

The Redescription of *Mormonilla phasma* Giesbrecht, 1891 (Copepoda: Mormonilloida) from the Northeastern Pacific

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Abstract – *Mormonilla phasma* is redescribed, based on the specimens from the Northeastern Pacific. *M. phasma* in the study area has the following morphological characteristics; second endopodal segment of mandible partly fused to basis and a distinct three-segmented exopod of mandible in anterior view and one indistinct segment in posterior view which are different from the description given by Boxshall (1979). In addition the first and the second endopodal segments of leg 1 were also separated indistinctly. Other morphological characteristics are similar to those reported in previous studies. The morphological anomalies in endopodal segments of the leg 1, unknown up to now are also discussed. This study is the first report on the distribution of *M. phasma* in the Northeastern Pacific.

Key words : Copepoda, Mormonilloida, *Mormonilla*, redescription, Northeastern Pacific

INTRODUCTION

The order Mormonilloida of the Giesbrechtian family Mormonillidae was established by Boxshall (1979) for the first time. There are only two *Mormonilla* species, *M. phasma* Giesbrecht and *M. minor* Giesbrecht in the order (Boxshall 1979, 1986; Boxshall and Halsey 2004). Boxshall (1985) described the skeletomusculature and external morphology of the feeding apparatus of adult females of *Mormonilla*. Males of *Mormonilla* were described in detail separately by Huys *et al.* (1992).

These species are widely distributed at a depth range of 400~4,000 m in the world's oceans such as the Arabian Sea, the Eastern Indian Ocean, the Gulf of Aden, the southern most parts of the Red Sea, the Western Pacific and the Antarctic Ocean (Beckmann 1984; Huys *et al.* 1992; Razouls 1994; Chihara and Murano 1997). However, the spe-

cies of *Mormonilla* was not reported in the northeastern Pacific. This study provides a description of *M. phasma* based on the newly sampled specimens in the northeastern Pacific.

MATERIALS AND METHODS

KORDI (Korea Ocean Research and Development Institute), carried out a marine scientific research cruise in the Northeastern Pacific in 2005 with an aim of collecting marine environmental factors. Zooplankton were collected during the cruise to understand their distribution characteristics. Specimens of *Mormonilla* were collected at a depth of 155 to 4,000 m at a station (10° 30'N, 131° 20'W) on 24 July 2005 by vertical hauling of an opening-closing net with a mesh size of 300 µm. The specimens were fixed in 4% formalin immediately after collection and were sorted out under a dissecting microscope (Zeiss Stemi 2000-C). The sorted specimens dissected with tungsten needles and mounted in lactophenol. All drawings were prepared using

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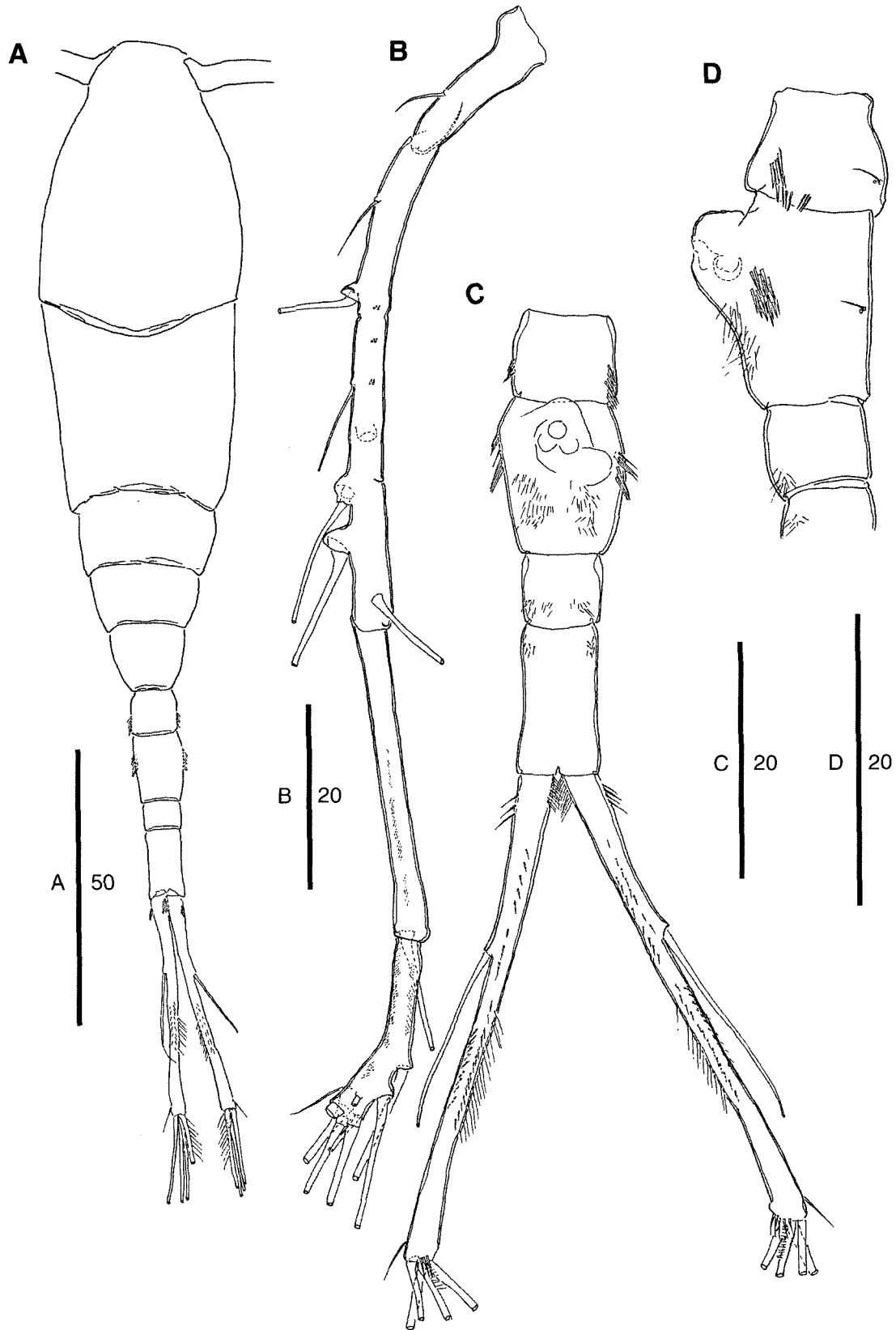


Fig. 1. *Mormonilla phasma*, female. A. habitus, dorsal view; B. antennule; C. urosome, lateral view; D. genital double somite and first urosome somite, lateral view (Scale bar unit: μm).

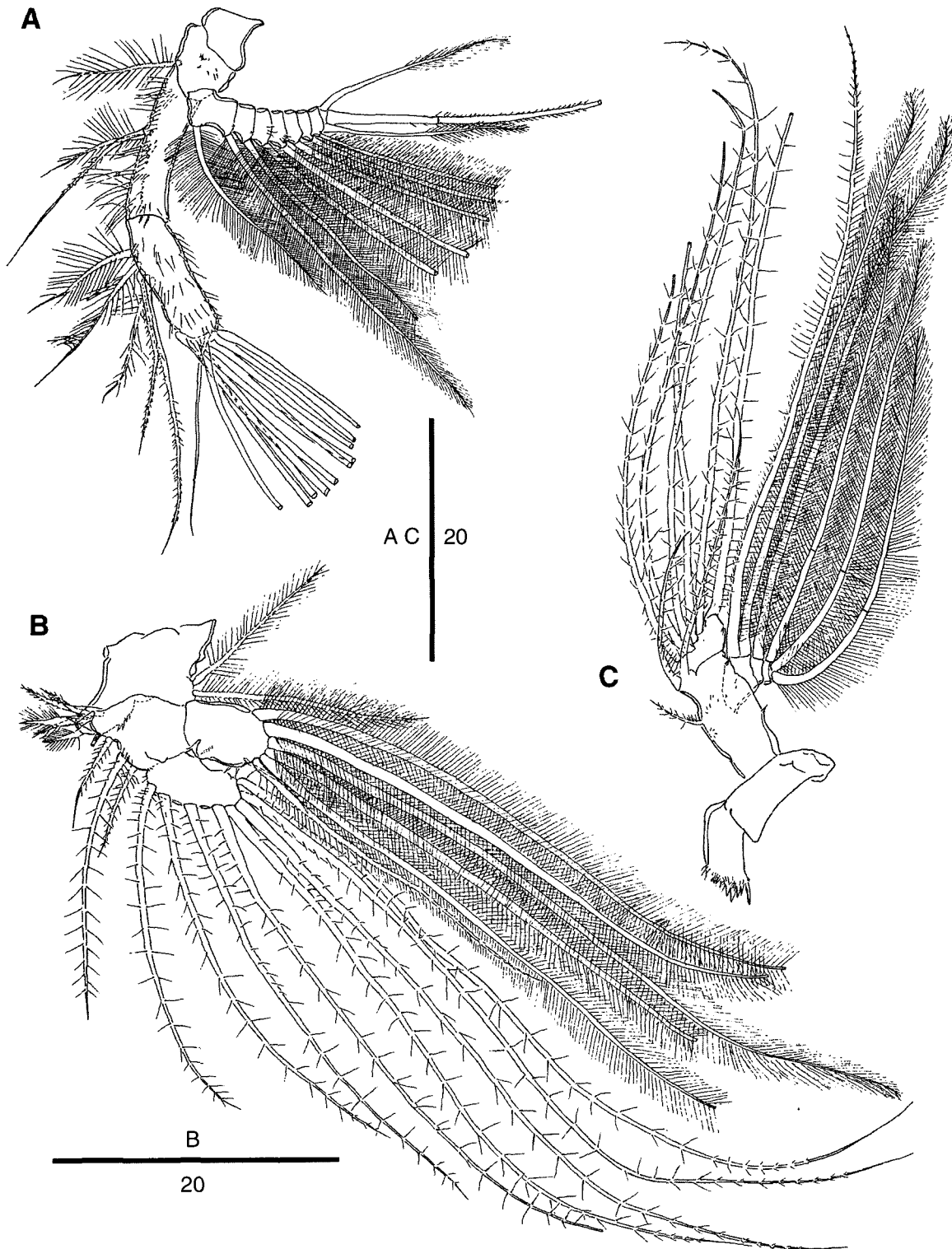


Fig. 2. *Mormonilla phasma*, female. A. antenna; B. maxillule; C. mandible (Scale bar unit: μm).

a drawing tube attached to a Leica DM2500 interference microscope. The descriptive terminology is adopted from

Huys & Boxshall (1991).

RESULTS

Order Mormonilloida Boxshall, 1979

Family Mormonillidae Giesbrecht, 1892

Genus *Mormonilla* Giesbrecht, 1891

Mormonilla phasma Giesbrecht, 1891

Material examined. 1 ♀ dissected on ten slides, 1 ♀ dissected on nine slides. 10 ♀♀ preserved in 70% alcohol. All the samples are from Northeastern Pacific at a station (10° 30'N, 131° 20'W), on 24 July 2005. The samples will be deposited to the National Institute of Biological Resources.

Description of female

Body length of figured specimen 2.01 mm (length range 1.5~2.01 mm, mean 1.75 mm, $SD \pm 0.13$). Body slender and elongated (Fig. 1A). Prosome comprising cephalosome and 4 free pedigerous somites; urosome 4-segmented; with genital and first abdominal somites fused internally to form genital double somite, distinctly separated on surface; with 2 free abdominal somites. Genital apparatus comprising single median genital aperture on ventral surface of genital double somites. Caudal ramus longer than urosome, bearing 6 armature elements (Fig. 1C).

Antennule 3-segmented and symmetrical (Fig. 1B); segment 1 with 9, segment 2 with 1, and proximal segment with 9 setae, respectively; each segment elongated, segment 1 comprising over half of total length.

Antenna (Fig. 2A) biramous; with separate coxa and basis; basis with single seta; endopod indistinctly 3-segmented; endopodal segment 1 with 2 setae, distal segment indistinctly separated second and third endopodal segments; second segment bearing 5 setae in position proximally on inner margin and third segment armed with 11 setae around apex. Exopod 8-segmented; setal formula 2, 1, 1, 1, 1, 1, 1, 3.

Mandible (Fig. 2B) with large coxal gnathobase and biramous palp; basis bearing 3 setae on inner margin; palp consisting of allobasis incorporating first endopodal segment armed with 1 seta derived from basis and 2 from endopodal segment. One-segmented endopod; second endopodal segment with 6 setae. Exopod indistinctly 3-segmented; dis-

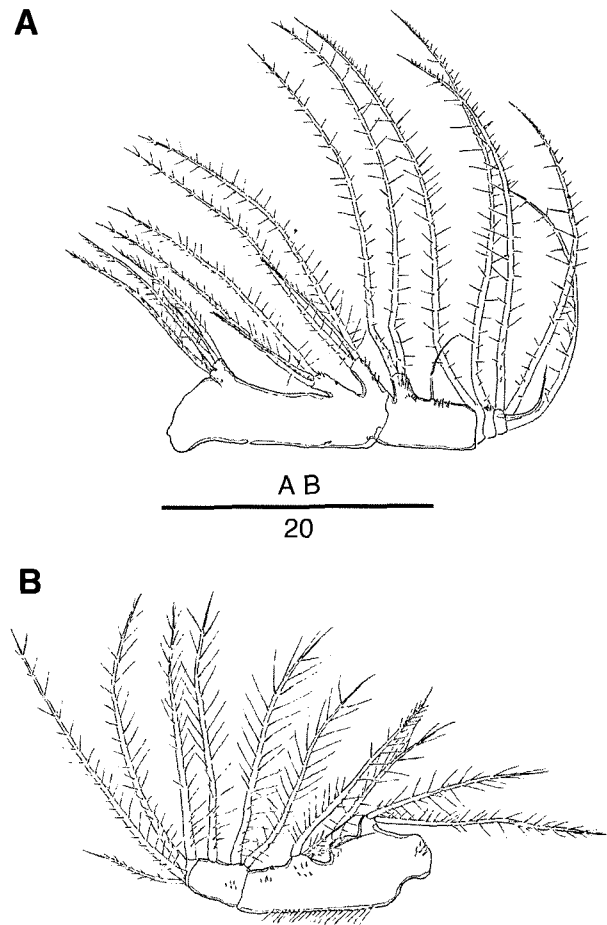


Fig. 3. *Mormonilla phasma*, female. A. maxilla; B. maxilliped (Scale bar unit: μm).

tinctly 3-segmented exopod in anterior view and indistinctly 1-segmented in posterior view; each exopodal segment with 2, 1, 3 setae, respectively.

Maxillule (Fig. 2C) with small praecoxal endite with 7 setae; coxa and basis fused; coxal endite bearing 4 setae; 2 setae on outer surface of segment representing epipodite; proximal basal endite with 2 setae; exopod 1-segmented with 7 setae; endopod with 8 setae.

Maxilla (Fig. 3A) 5-segmented; syncoxa with 4 endites; praecoxal endites indistinctly separated with all 5 elements; two coxal endites with 3 setae, respectively; allobasis with proximal endite bearing 2 setae, and distal endite probably represented by single seta; outer coxal seta absent; free endopod 3-segmented with 1, 1, 4 setae, respectively.

Maxilliped (Fig. 3B) 3-segmented; first segment representing fused syncoxa, basis and first endopod segment; 2 free endopodal segments; two syncoxal endites with 2, 1

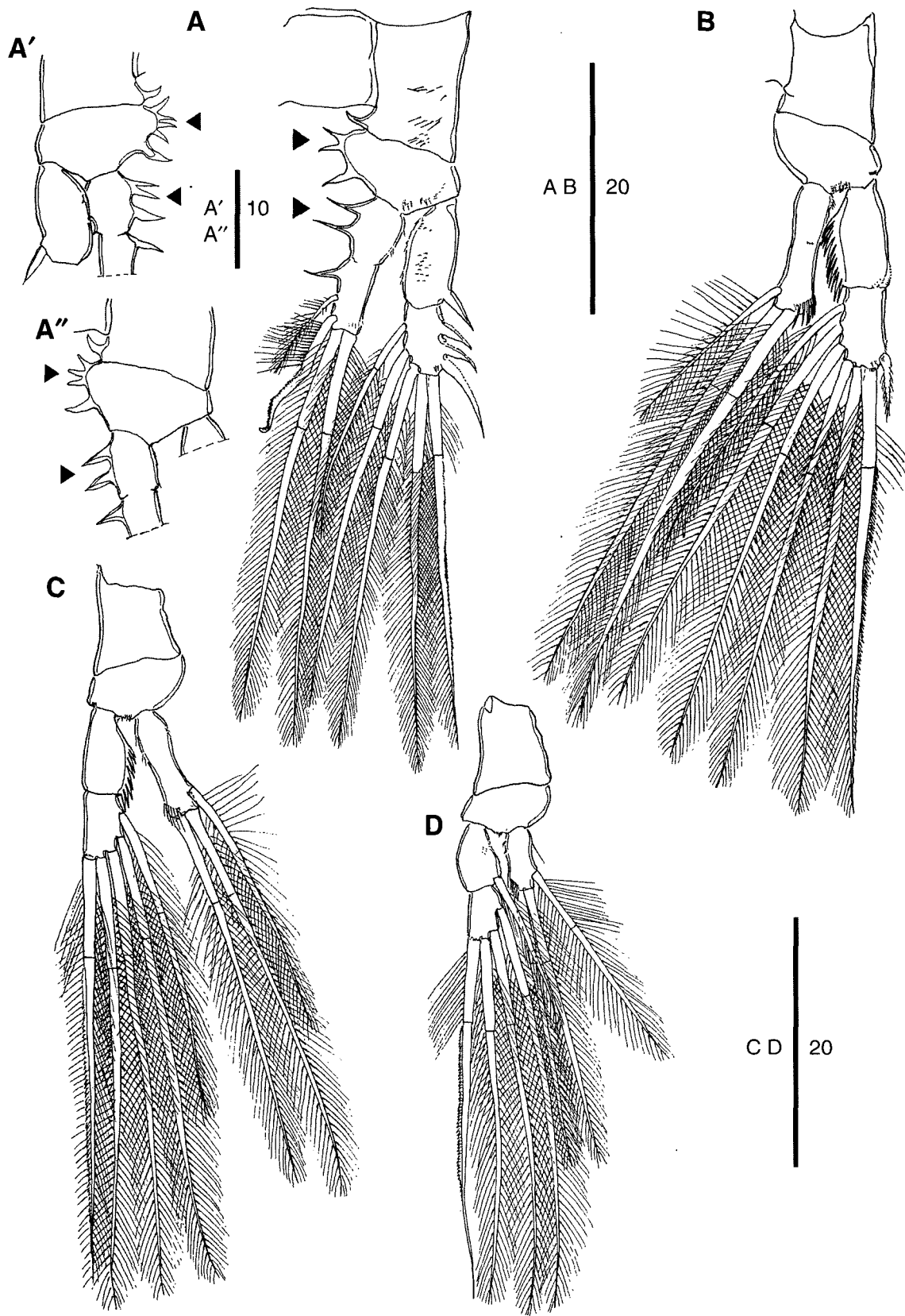


Fig. 4. *Mormonilla phasma*, female. A. P1; B. P2; C. P3; D. P4 (Scale bar unit: μm . Arrows in A indicate the difference of the spinous process number).

setae respectively; basal endite with 3 setae. Proximal free endopod segment with 3 setae; distal free endopod segment with 4 setae.

Swimming legs 1 to 4 biramous (Fig. 4A~D); P1 with 2-segmented rami; P2-P4 exopod 2-segmented, endopod 1-segmented.

P1 (Fig. 4A). Basis with 3 or 4 spinous processes on lateral inner margin. Endopod incompletely 2-segmented with surface suture showing original segmentation; enp-1 with 2-3 spinous processes on lateral inner margin.

P2-P4 (Fig. 4B-D). Bases with spinular row between proximal area of endopod and exopod. Exp-1 of P2-P3 with long spinular row along inner lateral margin. Endopod of P2-P4 with row of long spinules on outer distal margin. Setal formulae as follows:

	Exopod	Endopod
P1	I-0; III, 2, 3	0; 0, 2, 2
P2	0-0; I, 2, 4	0, 2, 1
P3	0-0; 0, 2, 3	0, 2, 1
P4	0-1; 0, 2, 2	0, 2, 1

P5 and P6 absent.

DISCUSSION

Mormonilla phasma has been reported in the restricted

oceans such as Arabian Sea, Red Sea and Mediterranean Sea as well as open ocean such as the Eastern Indian Ocean, the Western Pacific and Antarctic Ocean (Beckmann 1984; Huys *et al.* 1992; Razouls 1994; Chihara and Murano 1997), but not in the Northeast Pacific. Thus, this study is the first report of *M. phasma* in the northeastern Pacific (Fig. 5).

Specimens of *M. phasma* collected in the northeastern Pacific was longer in body length (1.50 to 2.01 mm) than those (1.58 to 1.73 mm) reported by Boxshall (1979) and showed general morphological characteristics similar to the Huys and Boxshall (1991)'s descriptions in the following features; 1) the 3-segmented antennule, 2) the 5-segmented maxilla with total 4 endites, 3) the 3-segmented maxilliped, 4) P2-4 with 2-segmented exopods and 1-segmented endopod, 5) the 4-segmented urosome with a genital complex formed by the fusion of the genital somite and the first abdominal somite.

However, morphological characteristics of antenna, mandible and leg 1 were slightly different from Boxshall (1979), Boxshall (1985) and Huys and Boxshall (1991)'s descriptions. Regarding antenna, Boxshall provided different descriptions for antenna segmentation of *Mormonilla* in 1979 and 1985 publications. The former described *Mormonilla*'s antenna with a 8-segmented exopod whereas the latter described it as a 7-segmented exopod. The segmentation of antenna exopod in this study was found to be 8-segmented as described in Boxshall (1979, see Fig. 26D).

In addition, Boxshall (1979) and Huys and Boxshall

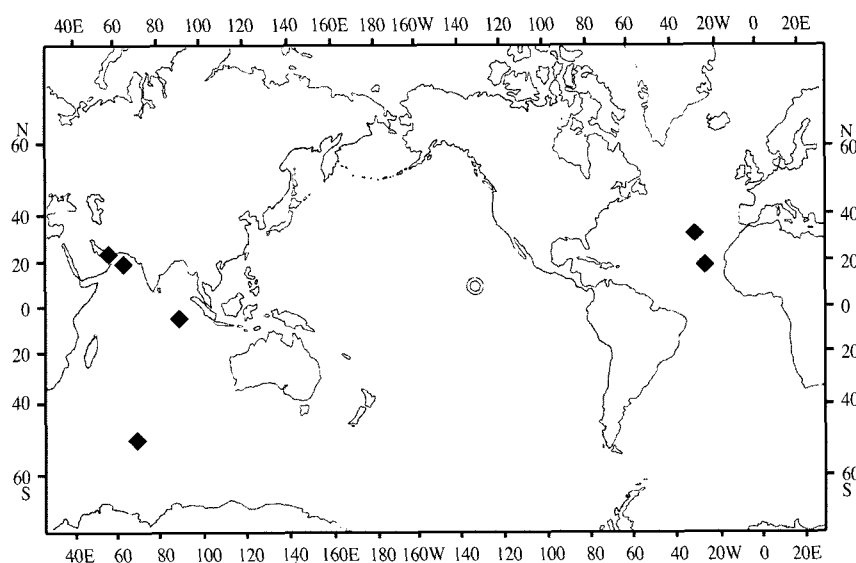


Fig. 5. The distribution of *Mormonilla phasma* (black lozenge: previously study, double circle: present study).

Table 1. The characters of *Mormonilla phasma*

	Boxshall, 1979	Boxshall, 1985	Boxshall and Huys, 1991	Present study
Antennule segments	3	3	3	3
Antenna exopodal segments /endopodal segments	8/2	7/2	8/2	8/2
Mandible exopodal segments /endopodal segments	1/1	?	4/1	4*/1
Maxilla segments	5	5	5	5
Maxilliped segments	2	2	3	3
Exopodal segments of P1	2	2	2	2
Endopodal segment (s) of P1	2	2	2	2*
Exopodal/endopodal segments of P2-P 4	2/1	2/1	2/1	2/1

?: Boxshall (1985) described the segmentation of mandible. 'The palp comprises the basis and two unsegmented distal lobes which probably represent the exopod and endopod'

*: Segments were separated indistinctly.

(1991) showed discrepancies in mandible descriptions. Boxshall (1979) described that mandible had a 1-segmented exopod and its basis was fused to endopod. In a meanwhile, Huys and Boxshall (1991) reported mandible characteristics with a 4 indistinctly segmented exopod and the second endopodal segment partly fused to basis. In this study, we found a 3 distinct segmentation in the exopod of mandible in anterior view and one additional indistinct segmentation in posterior view. Huys and Boxshall (1991) provided a detailed drawing of mandible in Fig. 2.6.6E. (p.178), in which they marked segmentations as three solid lines and one dashed line. If it was their intention to describe 3 distinct segmentations and 1 indistinct one, then the mandible characteristics found in this study agree with Huys and Boxshall (1991)'s description.

The segmentation of endopod in P1 is different from the description by Boxshall (1979), Boxshall (1985) and Huys and Boxshall (1991). They reported a 2-segmented endopod of P1, but the first and second endopodal segments of P1 were separated indistinctly.

We report additional characteristics of P1-P3, which were not described in Boxshall (1979), Boxshall (1985) and Huys and Boxshall (1991). First, we have found morphological anomalies in endopodal segments of the leg 1 in the female of *M. phasma*. The medial surfaces of coxa, basis and both endopod segments in leg 1 have long spinous processes projecting into the interlimb midline space (Fig. 4A). The spinous processes number is different as depicted in Figure 4 (arrow in Fig. 4A), specially in basis. Second, legs 2-3 shows various number of serration in inner margin of the first exopodal segment. The number of serration bears eight

to fifteen in leg 2 and seven to nine in leg 3. Although several morphological characters in the present specimens show discrepancy to those in the previous reports (Boxshall 1979, 1985; Huys and Boxshall 1991), those are minor variations and thus seem to be within the range of intra-specific variation (Table 1). Unfortunately male specimens were not found in this study and it would be interesting if we can compare the morphological characters of male specimens from various localities in a further study.

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