from base of eyestalks to base of telson: to 17 mm

a. Eyes and Rostrum



b. Telson



Distinguishing characteristics:

Rostrum: Rounded. Ventral keel present (not distinct in dorsal view).
Eyestalks: 1.8–2.2 times as long as wide. Cornea at apex.
Telson: Apex moderately truncate, length approximately 1.7–1.9 times width at base. Four apical spines, inner 2 spines 0.2–0.3 times as long as the outer 2. Marginal spines long, nearly equal to length of the outer apical spines.

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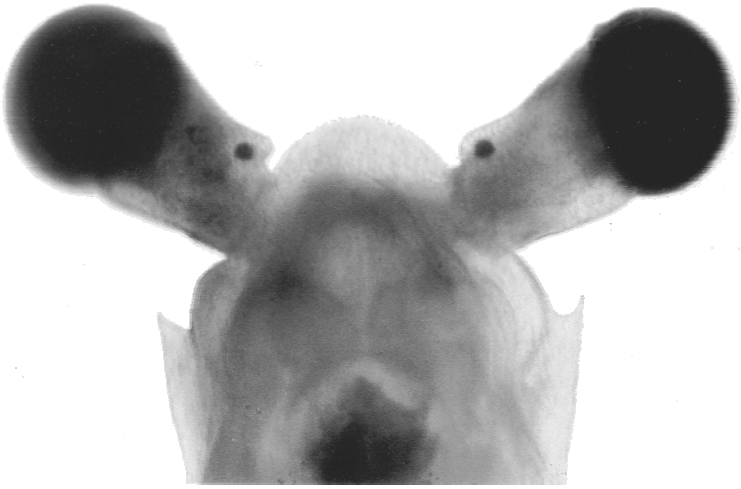
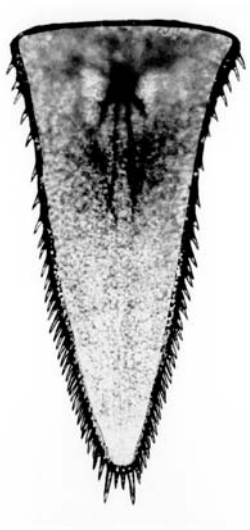
Plate 7. Dorsal View of *Neomysis kadiakensis*

Origin: Native
Salinity range: fresh water - 28 psu (EC 0.5–44 mS/cm)
Most abundant between: 5–23 psu (EC 9–37 mS/cm)
Peak abundance months: March–June and October–November
Length from base of eyestalks to base of telson: to 17 mm

a. Eyes and Rostrum



b. Telson



Distinguishing characteristics:

Rostrum: Rounded. Keel absent.
Eyestalks: 2.1–2.3 times as long as wide. Cornea at apex.
Telson: Apex narrowly truncate, length approximately 1.9–2.0 times width at base. Four apical spines, inner 2 spines about half as long as the outer 2. Marginal spines short, less than half the length of the outer apical spines.

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ACKNOWLEDGEMENTS

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PERSONAL COMMUNICATIONS

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