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*DELAVALIA QINGDAOENSIS* SP. NOV. (HARPACTICOIDA, MIRACIIDAE),  
A NEW COPEPOD SPECIES FROM JIAOZHOU BAY, YELLOW SEA

BY

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ABSTRACT

*Delavalia qingdaoensis*, a new species of harpacticoid copepod of the family Miraciidae is described based on specimens sorted from sediment samples collected in Jiaozhou Bay, Qingdao, Shandong Peninsula, Yellow Sea, in May 2008. The new species is easily distinguished from its congeners by the combined characters of the antennular segments, an apomorphic setal formula of the swimming legs, and the shape of P5 in both sexes. It is remarkably similar to *D. bocqueti* (Soyer, 1971) and *D. latioferculata* (Itô, 1981), but it differs from *D. bocqueti* by features of the caudal rami, antennule, antennary endopod, mandibular exopod, maxillipedal basis, and P5 endopodal lobe; from *D. latioferculata* by the caudal rami, the inner setae of P1-P4 enp-1, P2 enp-2, and P4 exp-3, and the shape of P5 in both sexes.

RÉSUMÉ

*Delavalia qingdaoensis*, une nouvelle espèce de copépode harpacticoïde de la famille des Miraciidae est décrite à partir de spécimens provenant d'échantillons de sédiments collectés dans la Baie de Jiaozhou, Qingdao, Péninsule de Shandong, Mer Jaune, en mai 2008. La nouvelle espèce se distingue aisément de ses congénères par une combinaison de caractères sur les segments de l'antennule, une formule sétale apomorphe des pattes natatoires ainsi que sur la forme de la P5 dans les deux sexes. Elle ressemble de façon remarquable à *D. bocqueti* (Soyer, 1971) et à *D. latioferculata* (Itô, 1981), mais diffère de *D. bocqueti* par des caractéristiques des rames furcales, de l'antennule, de l'endopodite de l'antenne, de l'exopodite de la mandibule, du basis du maxillipède et du lobe de l'endopodite de P5 ; elle se différencie de *D. latioferculata* par les rames furcales, les soies internes de l'endopodite 1 de P1-P4, de l'endopodite 2 de P2, de l'exopodite 3 de P4, et par la forme de la P5 dans les deux sexes.

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## INTRODUCTION

Brady (1869) established the genus *Delavalia* Brady, 1869 for a new species, *D. palustris*. Sars (1906) relocated *Delavalia* as a junior synonym of *Stenhelia* Boeck, 1865. Monard (1927, 1928) reinstated *Delavalia* as a subgenus of *Stenhelia*. Lang (1948) differentiated the subgenus *Delavalia* based on the first swimming leg being two-segmented. Mu & Huys (2002) pointed out that the use of a single discriminant without considering additional characters of higher phylogenetic significance raises doubts about the monophyletic status of the subgenus *Delavalia*. They abandoned the traditional subgeneric division and upgraded *Delavalia* to genus level. We adopt the action of Mu & Huys (2002) and treat *Delavalia* Brady, 1869 as an independent genus in this paper.

*Delavalia* Brady, 1869 is a large genus with more than 20 described species in the Miraciidae, which family currently includes 53 species from around the world (Wells, 2007). To date, only one species of the genus was previously reported from China, i.e., *Delavalia ornamentalia* (Shen & Tai, 1965), a freshwater species.

When we sorted benthic samples collected from Jiaozhou Bay, a semi-enclosed bay on the southern coast of the Shandong Peninsula, Yellow Sea, at Qingdao City, some harpacticoid specimens belonging to the genus *Delavalia* were found. After identification, we recognized they belong to an as yet undescribed species. We describe this as a new species in the present paper.

## MATERIAL AND METHODS

The copepod specimens were extracted from benthic samples using a 50  $\mu\text{m}$  sieve at the colloidal silica Ludox TM-50 suspension centrifugation flotation. The proportion between sediment and the colloidal silica Ludox TM-50 suspension is 1:3. Samples were fixed in 10% formalin. Specimens were preserved in 75% alcohol. The habitus was drawn and the whole body length was measured before dissection. Animals were dissected in lactic acid and mounted on slides in lactophenol, subsequently sealed with clear nail varnish. All drawings were made using an Olympus BH-2 phase contrast microscope with a drawing tube. Habitus were drawn at 400 $\times$  magnification. Other figures were drawn at 1000 $\times$  magnification, with an oil immersion lens. All drawings were checked using a Zeiss Axioskop plus phase contrast microscope.

The terminology used is adopted from Huys et al. (1996). Abbreviations used in the text and figures are: aes, aesthetasc; exp, exopod; exp-1(-2-3), the first (second, third) segment of the exopod; enp, endopod; enp-1(-2-3), the first (second, third) segment of the endopod; Mxp, maxilliped; benp, baseopod of P5; P1-P6, swimming legs 1-6.

Body length was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami.

The type material is deposited in the Marine Biological Museum, Chinese Academy of Sciences, Qingdao, China.

#### SYSTEMATIC PART

Order HARPACTICOIDA Sars, 1903

Family MIRACIIDAE Dana, 1846

Subfamily STENHELIINAE Brady, 1880

Genus *Delavalia* Brady, 1869

***Delavalia qingdaoensis* sp. nov.** (figs. 1-8)

Material examined. — Holotype: adult female, dissected, on 4 slides (MBM 188950), Jiaozhou Bay, Qingdao, Yellow Sea, soft mud, 28.2 m depth, collectors: B.-Q. Li, J. Zhou & L. Ma, 14 May 2008. Paratypes: 1 adult female, dissected on 2 slides (MBM 188951); 2 adult males, dissected on 3 slides (MBM 188952) and 2 slides (MBM 188953), respectively; 14 females, 4 males, preserved in alcohol (MBM 188954), same collection data as holotype.

Diagnosis. — Antennule 7-segmented in female, with one aesthetasc on fourth segment; antennal endopod with one slender seta and two stout pinnate spines laterally. Mandibular exopod with six setae. Maxillipedal basis with two setae, one long, another short; endopod with two setae, about equal in length. P1 exp-2 with one inner seta, P1 exp-3 with four setae/spines, P1 enp-1 shorter than P1 enp-2, inner seta of P1 enp-1 extending to middle of P1 enp-2, P1 enp-2 with two inner setae. P2 and P3 exp-3 with three inner setae; P2-P4 exp-3 with three outer spines; inner setae of P2 and P3 enp-1 stout; P2 exp-1 with one inner seta, P2 enp-2 with one inner seta; P4 exp-1 with one inner seta; P4 enp-2 with one inner seta, P4 enp-3 with two inner setae, inner seta of P4 enp-1 longer than that of P4 enp-2. Right and left legs of P5 separated; P5 enp in male without seta, in female with four endopodal setae; P5 endopodal lobe in female with small notch between second and third innermost setae, first and second innermost setae subequal in length. Caudal rami about 4.5 times as long as broad.

Description of the female holotype. — Body length 745  $\mu\text{m}$ ; maximum body width 220  $\mu\text{m}$  (measured at rear margin of cephalothorax).

Body (figs. 1, 5A, 5B) with clear distinction between broad prosome and narrow urosome. Cephalothorax slightly broader than long, cephalic shield with sensilla; thoracic and urosomal somites both tapering posteriorly. All somites except for penultimate furnished with sensilla, prosome without spinules, all urosomal somites excluding penultimate somite dorsally with spinules on distal margins; hyaline frills smooth; genital double-somite (free somites 5 and 6) not completely fused dorsally but fused ventrally, genital field see fig. 5B; urosomites 3

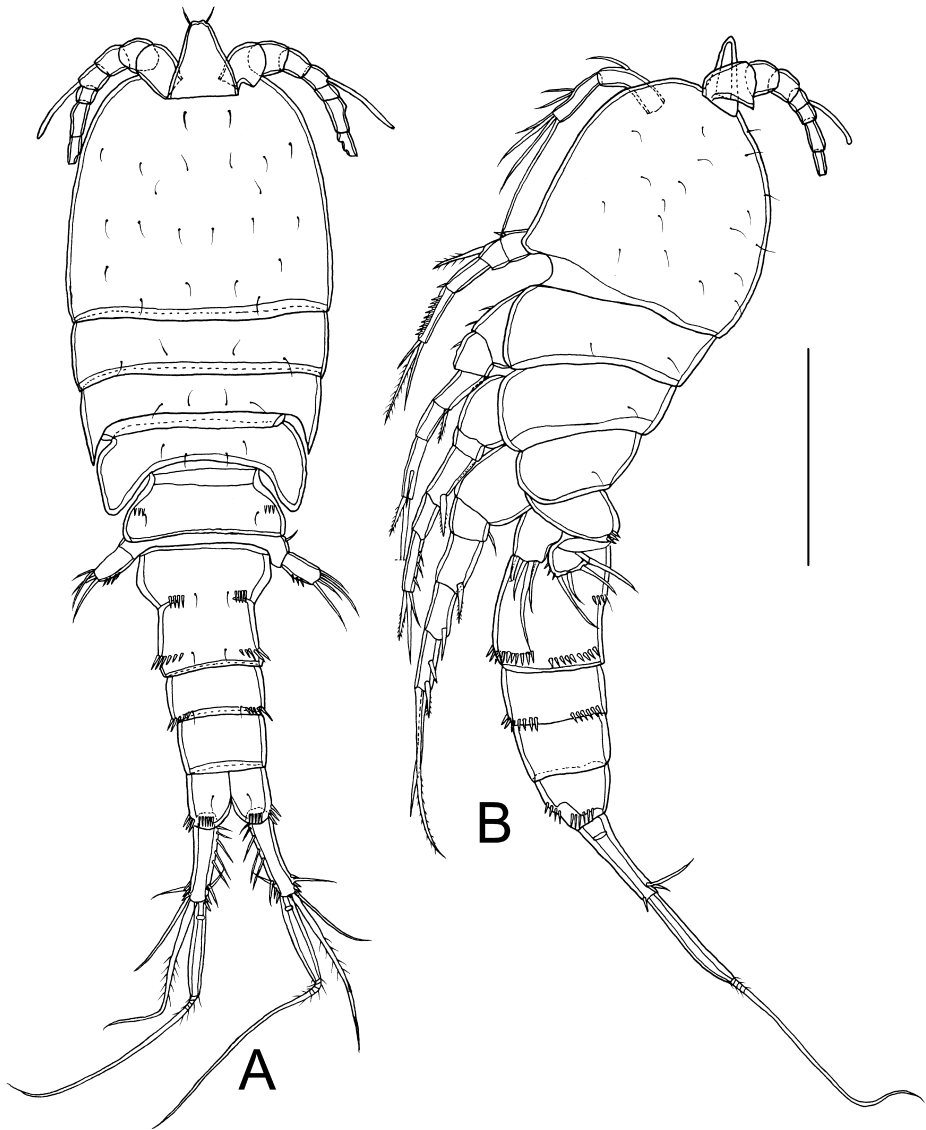


Fig. 1. *Delavalia qingdaoensis* sp. nov. Paratype (female, MBM 188951). A, habitus, dorsal; B, habitus, lateral. Scale bar = 200  $\mu$ m.

and 4 ventrally with spinules (fig. 5B); anal somite medially cleft, ventrally with spinules; anal operculum absent; anus terminal. Caudal rami about 4.5 times as long as broad, all ramal setae located terminally; setae I and II at outer edge, smooth, seta I short and stout; seta III slender, displaced to subdistal ventral margin; setae IV and V well developed, slightly pinnate; setae VI and VII very slender, located at inner edge.

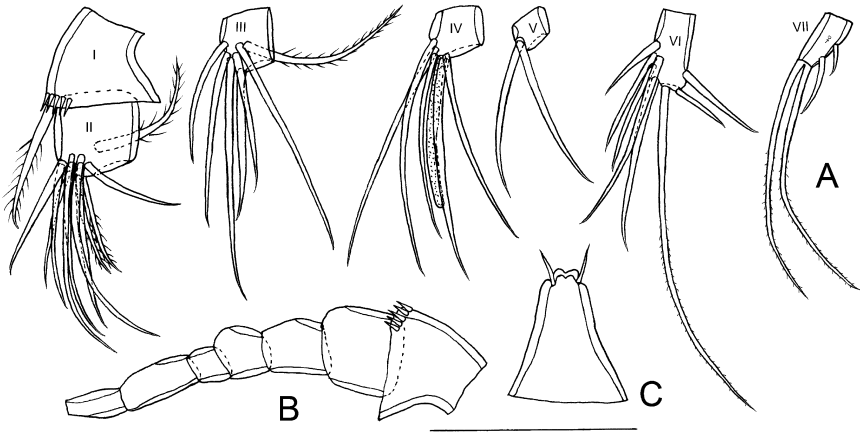


Fig. 2. *Delavalia qingdaoensis* sp. nov. Holotype. A, antennule (disarticulated); B, antennule (armature omitted); C, rostrum, dorsal. Scale bar = 100  $\mu$ m.

Rostrum (fig. 2C) demarcated from cephalothorax, broadly triangular with bifid tip, with a pair of sensilla subapically.

Antennule (fig. 2A, B) with seven short segments; armature: I(1), II(11), III(7), IV(5 + aes), V(2), VI(8), VII(5). Antenna (fig. 3A) with small coxa, with row of setules; allobasis with plumose seta in proximal half of abexopodal margin, with row of setules on abexopodal margin; exopod 3-segmented, with 1-1-(1 + 3) setae; exp-1 long, with short spinules on distal margin and long spinules on inner margin; exp-2 clearly shorter than exp-1; exp-3 with two rows of spinules; endopod with five rows of spinules; lateral armature consisting of one slender seta and two stout pinnate spines; apical armature consisting of six elements: one pinnate spine, three geniculate pinnate setae, and two slender setae, one fused basally to outermost geniculate seta.

Labrum (fig. 3B) large, with spinules subapically, several setae ventrally. Mandible (fig. 3C) with gnathobase compacted with fine and pointed teeth, inner edge bearing one pinnate seta; basis large, with two rows of spinules and three smooth setae subdistally; exopod well developed, with six naked setae altogether; endopod enlarged, recurved and twisted over exopod, with two marginal and four terminal setae, one elongated and fringed with hyaline membrane. Maxillule (fig. 3D) with praecoxa and coxa demarcated; arthrite with nine apical spines and one seta, two juxtaposed setae on surface, row of spinules around medial margin; coxal endite with four setae, with row of spinules on surface; basis with two endites, bearing 4 + 3 setae, respectively; endopod and exopod basally confluent, endopod broader and longer than exopod, with four setae; exopod with two setae. Maxilla (fig. 3E) with syncoxa bearing three rows of spinules and three endites; proximal endite with two apical pinnate setae and one lateral seta, middle and

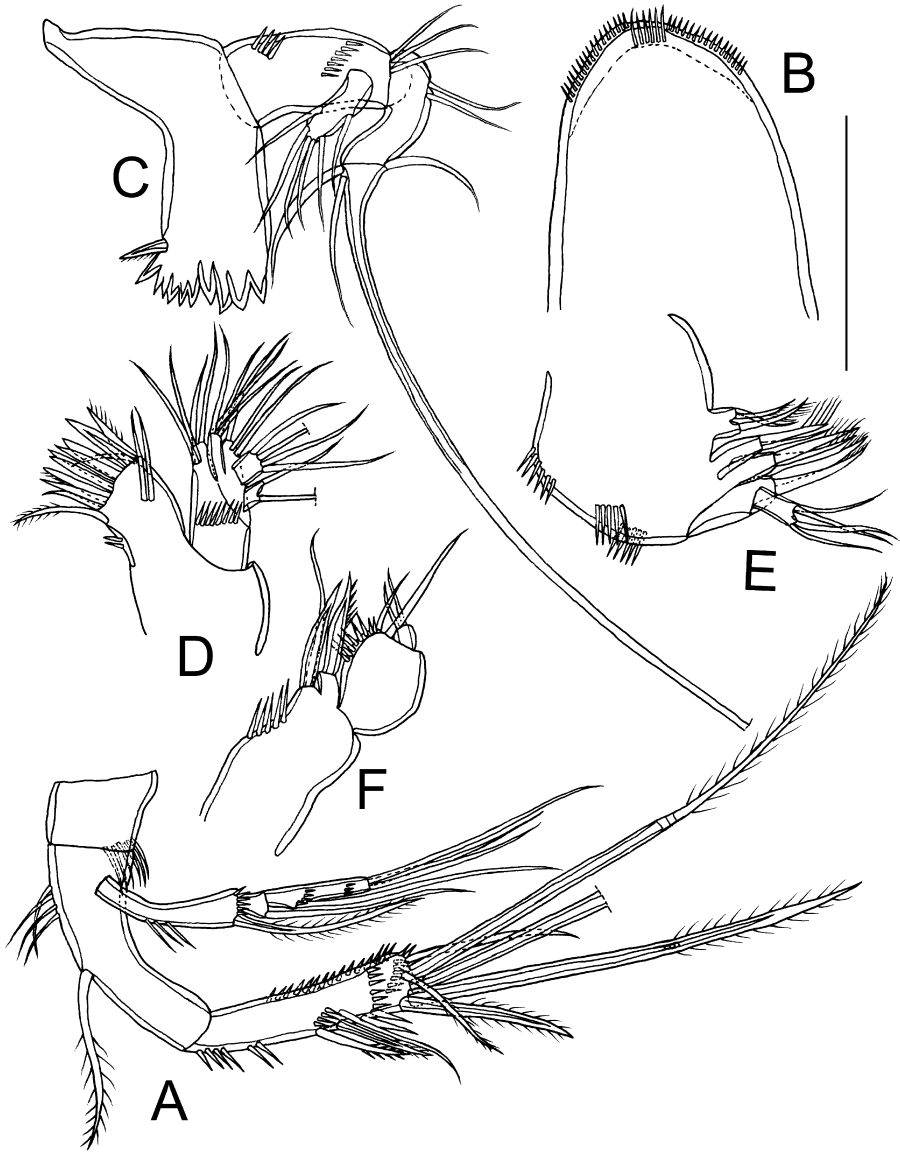


Fig. 3. *Delavalia qingdaoensis* sp. nov. A, C, E, F, holotype; B, D, paratype (female, MBM 188951). A, antenna; B, labrum; C, mandible; D, maxillule; E, maxilla; F, maxilliped. Scale bar = 100  $\mu\text{m}$ .

distal endite with two pinnate setae, basal endite with two pinnate setae; allobasis with two claw-like spines and one naked seta; endopod 1-segmented, bearing four setae. Maxilliped (fig. 3F) subchelate; syncoxa with row of spinules, with three well developed pinnate setae located at distal margin; basis short, bearing two setae on distal margin; endopod with two slender setae.

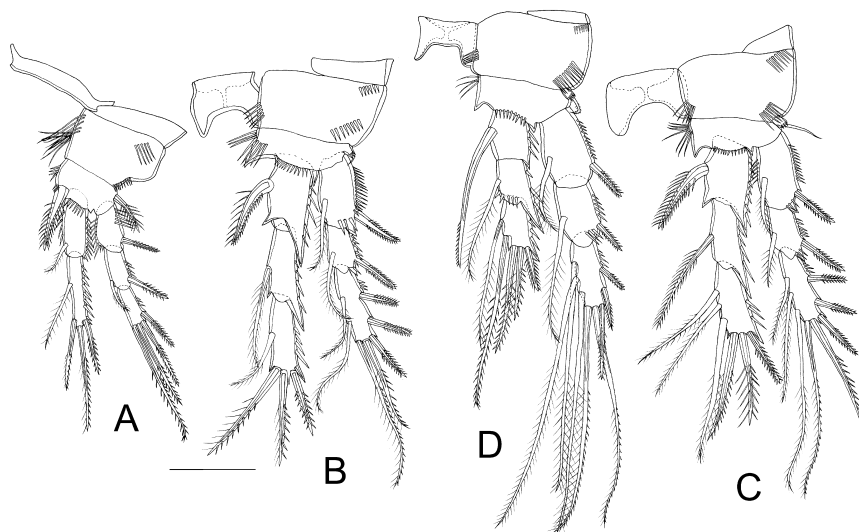


Fig. 4. *Delavalia qingdaoensis* sp. nov. Holotype. A, P1, anterior; B, P2, anterior; C, P3, anterior; D, P4, anterior. Scale bar = 100  $\mu$ m.

P1 (fig. 4A) smaller than other swimming legs; coxa with row of long spinules on anterior surface, row of short spinules on outer margin, row of setules on inner margin; basis with pinnate outer seta and strong inner pinnate spine, terminal margin with spinules, inner margin with setules; exopod 3-segmented, outer and distal margins with spinules, exp-1 and -2 each with outer pinnate spine, exp-1 inner margin with row of setules, exp-3 with two outer pinnate spines, two terminal pinnate setae; endopod 2-segmented, outer and distal margins with spinules; enp-1 with spinules along outer and distal margins, with short inner seta, enp-2 slightly longer, with brushy inner seta and pinnate spine, terminally with pinnate outer spine and inner seta.

P2-P4 (fig. 4B-D) with exopods and endopods 3-segmented, intercoxal sclerites with two lateral blunt projections; coxae of almost rectangular shape with few rows of spinules each; basis with small and slender outer seta (bare in P2 and P3), inner distal corner produced into spinous process, distal margin between rami forming blunt or spinous process; outer distal corner of exp-1 (except P4) and exp-2 produced into spinous process; endopod longer than exopod in P2, of equal length in P3, shorter in P4, enp-1 inner seta in P2 and P3 stout. Setal formulae as follows:

	Exp	Enp
P2	1-1-2, 2, 3	1-1-1, 2, 1
P3	1-1-3, 2, 3	1-1-3, 2, 1
P4	1-1-3, 2, 3	1-1-2, 2, 1

Right and left P5 (fig. 5C) not fused medially, baseoendopod and exopod separated. Baseoendopod wide, endopodal lobe not prominent, with four setae,



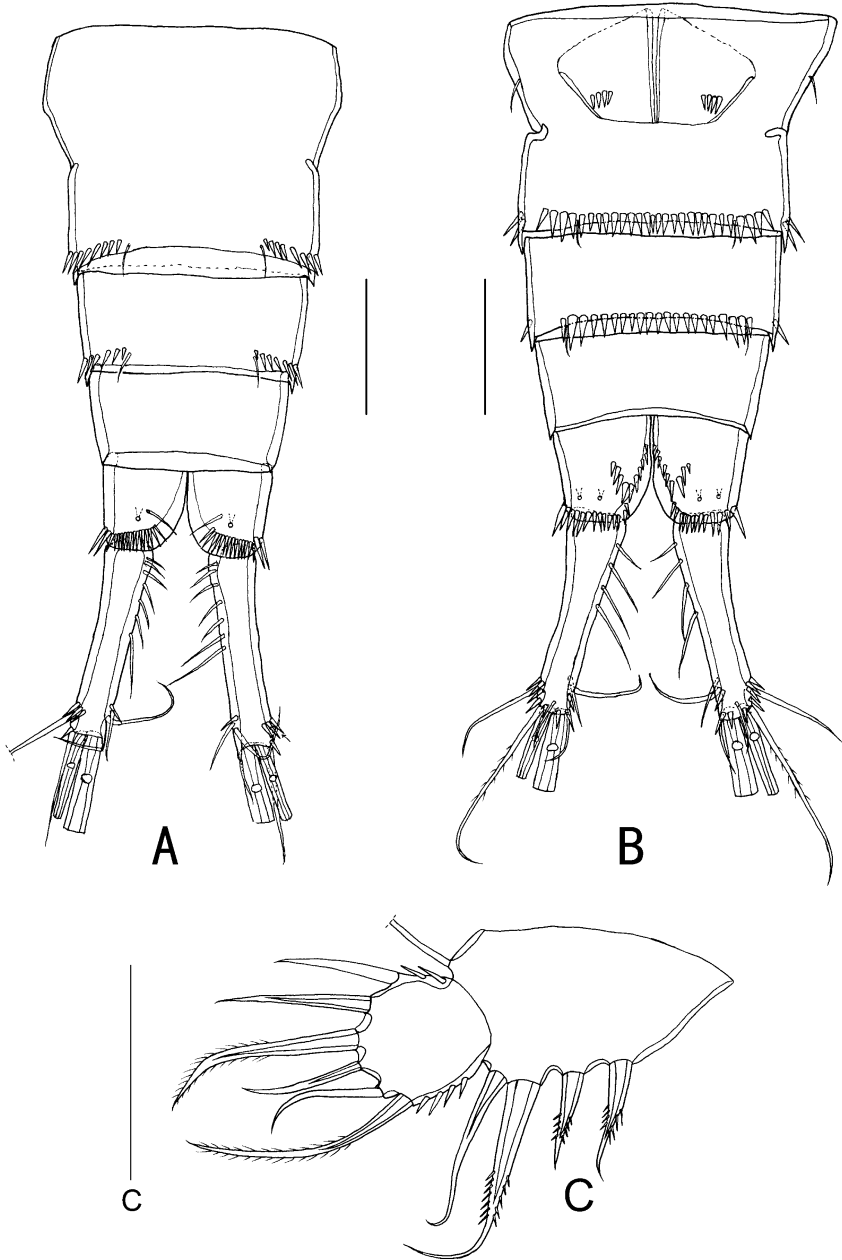


Fig. 5. *Delavalia qingdaoensis* sp. nov. A, C, holotype; B, paratype (female, MBM 188951). A, urosome (excluding P5-bearing somite), dorsal; B, urosome (excluding P5-bearing somite), ventral; C, P5, anterior. Scale bars = 100  $\mu$ m.

three pinnate, first and second innermost setae shorter than others; exopod oval with spinules around inner and outer margins, with five terminal setae and outer subterminal seta.

Description of male paratype (MBM no. 188952). — Males are similar to the females except for the following characters. Body length 670  $\mu\text{m}$ ; maximum body width 200  $\mu\text{m}$  (measured at rear margin of cephalothorax).

Body (figs. 6A, 8) slightly shorter than that of female holotype, somites 5 and 6 completely separated, ventral spinules on urosomite 4 (fig. 8B) different from female holotype. Antennule (fig. 6B) haplocer, 9-segmented, armature: I(1), II(8), III(6), IV(1 + aes), V(9 + aes), VI(1), VII(2), VIII(1), IX(9). Antenna, mouthparts, Mxp, P1, and P3 as in female holotype. P2 (fig. 7A) with protopod and exopod as in female holotype; endopod 2-segmented, enp-1 with stout serrate inner seta, long spinules on outer margin, enp-2 with two plumose inner setae, long spinules on outer margin, terminal margin with two pinnate setae. P4 (fig. 7B) with exopod as in female holotype; endopod modified, enp-1 with slightly plumose inner seta, enp-2 similar to that of female holotype, enp-3 with two plumose inner setae, terminal margin with two setae, outer seta similar to that of female holotype, inner seta strong, with short setules on inner side. P5 (fig. 6C) with baseoendopods separated, without endopodal seta; exopod demarcated from baseoendopod, bearing three setae, one pinnate. P6 (fig. 8B) with three elements, middle seta pinnate, others smooth.

Etymology. — The species is named after its type locality, Qingdao, whence the specific name is an adjective agreeing in gender with the (feminine) generic name.

Remarks. — Huys & Mu (2008) divided all species belonging to the genus *Delavalia* into four groups by the number of setae/spines on P1 exp-3 and the numbers of outer spines on P2-P4 exp-3. *Delavalia qingdaoensis* sp. nov. belongs to *Delavalia* group IV, with four setae/spines on P1 exp-3 and 3, 3, 3 outer spines on P2-P4 exp-3, respectively. Within this group, the new species most closely resembles *D. bocqueti* and *D. latioperculata*. These three species share the following features: the antennule in the female is 7-segmented; the Mxp enp is armed with two setae; the P1 enp-1 is shorter than enp-2; the P1 exp-2 bears one inner seta, the P1 enp-2 bears two inner setae; the P2 exp-1 bears one inner seta, the exp-3 bears three inner setae; the P3 exp-3 bears three inner setae; the P4 exp-1 bears one inner seta, the enp-2 bears one inner seta, the enp-3 bears two inner setae; the P5 in the female bears four endopodal setae.

*Delavalia qingdaoensis* sp. nov. differs from *D. bocqueti* (only the female of *D. bocqueti* has been described) by the following characteristics: caudal rami are about 4.5 times as long as broad (3 times in *D. bocqueti*); the antennule bears one aesthetasc (two aesthetascs in *D. bocqueti*); the antennal endopod bears one slender

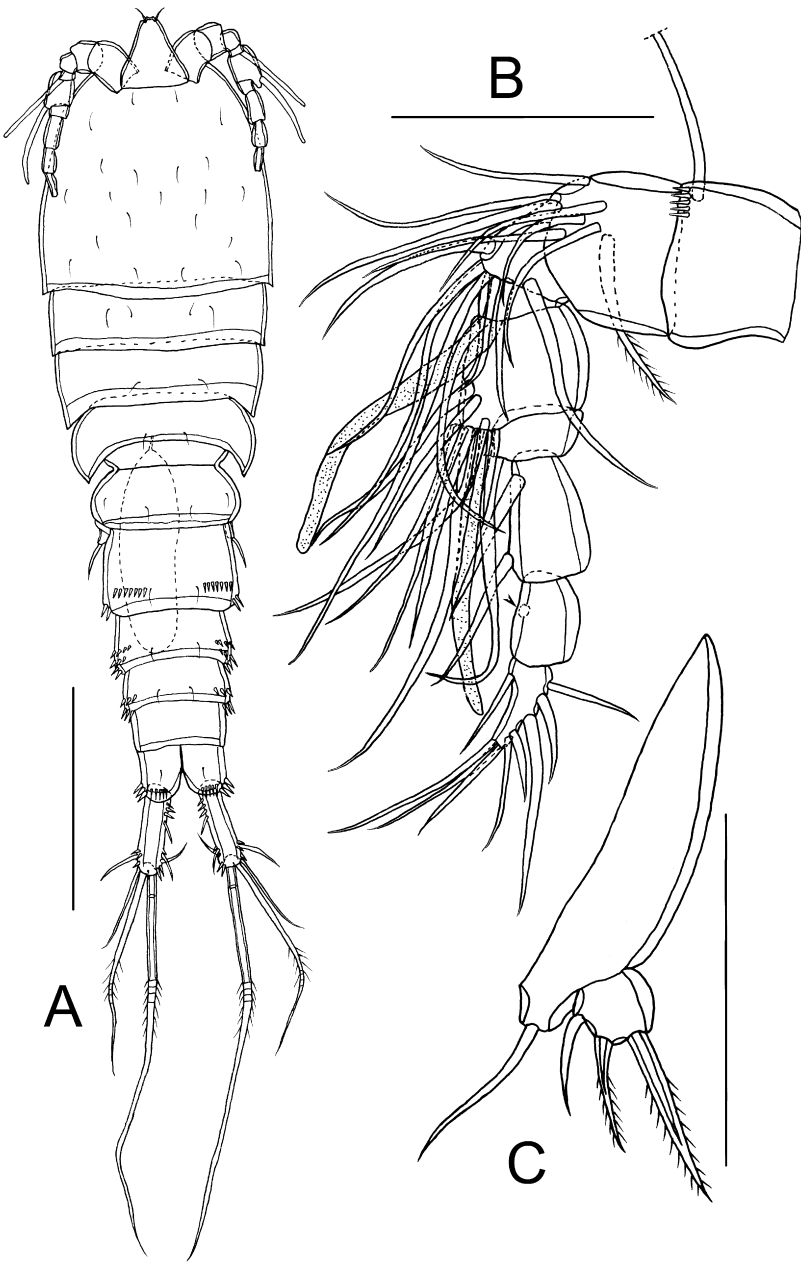


Fig. 6. *Delavalia qingdaoensis* sp. nov. Paratypes (male). A, B, MBM 188952; C, MBM 188953. A, habitus, dorsal; B, antennule; C, P5, anterior. Scale bars = 200  $\mu$ m (A), 100  $\mu$ m (B, C).

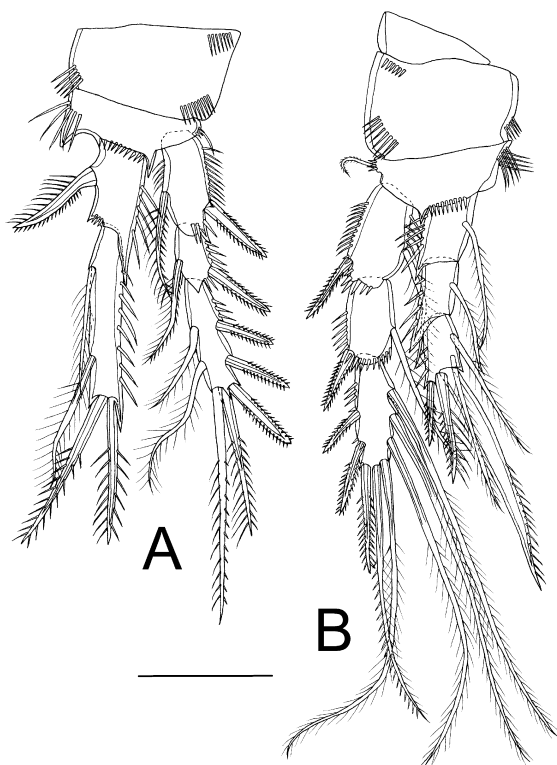


Fig. 7. *Delavalia qingdaoensis* sp. nov. Paratype (male, MBM 188952). A, P2, anterior; B, P4, anterior. Scale bar = 100  $\mu$ m.

seta and two stout pinnate spines laterally (two strong hooks in *D. bocqueti*); the mandibular exopod has six setae (five setae in *D. bocqueti*); the maxillipedal basis has two setae, one long, the other short (about equally long in *D. bocqueti*); the endopodal setae on the maxilliped are of equal length (unequal in *D. bocqueti*); the P5 endopodal lobe in the female has a small notch between the second and third innermost setae (with a big notch between the first and second innermost setae in *D. bocqueti*), the first and second innermost setae are about equally long (the first innermost seta shorter than the second in *D. bocqueti*).

*Delavalia qingdaoensis* sp. nov. can be distinguished from *D. latioperkulata* by the following characteristics: caudal rami are about 4.5 times as long as broad (about 3 times in *D. latioperkulata*); the inner seta of P1 enp-1 extends to the middle of P1 enp-2 (extending to the distal end of P1 enp-2 in *D. latioperkulata*); the inner setae of P2 enp-1 and P3 enp-1 are stout (slender in *D. latioperkulata*); the P2 enp-2 bears one inner seta (two setae in *D. latioperkulata*); the inner seta of P4 enp-1 is longer than that of P4 enp-2 (elongated to the distal end of P4 enp-2 in *D. latioperkulata*); the P4 exp-3 bears three outer setae (two setae in

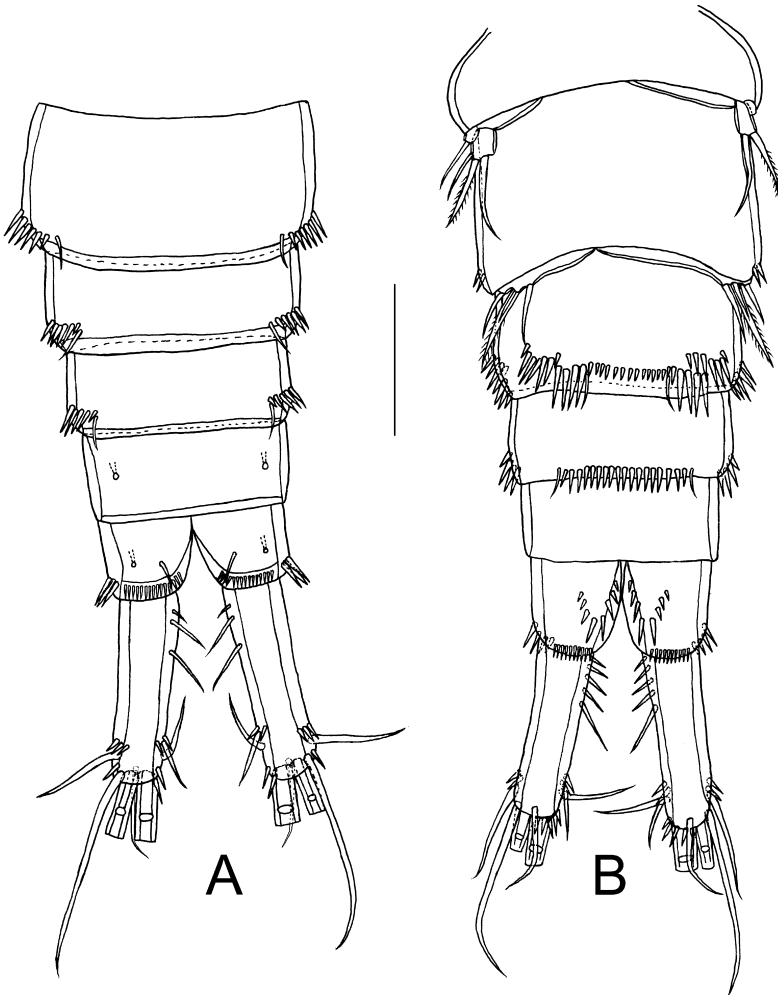


Fig. 8. *Delavalia qingdaoensis* sp. nov. Paratypes (male). A, urosome (excluding P5-bearing somite), dorsal view, MBM 188953; B, urosome, ventral view, MBM 188952. Scale bar = 200  $\mu$ m.

*D. latioperculata*); the legs of the pair P5 are separate (fused in *D. latioperculata*); the P5 exp in the female bears six setae (five setae in *D. latioperculata*); the P5 benp in the male lacks a seta (one spine and one setule in *D. latioperculata*), the exp bears three setae (four setae in *D. latioperculata*).

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