Trench treasures: the genus *Princaxelia* (Pardaliscidae, Amphipoda)

Tesoros de las fosas: el género *Princaxelia* (Pardaliscidae, Amphipoda)

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Key words: Trench, hadal, baited trap, Amphipoda, Pardaliscidae, *Princaxelia jamiesoni* new species.
Palabras clave: Fosa, hadal, trampa, Amphipoda, Pardaliscidae, *Princaxelia.*

ABSTRACT

The hadal amphipod fauna remains largely unknown. Recent investigations of the Japan and Izu-Ogasawara Trench with baited traps collected the largest specimens known so far of the genus *Princaxelia* (Pardaliscidae) at 7703 and 9316 meters. These belong to a new species which is here described in detail. A brief synopsis of the genus, a key to the species as well as a table with special morphological characters of all known *Princaxelia* is provided. The morphological adaptations for life in the hadal zone are briefly discussed.

RESUMEN

La fauna hadal de anfípodos es todavía desconocida. Investigaciones recientes de las fosas de Japón y Izu-Ogasawara permitieron la recolección con trampas de los ejemplares más grandes conocidos hasta ahora del género *Princaxelia* (Pardaliscidae) a 7703 y 9316 metros. Estos especímenes pertenecen a una nueva especie que es descrita en detalle en este artículo. Se incluye una breve sinopsis del género, una clave a nivel de especie y una tabla con caracteres de todas las especies conocidas de *Princaxelia*. Se discuten brevemente las adaptaciones morfológicas para la vida en la zona hadal.

INTRODUCTION

Even though only a few specimens of the genus *Princaxelia* are known, these have a huge horizontal and vertical distribution. In the Pacific they are described from the Kermadec, Yap and Japan trenches as well as from the north Atlantic off Iceland. According to Kamenskaya (1981) specimens also occur in the Aleutian, Kurile-Kamchatka, Izu-Bonin (= Izu-Ogasawara), Philippine and Bougainville trenches. The depth distribution ranges from 1505 –9316 m. Three of the four species, equalling all species known from the Pacific, were sampled in trenches.

The systematic history of the genus *Princaxelia* is not straightforward, therefore listed in the following, beginning with Stebbing's (1888) description of the genus *Pardaliscoides*.

Synopsis of the genus *Princaxelia*:

1. **1888. Stebbing** briefly describes *Pardaliscoides* new genus (closely related to *Pardalisca)* and briefly desribes *P. tenellus* new spec. from the Challenger expedition, South Pacific (off Chile), a single female of 8 mm length.
2. **1897. Stebbing** provides drawings of the single female *Pardaliscoides tenellus,* nine years after the first description of the same specimen.
3. **1931. Stephensen** identifies two specimens (one female 11 mm, one male 10 mm) from the Danish Ingolf expedition to the North Atlantic, southwest off Iceland as *Pardaliscoides tenellus* Stebbing 1888 and provides additional illustrations.
4. **1959. Dahl** describes *Princaxelia* new genus from the Galathea expedition south west Pacific, Kermadec Trench. *Princaxelia abyssalis* new spec. is described with illustrations (males: 15, 21 mm, females: 32, 18, 11 mm).
5. **1959. Dahl** regards the specimens figured by Stephensen (1931) as *Pardaliscoides tenellus* from the North Atlantic as belonging to the new genus *Princaxelia*, but type specimens described by Stebbing as *Pardaliscoides tenellus* as belonging to a *Pardaliscoides*, not to the new genus *Princaxelia*. Dahl (1959) briefly describes the two specimens from the Ingolf expedition as belonging to the new genus *Princaxelia*. *Pardaliscoides tenellus* illustrated by Stephensen (1931) is now a junior synonymy of *Princaxelia stephenseni*.
6. **1977. Kamenskaya** describes *Princaxelia magna* new spec. from the Yap trench, based on a single male specimen of 52 mm.

7. **1981. Kamenskaya** claims *P. abyssalis* occurs in the Aleutian, Kurile-Kamchatka, Izu-Bonin, Yap, Japan, Philippine, Bougainville and Kermadec trenches.

No further records other than the type material have been reported from *Princaxelia magna* or *P. stephenseni*. No habitus drawing of a species of the genus *Princaxelia* has been published and no *Princaxelia* species has been described in full detail so far.

No complete type material of *Princaxelia* is available. The material of the Danish Galathea and Ingolf expeditions are at the Zoological Museum Copenhagen, but only slides with dissected appendages could be located of *P. abyssalis* and only damaged specimens missing the mouthparts of *P. stephenseni*. It is unclear where Kamenskaya deposited her amphipod material, it is neither retrievable in the Zoological Museum Moscow nor Petersburg.

During a HADEEP expeditions in 2008 and 2009 (see Jamieson *et al.* 2010) baited traps were used in the Japan- and Izu-Ogasawara trench and five specimens belonging to the genus *Princaxelia* were caught. These are the largest members of the genus and belong to a new species, which is here described in detail.

MATERIAL AND METHODS

The material was preserved in 80% ethanol. Non-permanent slides were made in glycerol. Specimens were examined and dissected under a Leica MZ12 stereomicroscope and drawn using a camera lucida. The body lengths of specimens examined were measured by tracing an individual's mid-trunk length (tip of the rostrum to end of the telson) using a camera lucida. Line drawings were made using the techniques described in Coleman (2003, 2009).

Amphipoda
Pardaliscidae
Princaxelia Dahl, 1959
Princaxelia jamiesoni new spec.
Figures 1-10

Type locality. Holotype, female NSMT-Cr 21250, 56.2 mm (Tokyo Museum); paratype, male, NSMT-Cr 21251, 57.5 mm (Tokyo museum); paratype, female, K42581, 61 mm (Zoological Museum Hamburg); collected from the Japan trench, 36º 14.96 N, 142º 49.01 E, 7703 m.

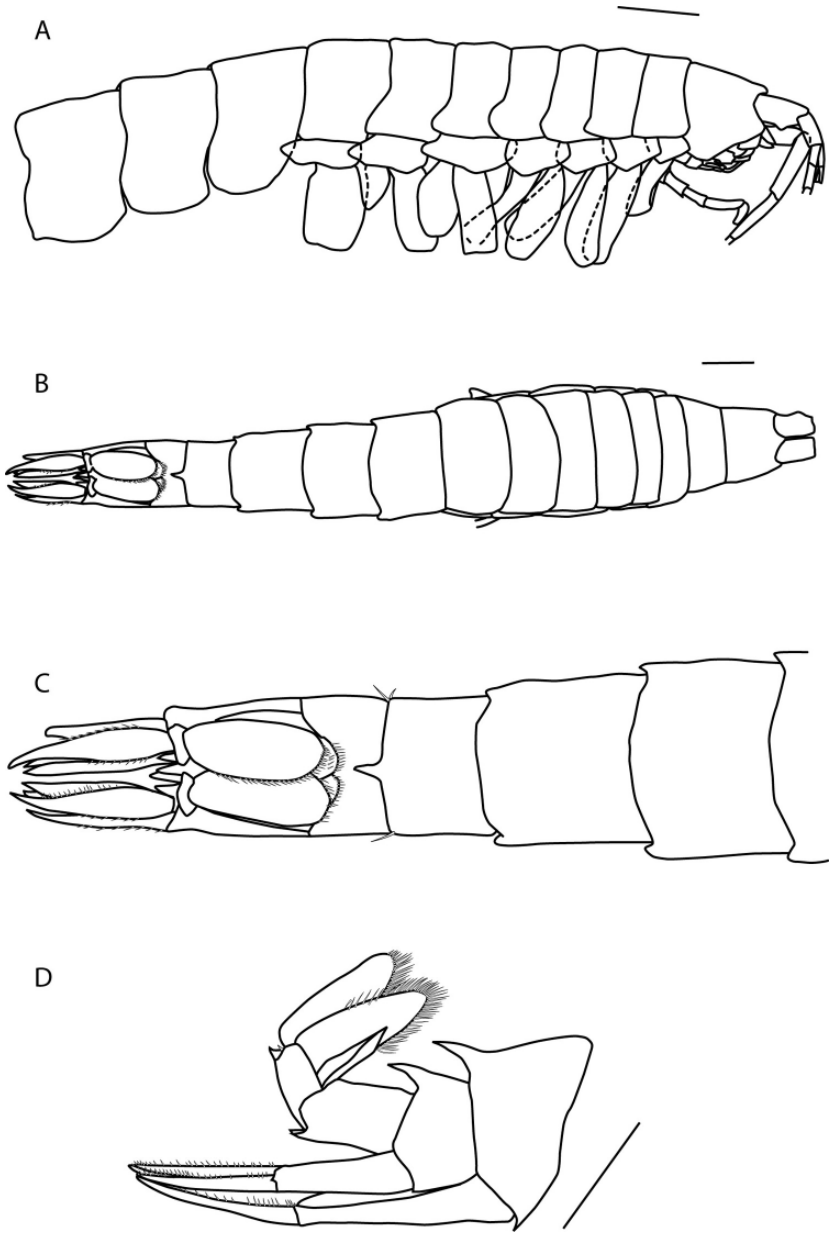

Fig. 1.—*Princaxelia jamiesoni* new spec., holotype, female 56.2 mm; A) habitus lateral view; B) habitus dorsal view; C) urosome dorsal view; D) urosome lateral view; Scale bars: A, B: 0.5 mm, C, D: 1mm.
Fig. 1.—*Princaxelia jamiesoni* nueva especie, holotipo, hembra 56.2 mm; A) vista latera; B) vista dorsal; C) vista dorsal del urosoma; D) vista lateral del urosoma; Escalas: A, B: 0.5 mm, C,D: 1 mm.

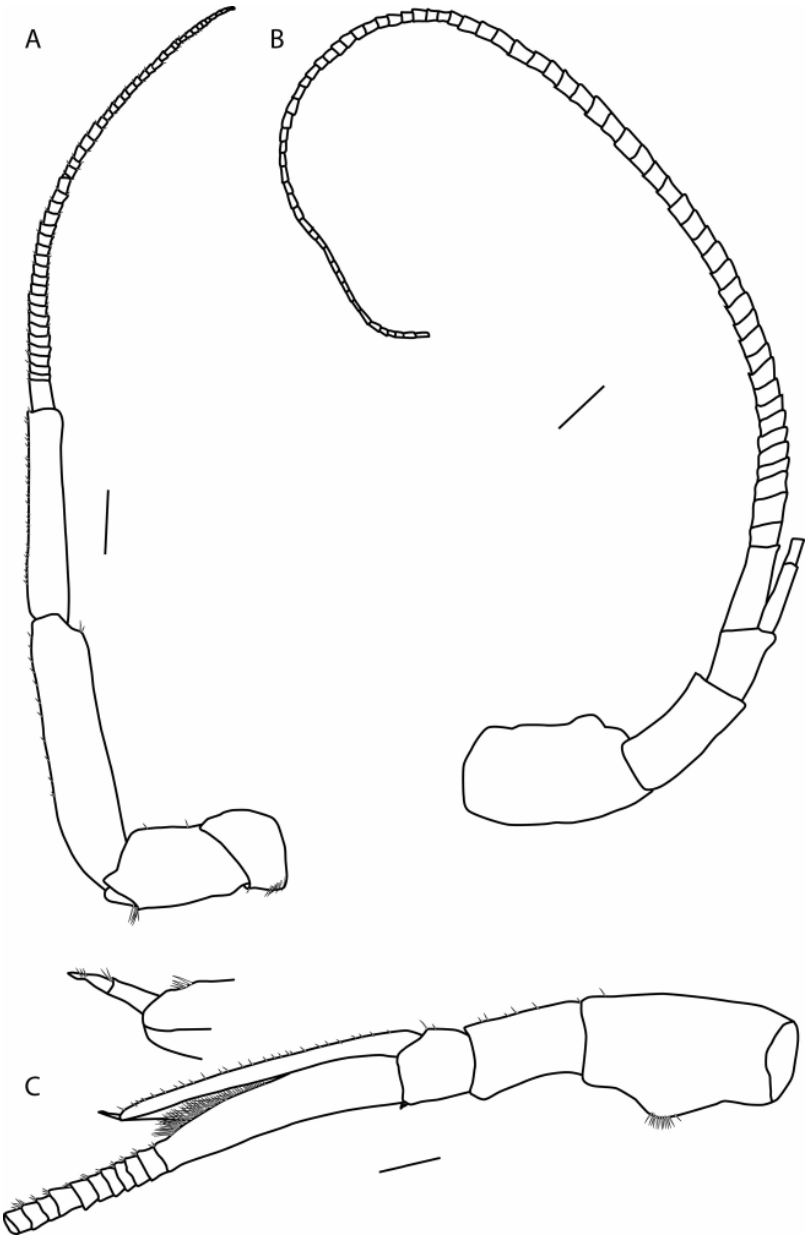

Fig. 2.—*Princaxelia jamiesoni* new spec., holotype, female 56.2 mm; A) antenna 2; B) antenna 1; *Princaxelia jamiesoni* new spec., paratype, male 57.5 mm; C) antenna 1; Scale bars A-C: 1 mm.

Fig. 2.—*Princaxelia jamiesoni* nueva especie, holotipo, hembra 56.2 mm; A) antena 2; B) antena 1; *Princaxelia jamiesoni* nueva especie., paratipo, macho 57.5 mm; C) antena 1; Escalas A-C: 1 mm.

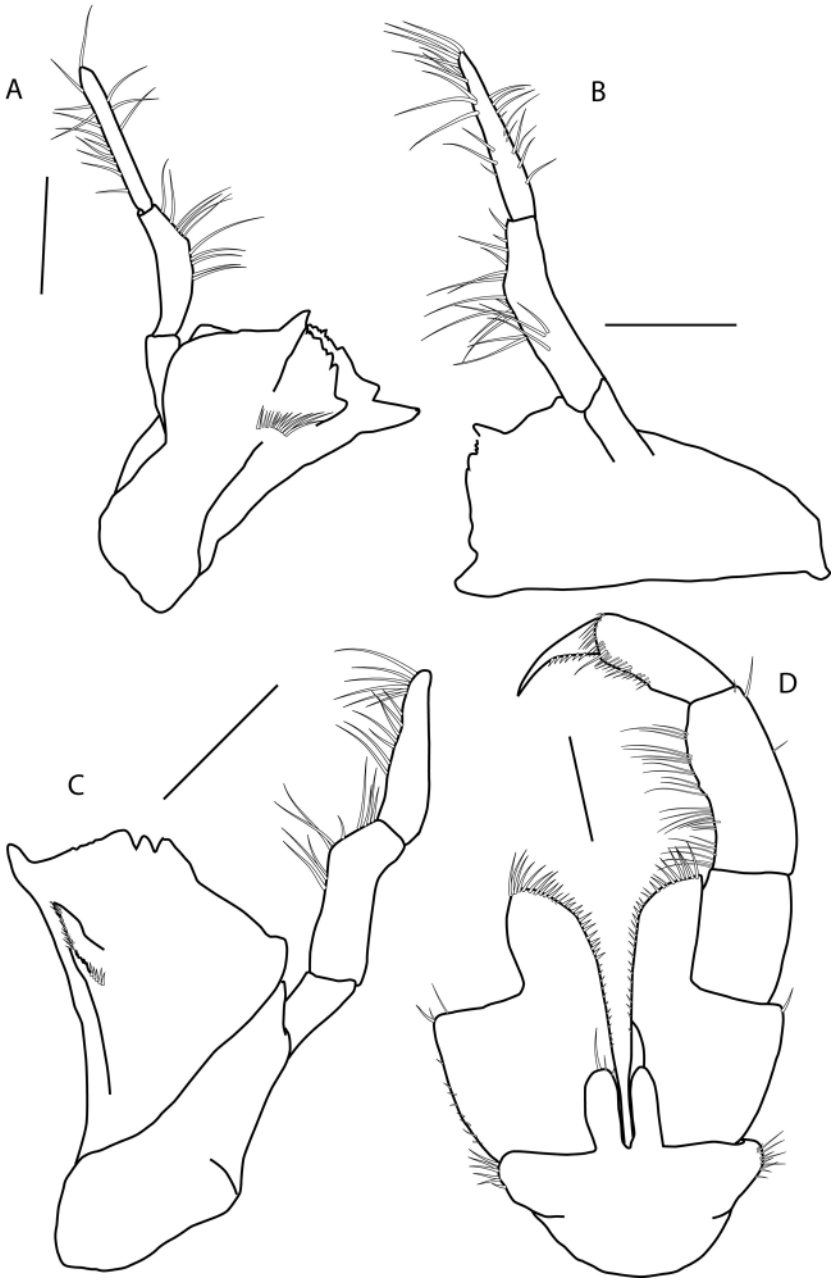

Fig. 3.—*Princaxelia jamiesoni* new spec., holotype, female 56.2 mm; A) left mandible; B) left mandible; C) right mandible; D) maxilliped; Scale bars A-D: 1mm.
Fig. 3.—*Princaxelia jamiesoni* nueva especie, holotipo, hembra 56.2 mm; A) mandíbula izquierda; B) mandíbula izquierda; C) mandíbula derecha; D) maxilípedo; Escalas A-D: 1mm.

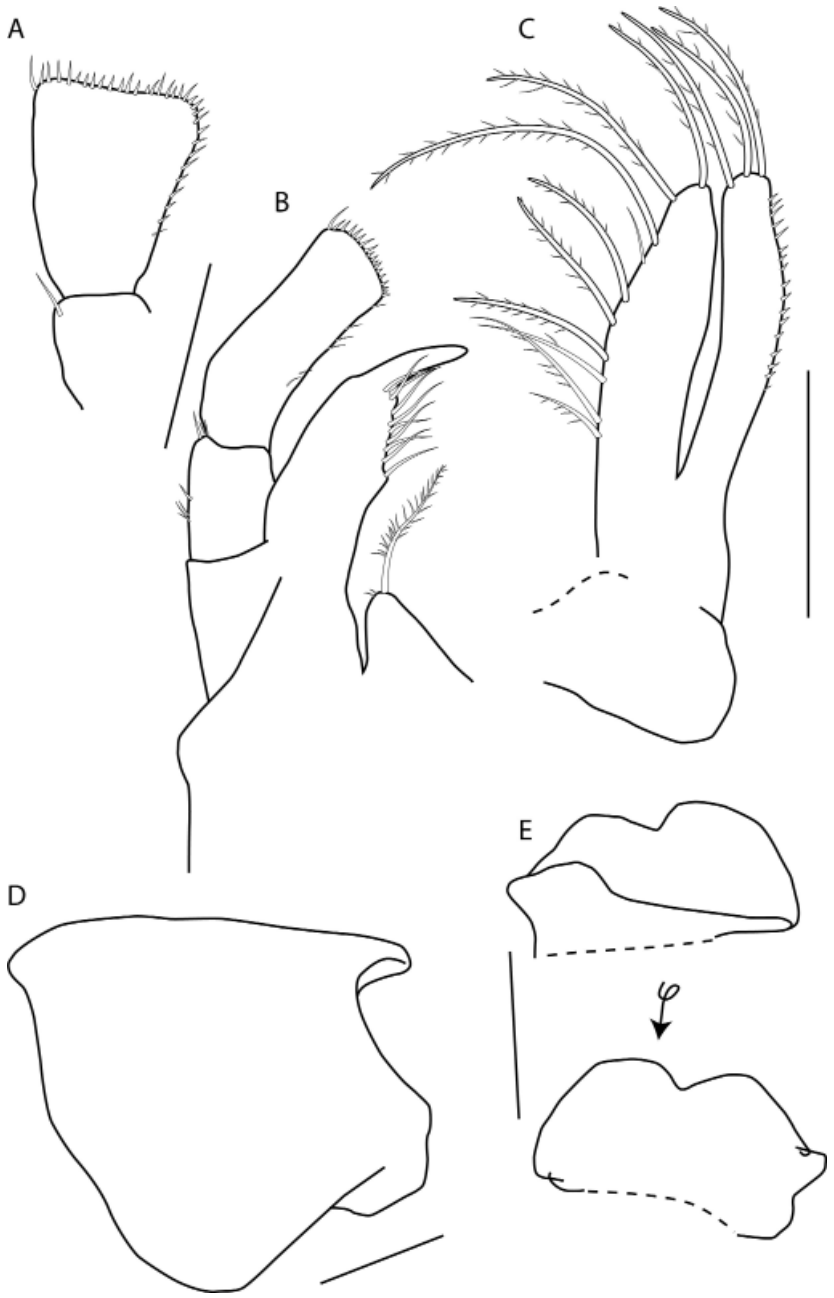

Fig. 4.—*Princaxelia jamiesoni* new spec., holotype, female 56.2 mm; A) frontal view of maxilla palp; B) maxilla 1; C) maxilla 2; D) head; E) labrum; Scale bars: A-D: 1 mm.
Fig. 4.—*Princaxelia jamiesoni* nueva especie, holotipo, hembra 56.2 mm; A) vista frontal del palpo de la maxilla; B) maxilla 1; C) maxilla 2; D) cabeza; E) labro; Escalas: A-D: 1 mm.

Fig. 5.—*Princaxelia jamiesoni* new spec., holotype, female 56.2 mm; A) pereopod 3; B) gnathopod 1; C) gnathopod 2; Scale bars A-C: 1 mm.
Fig. 5.—*Princaxelia jamiesoni* nueva especie, holotipo, hembra 56.2 mm; A) pereiópodo 3; B) gnatópodo 1; C) gnatópodo 2; Escalas A-C: 1 mm.

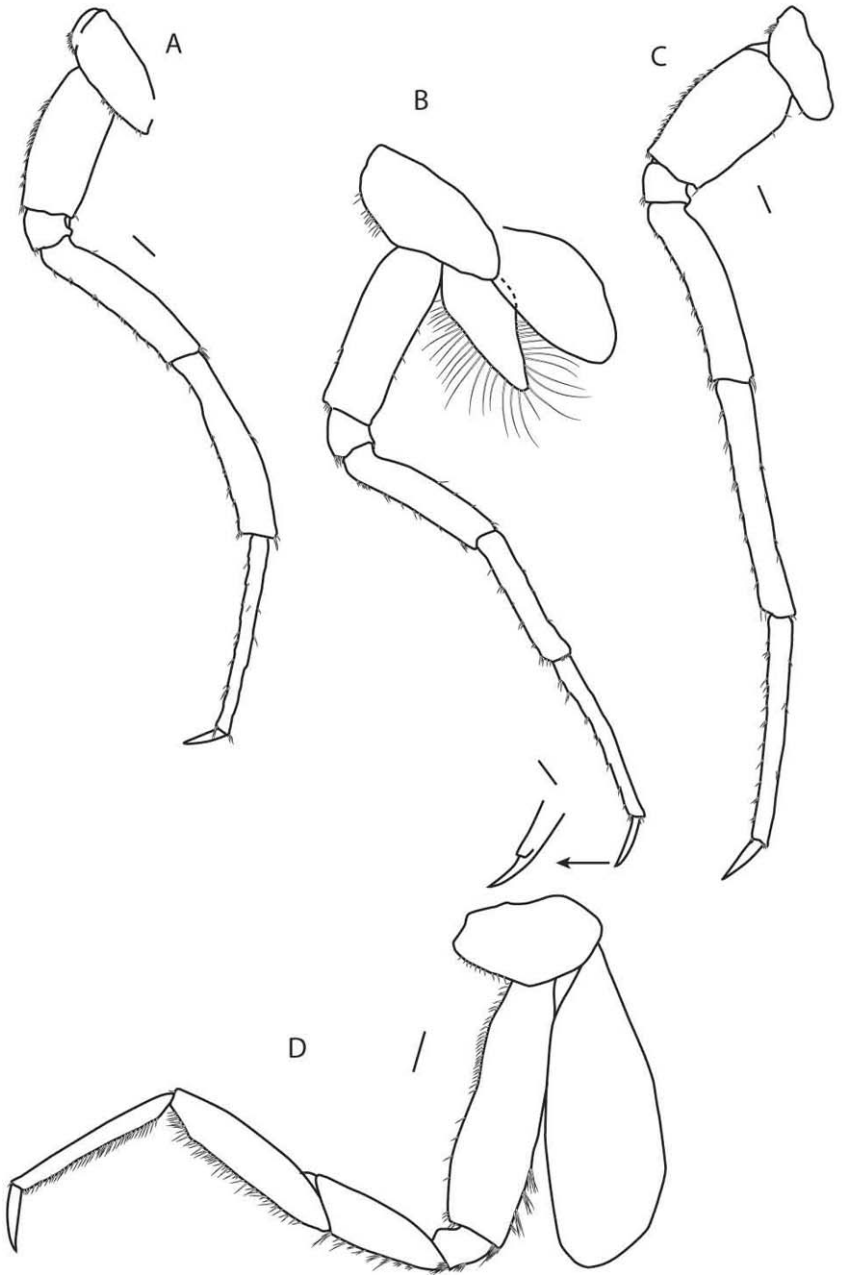

Fig. 6.—*Princaxelia jamiesoni* new spec., holotype, female 56.2 mm; A) pereopod 6; B) pereopod 5; C) pereopod 7; D) pereopod 4; Scale bars A-D: 1mm.
Fig. 6.—*Princaxelia jamiesoni* nueva especie, holotipo, hembra 56.2 mm; A) pereiópodo 6; B) pereiópodo 5; C) pereiópodo 7; D) pereiópodo 4; Escalas A-D: 1mm.

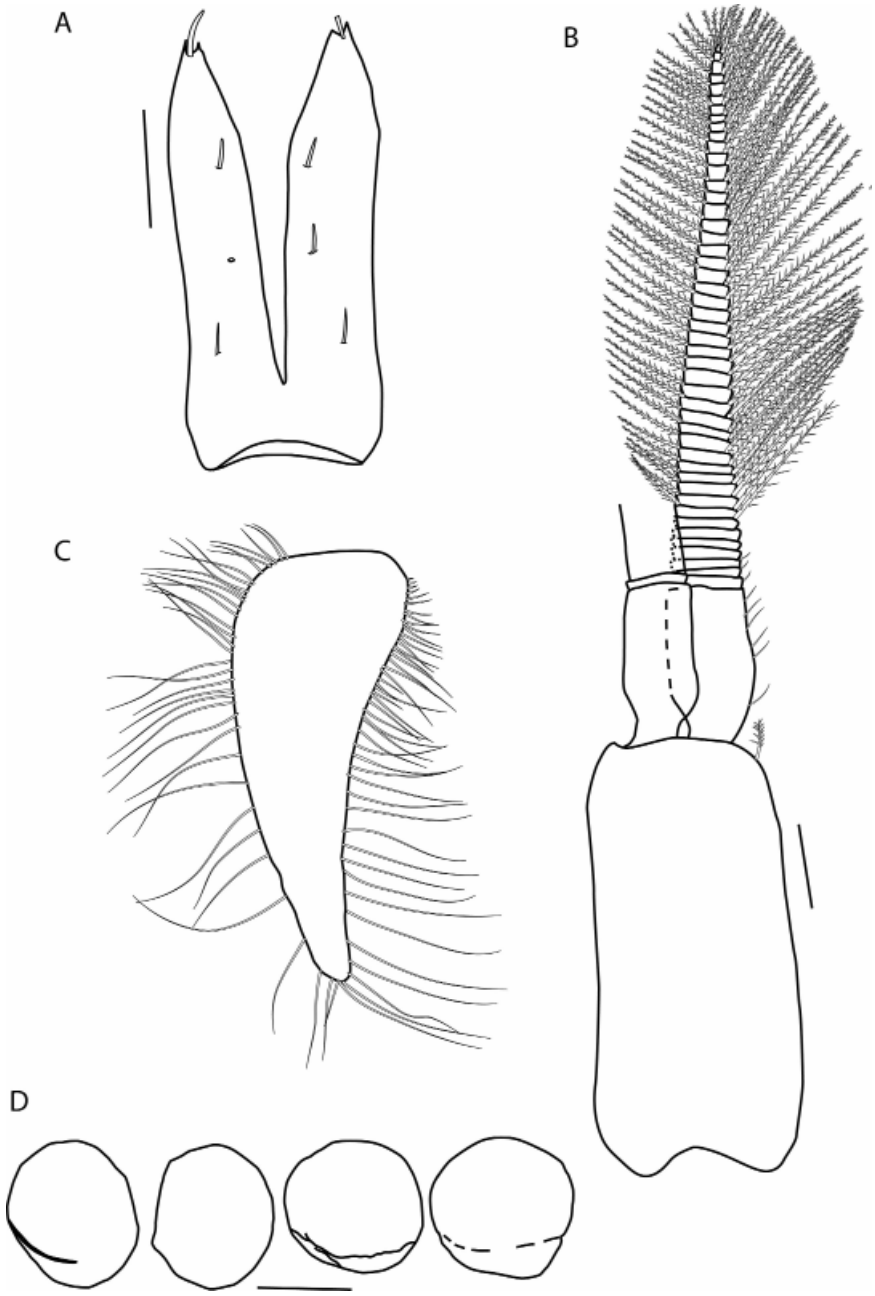

Fig. 7.—*Princaxelia jamiesoni* new spec., holotype, female 56.2 mm; A) telson; B) pleopod 2; C) oostegite at gnathopod 2; D) eggs; Scalebars A-D: 1 mm.
Fig. 7.—*Princaxelia jamiesoni* nueva especie, holotipo, hembra 56.2 mm; A) telson; B) pleópodo 2; C) oosteguito y gnatópodo 2; D) huevos; Escalas A-D: 1 mm.

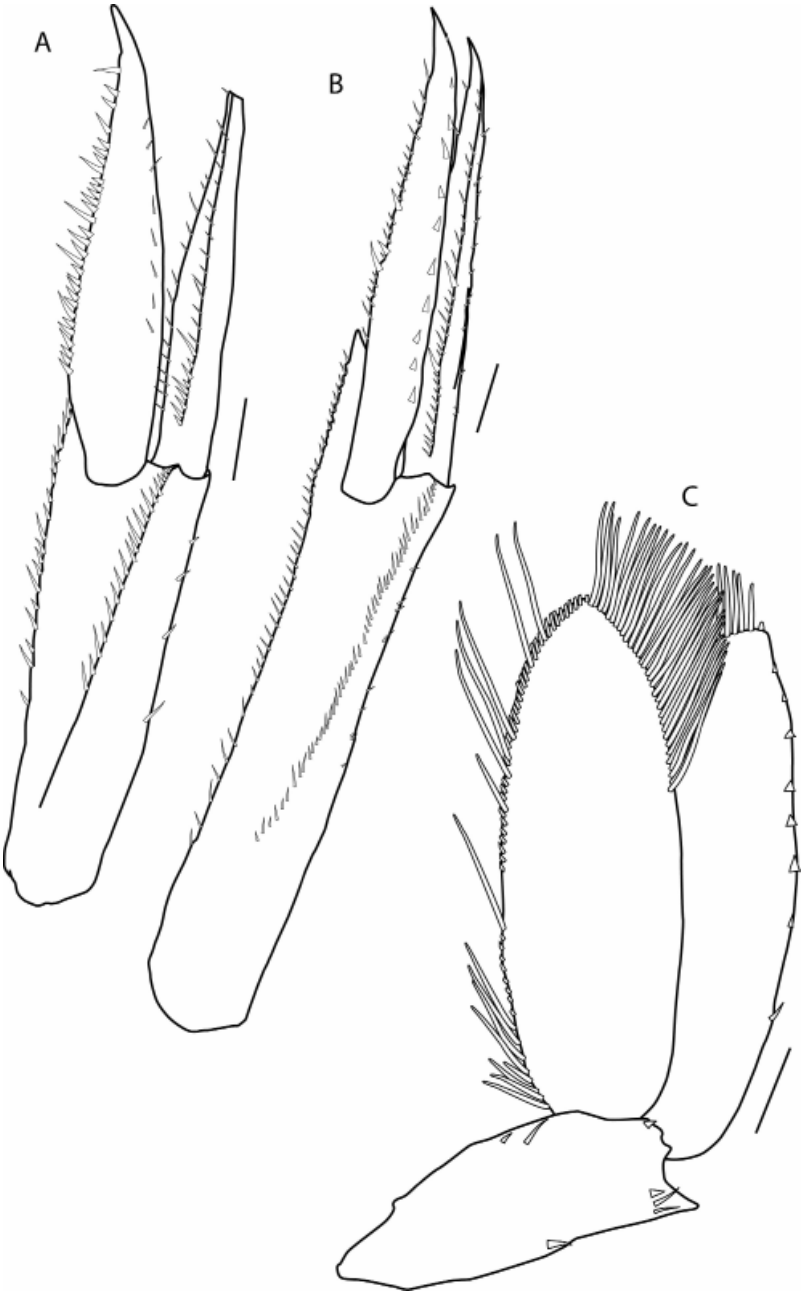

Fig. 8.—*Princaxelia jamiesoni* new spec., holotype, female 56.2 mm; A) uropod 2; B) uropod 1; C) uropod 3; Scale bars A-C: 1mm.
Fig. 8.—*Princaxelia jamiesoni* nueva especie, holotipo, hembra 56.2 mm; A) urópodo 2; B) urópodo 1; C) urópodo 3; Escalas A-C: 1mm.

Fig. 9.—*Princaxelia jamiesoni* new spec. paratypes male 57.5 mm and female 61 mm; lateral view, male top row; Scale bar 10 mm.
Fig. 9.—*Princaxelia jamiesoni* nueva especie, macho paratipo 57.5 mm y hembra 61 mm; vista lateral, macho arriba; Escala 10 mm.

Project: HADEEP; Cruise: Hakuho-maru (KH08-03 Leg1); Collection date: 30 September 2008

Collection method: Baited funnelled trap (bait: mackerel); *In situ* temperature: 1.905 degree C; *In situ* salinity: 34.68; Collectors: Dr. Alan Jamieson & Dr. Toyonobu Fujii (University of Aberdeen), Dr. Asako K. Matsumoto (University of Tokyo).

Additional material studied. *Princaxelia jamiesoni* new spec. NIWA 68855, 1 ovigerous female 36 mm, 1 juvenile 24 mm, collected from the Izu-Ogasawara Trench, 27º22.09'N, 143º13.49'E, 9316 m in March 2009.

Princaxelia abyssalis Dahl 1959, from the Zoological Museum Copenhagen, Holotype ZMUC CRU-5020, Paratype ZMUC CRU-5021; *Princaxelia stephenseni* Dahl, 1959, from the Zoological Museum Copenhagen, Holotype ZMUC CRU-8265, Paratype ZMUC CRU-8266.

Etymology. This species is named for Dr. Alan Jamieson, one of the organisers of the HADEEP project and RV Hakuho-Maru expedition to the Japan trench 2008 and RV Tansei-Maru expedition to the Izu-Ogasawara

Fig. 10.—*Princaxelia jamiesoni* new spec. paratypes male 57.5 mm and female 61 mm, dorsal view, male left.
Fig. 10.—*Princaxelia jamiesoni* nueva especie, macho paratipo 57.5 mm y hembra 61 mm, vista dorsal, macho a la izquierda.

Fig. 11.—*Princaxelia jamiesoni* new spec. paratype female, 61 mm, lateral view of urosome.
Fig. 11.—*Princaxelia jamiesoni* nueva especie, hembra paratipo 61 mm, vista lateral del urosoma.

trench 2009 during which the new species was sampled. Dr. Alan Jamieson's dedication to trench research is greatly advancing the scientific knowledge of deep sea biology.

Diagnosis. Urosomite 1 and 2 with prominent dorsal teeth; large maxilliped, expanded palp of first maxilla; rami of uropod 3 paddle-shaped and setose; telson deeply cleft.

Description. Holotype NSMT-Cr 21250, ovig. female.

Head. Rostrum very short. Lateral lobes prominent. Antenna 1. Accessory flagellum of holotype broken off at second article; flagellum with 75 articles. Antenna 2 peduncle articles 4 and 5 elongate, fifth segment slightly shorter than fourth; 52 articles; each article 2 small spines at basis. Labrum slightly irregular, wider than long with apical incision. Left mandible palp second article midlaterally expanded, both mandible palps bear slender setae on articles 2 and 3. Left mandible with lacina mobilis and spine row, cutting edge with several blunt teeth, a second row of teeth is nearly parallel to

cutting edge. Right mandible also blunt teeth at cutting edge, and accessory spine row, but no lacina mobilis or additional teeth row. Maxilla 1 inner plate with 1 terminal seta; outer plate total of 10 setae, with 9 spine like apical setae, the tenth- most distal seta much larger than the 9 others is not articulated from the outer plate; palp with expanded apical article, numerous setae on apical and distal margins. Maxilla 2 inner plate with 3 terminal setae, outer plate with one distal and several lateral setae; outer plate wider than inner plate. Maxilliped inner plates short and narrow, terminal setae on each; outer plates 3 times as long as inner plate; four articles of palp with spines and setae mainly on the inside, dactylus serrate.

Pereon. Gills on pereopods 2-6, about 2.5 times as long as wide. The gills on pereopods 2-4 were found on the outside of the bases. Oostegites on pereopods 2- 5; about 3 times as long as wide. All coxal plates wider than long. Coxae 2-4 tapering anteriorly and posteriorly, creating a rhomboid impression. Coxae 5-7 slightly bilobed with prominent rounded anterior lobe, posterior lobe slightly produced. Gnathopod 1 basis, ischium and merus with several setae on posteroventral corner; carpus expanded; dactylus reaching 80% length of propodus, dactylus with 7 thick spines. Gnathopod 2 carpus more expanded than in gnathopod 1, basis, ischium, merus, carpus and propodus with more setae on posterior margin than on gnathopod 1; dactylus about 25% length of propodus with 2 lateral and one terminal spine. Pereopod 3 basis slender, subrectangular; ischium short with several setae posteromarginally; merus expanded distally, several setae on posterior margin; carpus expanded, strongly setose posterior margin; propodus slim, about same length as carpus and merus, setae on posterior margin; dactylus with separated tip at terminal end. Pereopod 4 similar to pereopod 3. Pereopods 5-7 long, slender with sparse setation. Pereopod 5 basis length to width 5:2; merus and carpus subequal in length; propodus longer than merus; dactylus with incision. Pereopod 6 longer than pereopod 5; basis length to width 4:2; merus slightly shorter than carpus; carups and propodus subequal in length. Pereopod 7 larger than pereopod 6 but of similar proportions.

Urosome. Uropod 1 peduncle and rami with slender setae; peduncle longer than rami, drawn out into pointed process, process of peduncle as long as 1/3 of rami; rami slender; outer ramus slightly longer than inner ramus. Uropod 2 peduncle and rami with rows of setae, peduncle same length as rami, drawn out into pointed process. Uropod 3 peduncle 2.5 times as long as wide, drawn out into short pointed process, single short setae; rami widened, oval shaped; inner ramus with long slender setae on all margins; outer ramus long slender setae on inner margin and terminal end, outer margin with single short wide setae and a small terminal process

which represents a second segment. Telson more than twice as long as wide, cleft 8/10, each lobe with 3 dorsal and one terminal setae.

Distribution. Japan Trench, 7703 m and Izu-Ogasawara Trench, 9316 m.

Remarks. The left side of the female holotype was dissected, the marsupium was left entire as far as possible, about 40 eggs were counted. The accessory flagellum of female paratype with 6 articles; accessory flagellum of male paratype with 3 articles, first article very large and scale like. Antenna 1 of the female paratype 88 articles, male paratype 48 articles. Antenna 2 of the female paratype flagellum with 54 articles

Sexual dimorphism. The males have the first article of the accessory flagellum enlarged and scale like with numerous sensory setae. The females appear wider from dorsal view (see Fig. 9) due to the filled marsupium.

For differences amongst *Princaxelia jamiesoni* new spec. and the other three known species of *Princaxelia* see table 1. The table comparing morphological characters of *Princaxelia* species remains uncompleted because type material was not retrievable (*P. magna*) or only partly retrieved (only dissected appendices from *P. abyssalis*) or only parts of the specimens were drawn and described in the original descriptions.

Variable characters. Both female specimens NIWA68855 from the Izu-Ogasawara trench in 9316 m show a very slight variation of maxilla 1. The maxillae seem to be asymmetrical. The right maxilla 1 has 8 spine-like setae and one large spine, which also does not seem to be articulated from the outer plate. It has one less setae than holotype NSMT-Cr 21250. The left maxilla 1 on the other hand, has 9 spine-like setae and 2 larger spines, one slightly larger than the other but not as big as the one on the right maxilla.

DISCUSSION

Princaxelid amphipods are carnivores and very good swimmers. Kamenskaya (1981) investigated the mouthparts and gut contents of several amphipod species found in Pacific trenches and regarded *P. abyssalis* as a carnivore and “active long time swimmer”. There is a possibility that some of the material recorded by Kamenskaya (1981) as *Princaxelia abyssalis* from eight trenches belongs to other or so far undescribed species of *Princaxelia*, since they are morphologically very similar. Unfortunately the material can not

Table I.—*Princaxelia* species locality data and morphological characters.
Table I.—Datos sobre las localidades y caracteres morfológicos de las especies de *Princaxelia*.

	***Princaxelia jamiesoni* new spec.**	***Princaxelia abyssalis* Dahl 1959**	***Princaxelia magna* Kamenskaya 1977**	***Princaxelia stephenseni* Dahl 1959**
type locality	Japan trench, 36º 14.96 N 142º 49.01 E	Kermadec trench 32 - 35° S 176- 178° W	Yap trench, 8°28,3' N 137°53 E	SW of Iceland, 60°37 N 27°52 W
depth record	7703 m 9316 m	6620-8300 m	7190-7250 m	1505 m
distribution	Japan – and Izu-Ogasawara trench	Aleutian, Kurile Kamchatka, Izu Bonin (=Izu-Ogasawara), Yap, Japan, Philippine, Bougenville and Kermadec trench (Kamenskaya 1981)	only known from type locality	only known from type locality
maximum body size	male: 57 mm female: 61 mm	male: 21 mm female: 32 mm	male: 52 mm	male: 10 mm ov.. female: 11 mm
dorsal projections urosom 1 and 2	pointing towards distal end	unknown	pointing upright	pointing towards distal end
maxilla 1 palp	expanded	expanded	expanded	not expanded
maxilla 1 internal lobe	1 plumose setae	1 plumose setae	6 plumose setae (vers generic description)	1 plumose setae
mandible spine row	Left mandible with 1 spine row left, none on right	2 spine rows, 15 slender spines in row	1 spine row, 'not a separate group of setae'	1 spine row each mandible
labrum	slightly asymmetrical	unknown	strongly asymmetrical	nearly symmetrical
female A1 first flagellar article	elongated	not elongated	female unknown	elongated
coxa 5 dorsal margin	straight	highest at proximal end	concave	straight/ convex
coxa 5 distal margin	rounded	rounded	slightly pointed	straight
coxae 5-7 ventral margin	slightly bilobed	straight	slightly bilobed	straight

be located and therefore not investigated in detail. The capture of the new species via baited trap underlies the assumption that *Princaxelia* species have well developed olfactory senses, are carnivores and good swimmers.

Several setae of the new species are likely to be sensory organs, especially the aesthetascs on the first antenna of the male and the setae on the rami of uropod 3 as well as the telson.

The body shape is ideal for fast swimming, the uropods and the telson can be folded like a tip of a torpedo – reducing water resistance. The wide uropod 3 can be used as paddle for additional acceleration or as fin for steering. Whilst the body shape is ideal for swimming, the gills are located on the outer side of the pereopods, enabling simplified oxygen uptake. Boudrias (2002) studied the functional morphology of pleopods of the deep-sea scavenger *Eurythenes gryllus* and summarised the complex skeletomusculature construction. The ancillary structures of the propulsive limbs interact strongly with the fluid dynamics forces affecting their locomotion. On first view the pleopods of *Princaxelia* seem very similar to those of *E. gryllus.* Analysis of in situ observations via baited trap video images (Jamieson *et al.* in preparation) will reveal potential differences of swimming movements and behaviour of *Princaxelia* spec. and *E. gryllus*.

Overall *Princaxelia jamiesoni* new spec. is well adapted to its hadal trench habitat; I assume a similar level of adaption is true for the other members of the genus. To live in a trench with rare food availability for carnivores requires good senses when food is available and fast swimming abilities to get there to either feed of a large item or —more likely— feed on the feeding scavengers (e.g. lysianassid amphipods). Lysianassid amphipods are always numerically dominant in baited traps, in shallow waters as well as abyssal and hadal environments (eg. Jamieson et al.in press; Sainte-Marie et al. 1989; Thurston et al. 2002). Sainte-Marie (1992) divided two sets of morphological, physiological and behavioural traits in deep-sea bait attending lysianassoids; one implies carnivory (possibly necrophagy), the other omnivory/ detrivory. The first group have mandibles and guts modified for rapid and gluttonous feeding and may survive long periods without feeding. Amphipods of the second group have mandibles not suitable for the rapid ingestion of bait, rather small guts and may withstand only short periods of starvation. *Princaxelia* would clearly belong to the first group. The strong mouthparts of *Princaxelia* enable fast eating, the maxilliped is especially long , the mandibles strongly spinose, the maxilla plate has several terminal spines and the molar is strongly dentate, these are all generic characters. The morphology of the body and the mouthparts indicate that the genus *Princaxelia* could belong to the top predators of the hadal trench environment.

Key to the species of *Princaxelia*:

1.a) Palp of maxilla 1 second article expanded..... 2
1.b) Palp maxilla 1 second article not expanded; coxal plates 5-7 distal margin straight ……...……..…***P. stephenseni***

2.a) Maxilla 1 inner plate with1 terminal plumose seta..... 3
2.b) Maxilla 1 inner plate with several plumose setae; labrum strongly asymmetrical..... ***P. magna***

3.a) Coxae 5-7 ventral margin straight; female antenna 1 first flagellar article not elongated..... ***P. abyssalis***
3.b) Coxae 5-7 ventral margin slightly bilobed; female antenna 1 first flagellar article elongate, as long as third peduncle article .....
..... ***P. jamiesoni*** **new spec**

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