

# New Record of Miraciidae (Copepoda: Harpacticoida) from Tioman Waters

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**Abstract:** A series of meiobenthic sampling were carried in Tioman Island coral area between July to September 2016 and from August until October 2017. Four species from three different genera were identified as family members of Miraciidae Dana, 1846: *Robertgurneya smithi* Hamond, 1973, *Typhlamphiascus typhloides* Sars G.O, 1911, *Typhlamphiascus lutincola* Soyer, 1963 and *Delavalia clavus* Wells & Rao, 1987. Miraciidae is known as a cosmopolitan family since they dominated all sediment layers and can be distinguished from other families due to the presence of duality ovisac, a rare feature met within harpacticoid. Both *Typhlamphiascus* were put under different group (1 and 2) due to presence of one or two setae on Enp-3 P4. Presence of spinules on the anterior surface of P1 and P4; and spinules laterally align on P1-P4 endopod of *Delavalia clavus* showed the morphological adaptations of harpacticoid at different habitat. As a comparison with published marine harpacticoid reported from Malaysia, *Robertgurneya smithi* and *Typhlamphiascus typhloides* are newly recorded from Malaysian waters.

**Index Terms:** Keywords: Benthic harpacticoid, Miraciidae, Cosmopolitan, Corals, Tioman Waters.

## I. INTRODUCTION

Known as the Hidden Gem of The Sea, Tioman Island located at the centre of the Sunda shelf 38 km off the southeast coast of Peninsular Malaysia of South China Sea is rich with coral reefs. Besides of protecting the coastlines from damaging effects of wave action and tropical storm, coral reefs also provide habitats and shelter for many marine organisms including sponges, fishes and crustaceans. Harpacticoid copepods are considered as one of the most significant element of the marine environment since they act as a food source for other members of the meiobenthos, benthic macrofauna (Tita et al. 2000) as well as fish larvae (Buffan-Dubau and Carman 2000). They are ubiquitous in marine soft-sediments and generally the second most abundant meiobenthic taxon after the numerically dominant nematode (Coull & Bell, 1979; Hicks & Coull, 1983; Higgins

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& Thiel, 1988; Giere, 1993).

## II. LITERATURE REVIEW

The order of harpacticoid copepod covers over 4,300 species belonging to 589 genera in 56 families (Wells, 2007). Miraciidae Dana, 1846 is the second harpacticoid largest group after Canthocamptidae Sars, 1906. Currently, the Miraciidae accommodates 53 genera with 426 species/subspecies (Song ve ark., 2007; Wells, 2007; Karanovic ve Cooper, 2012; Huys ve Mu 2008; Chullasorn, 2011) which were transferred from Diosaccidae by Willen (2002). Miraciids occupy in a wide variety of sediments ranging in grain size from flocculent mud to coralline debris and are primarily found in intertidal and shallow subtidal areas of continental shelves (Chullasorn 2009). The genus-group name *Robertgurneya* was first made available by Apostolov & Marinov, 1988. There are 18 species under *Robertgurneya* Lang (WORMS 2015). According to Ma (2017), there are 15 species and 4 subspecies currently recognized as valid under the genus *Typhlamphiascus*. *Delavalia* Brady, 1869 is a large genus with 53 described species in Miraciidae (Wells, 2007). To date, there are only 19 species from 8 genera (Zaleha et al, 2007) of Miraciidae reported from Malaysian waters which includes intertidal west coast (Zaleha, 2001), subtidal Redang Island, Terengganu (Zaleha et al, 2001), seagrass east coast (Nurul Huda & Zaleha, 2005), bottom of South China Sea (Zaleha et al., rockpool seaweed west coast (Zaleha & Nazia, 2006), bottom of east coast Peninsula (Zaleha & Roswati, 2006) and vegetative area of Sungai Pulai, Johor (Zaleha et al, 2017). However, so far, there is no published data on harpacticoid copepod from Tioman waters.

## III. METHODOLOGY/MATERIALS

Sediment samples were collected from Tioman Island from July until September 2016 and from August until October 2017. Triplicate sediment samples were collected by SCUBA divers by hand corers at the sampling stations in Renggis, Tulai, Salang, Batu Malang and Pulau Soyak as part of the coral area found in Tioman Islands. Each cores were transferred and fixed with 5% formalin and were brought to the laboratory for further process. In the laboratory, the sediments were mixed with water and decanted to separate the meiofauna from sediments. Meiofauna was separated from sediment and macrofauna by using 500 microns and



followed by 62 microns mesh sieve. Harpacticoid copepod were separated from other meiobenthos by using Irwin loops and fixed by using 5% buffered formaldehyde and stained with Rose Bengal solution. The harpacticoids then preserved in 70% ethanol. Samples were examined under Leica EZ4 stereomicroscope. Each appendages were dissected in 50% glycerol solution using fine tungsten needles (0.005mm). The dissected appendages immersed in lactophenol solution, CMCP-9 on clean slides and covered with micro coverslip before sealed with clear nail varnish. All slides were observed and illustrated under 1000 magnification of Leica DM500 compound microscope equipped with lucida camera. The terminology used to describe the body, appendages and setal formula were adapted from Huys and Boxshall (1991) and Huys (1996). The abbreviations used in this article : Aesthetacs-Ae, Exp- exopod, Enp- endopod, P1-P5, first to fifth thoracic legs.

#### IV. RESULTS AND FINDINGS

##### A. SYSTEMATICS

FAMILY Miraciidae Dana, 1846

Subfamily Diosaccinae Sars M, 1906

Genera *Robertgurneya* Lang 1948

Species *smithi* Hamond, 1973

Material examined : 2 ♀

Type of locality- Batu Malang, Pulau Tioman (2°54'14.94"N104° 6'14.93"E)

##### 1) Description

Body fusiform and prehensile. Body length is 648 µm. Abdomen slightly tapering towards the urosome. Urosomites furnished with row of spinules dorsoventrally and ventrally. Caudal rami (FIGURE 1G) are short with five setae. Presence of coarse spine at the base of penultimate somite.

Antennule (FIGURE 1A) 8 segmented. Segment 2 is the longest. Aesthetacs bears at segment 4 and 8.

P1 (FIGURE 1B) Coxa widened with five slender setae at the outer lateral setae. Basis with one outer strong setae and one inner strong setae at the outer lateral corner. Presence of row of spinules along distal margin at the articulation of endopod. Endopod three segmented. Enp-1 is prehensile and two times longer than Enp-3. One slender setae at the outer lateral and almost near the distal margin. Enp-2 is the shortest with one short setae on both inner and outer margin. Enp-3 has one short setae, one slender setae and one spine. Exopod three segmented. Exp-3 reached three quarter of endopod. Each exopod segments are subequal in size. Exp-3 has three spine and one geniculate setae.

P2 (FIGURE 1C) Coxa widened and almost square. Presence of two rows of spinule on the anterior surface of coxa. Basis has a row of short spinules at the anterior surface near the distal corner and a row of spinules along distal margin at the articulation of endopod. Endopod three segmented. Enp-1 has one inner setae. Enp-2 has one short and one long plumose inner setae. Enp-2 has elongated outer distal end forming triangular tip. Enp-3 is the longest segment with one inner long plumose setae. At the distal of Enp-3, presence of one plumose setae, one unipinnate sete and one

spine. Presence rows of intermediate spinules along the outer lateral margin of each segment. Exopod three segmented. Exp-1 and Exp-2 has one strong lateral spine at the outer lateral margin. Exp-2 and Exp-3 has one inner plumose setae at the inner lateral margin. Exp-3 has three strong outer lateral setae and two long pinnate setae at the terminal.

P3 (FIGURE 1D) Coxa widened with a row of spinules near the corner of outer lateral margin. Basis has one slender outer setae and row of spinules along distal margin at the articulation between endopod and exopod. Endopod three segmented. Enp-1 and Enp-2 has one inner plumose setae. Enp-3 has two long inner setae with one long slender setae, one bipinnate setae and one spine at the terminal. Exopod three segmented. Exp-1 has one setae at the outer lateral margin and minute spinules at the distal margin. Exp-2 has one outer lateral setae and one inner plumose setae. Exp-3 has three outer bipinnate setae, two pinnate setae at the distal margin and two plumose setae at the inner lateral margin.

P4 (FIGURE 1E) Coxa widened. Basis has three short spinules at the corner near the distal and row of spinules along distal margin at the articulation between endopod and exopod. Endopod three segmented. Enp-3 has one long pinnate setae, two unipinnate setae at the terminal and one inner short setae. Exopod three segmented. Exp-1 and Exp-2 has one pinnate setae. Exp-3 has pinnate setae and one bipinnate setae at the outer lateral margin, one bipinnate setae and one long slender setae at the distal margin; and two long plumose setae at the inner lateral margin.

##### Setal formula

	Exopod	Endopod
P2	0.1.123	1.2.121
P3	0.1.123	1.1.221
P4	0.1.223	1.1.121

P5 (FIGURE 1F) Exopod ovoid shaped and extending beyond the baseoendopod. Exopod has 6 setae whereas baseoendopod has five setae.

##### 2) Remarks

*R. smithi* first reported by Hamond in 1973 collected near Adelaide, Australia. The setal formula of both specimens are the same. The differences from these two *R. smithi* Hamond and the specimen from present studies are: a) The body of *R. smithi* Hamond was slightly slender and larger in size, b) Each endopodal segment has an outer plumose setae, c) Presence of outer lateral spinules along Enp-1 and; d) Presence of two bifid setae on baseoendopod. The specimen is different in setal formula from *R. oligochaeta* Noodt, 1955 (Zaleha, 2001) and the number of setae on baseoendopod are four with two bifid setae while exopod consist of five setae. It is also different from *R. rostrata* Gurney, 1927 as presence of one setae in *R. rostrata*. Both *Robertgurneya* are also smaller in size: *R. oligochaeta* (534.90 microns) and *R. rostrata* (497.28 microns). Lang (1948) stated that the range size for *R. rostrata* is between 0.65 mm to 0.8 mm.

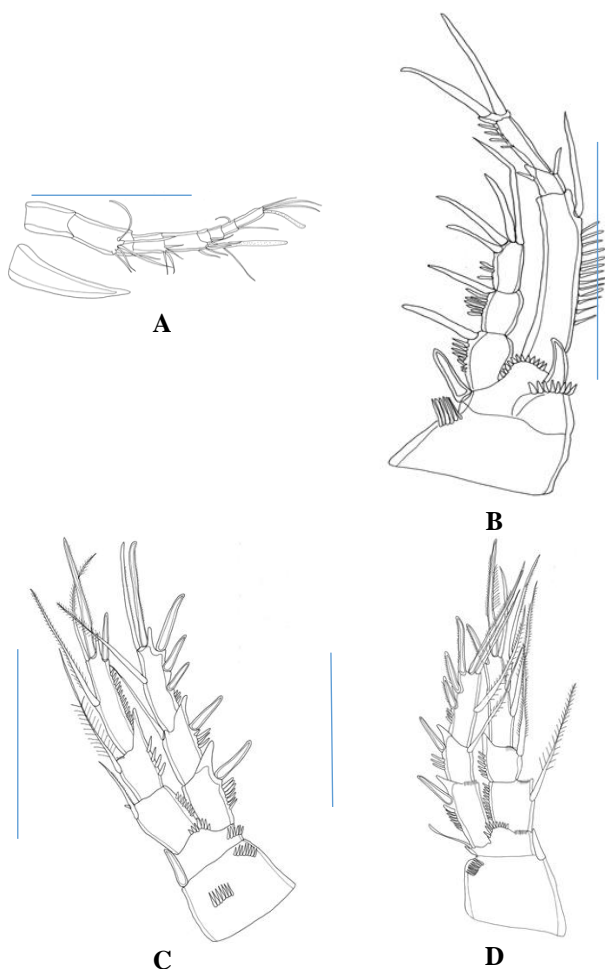


FIGURE 1 *Robertgurneya smithi* (♀) A.A1& rostrum B. P1. C.P2 D.P3.  
Scale bar (mm): A= 0.037, B: 0.023, C= 0.018, D=0.021.

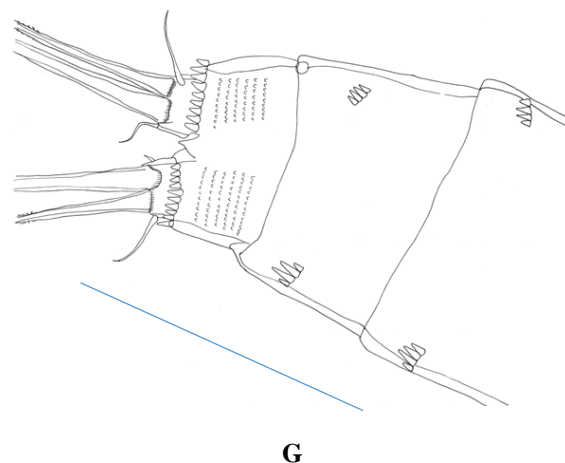
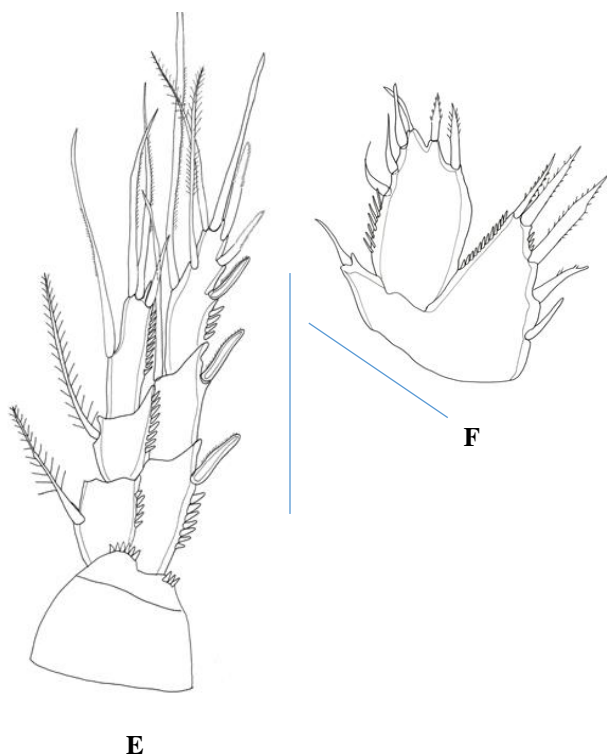


FIGURE 1 *Robertgurneya smithi* (♀) E.P4 F. P5. G. Caudal rami.  
Scale bar (mm): E= 0.023, F: 0.0012, G= 0.023.

## B. SYSTEMATICS

Genera *Typhlamphiascus* Sars G.O 1905

Species *typhloides* Sars G.O 1911

Material examined: 2 ♀

(Synm: *Amphiascus typhloides* Sars G.O, 1911)

Type of locality. Tulai 1, Pulau Tioman (2°54'21.73"N 104° 5'58.73"E)

### 1) Description

Female. Body comparatively slender and sub-cylindrical. Body length from the anterior of cephalotorax towards the posterior of caudal rami is 690 µm. Caudal rami (FIGURE 2G) bulbous with six setae. Presence of spinules at the base of penultimate somites.

Antennule (FIGURE 2A) Composed of 8 segments and slender. Aesthetacs bears at segment number four. Segment one and two are the longest and they are subequal in size.

P1 (FIGURE 2B) Coxa is widened and almost square shape. Presence of 4 short arched of spine on the anterior surface of coxa. Basis is small. Presence of short spine at the corner of inner lateral. Endopod 3 segmented. Enp-1 is prehensile and 2 times longer than Enp-3. Plumose setae at the inner lateral near the corner of terminal. Enp-2 the shortest with a short plumose setae at the inner lateral. Enp-3 has one geniculate setae, one slender setae and one short setae at the distal.

P2 (FIGURE 2C) Coxa wide and bare. Basis with a row of spinules at the inner lateral margin and one spine at the outer lateral margin. Endopod three segmented. Enp-1 has one short plumose setae at the distal corner. Enp-2 with 1 spine and 1 plumose setae near the distal corner. Enp-3 has one long plumose setae at the inner lateral margin. Presence of 2 long plumose setae and 1 short plumose setae at the distal margin of Enp-3. Exopod three segmented. Exp-1 and Exp-2 has one inner and one outer setae. Exp-3 has one inner setae, three outer lateral setae and 2 long setae at the terminal.

P3 (FIGURE 2D) Coxa widened and trapezoidal. Presence of two rows of spinules on the anterior surface and a row row of spinules at the outer lateral margin of coxa. Basis has one slender setae at the outer lateral margin. Endopod three segmented. Enp-2 and Enp-3



are longer than Enp-1. Enp-1 and Enp-2 has one inner plumose setae at the inner lateral margin. Enp-3 has two 2 plumose inner setae at the lateral and 2 plumose setae and one short setae at the terminal. Exopod three segmented. Each exopod segment has 1 long bipinnate setae at the inner lateral margin. Exp-1 and Exp-2 has one pinnate setae at the outer lateral margin. Exp-3 has 2 pinnate setae at the outer lateral margin and two bipinnate setae at the terminal.

P4 (FIGURE 2E) Coxa widened. Basis small with one small slender setae at the outer lateral margin. Both endopod and exopod are three segmented. Exopod is longer than endopod. Both Enp-1 and Enp-2 has one inner long setae with one third pectinate. Along the outer lateral margin of Enp-1 and Enp-2 ornamented with spine. Enp-3 had one outer setae, two apical setae and one inner with one third pectinate setae. Each exopod segment has one outer unipinnate spine. Exp-1 has one inner one third pectinate setae, Exp-2 has one inner unipinnate setae. Exp-3 has two inner one third pectinate setae, two plumose setae and one media setae at the apical.

Setal formula

	Exopod	Endopod
P2	1.1.123	1.2.121
P3	1.1.123	1.1.221
P4	1.1.223	1.1.121

P5 (FIGURE 2F) Without chitinous ornamentation. Baseoendopod is separated from exopod. Baseoendopod has 3 setae and 1 bifid setae at the outer. Exopod five setae.

2) Remarks

The taxonomy of *Typhlamphiascus* is very confusing (Wells, 2007). It is grouped as group 2 Por's (1963) due to the presence of one setae on the Enp-3 of P4. *Typhlamphiascus typhloides* of Tioman were different from *Typhlamphiascus typhloides* Sars as the number of caudal rami is four rather than six. It is different from its congeners as *T. confusus*: 1) The furcal rami are normal and not swollen at the basal, presence of two bifid setae on the baseoendopod and exopod is elongated. It is different from *T. bervicornis* due to the presence of seven setae on the exopod. Exopod elongated and the furcal rami are filiform. It can also be distinguished from *T. sp Vilela* and *T. confuses glumaricus* as a filiform shape of furcal rami. It is different from *T. pectinifer* found from sediment of seagrass area in Sungai Pulaui Johor as the setal formula of P4 endopod and larger size (800 microns).

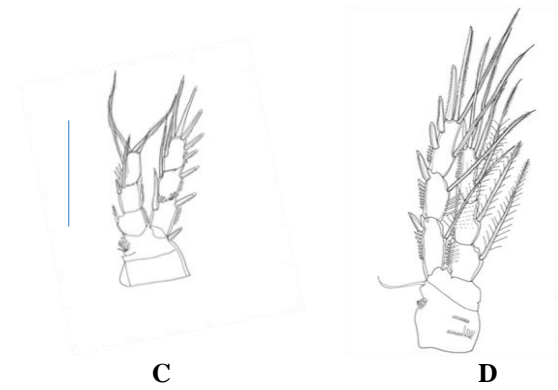
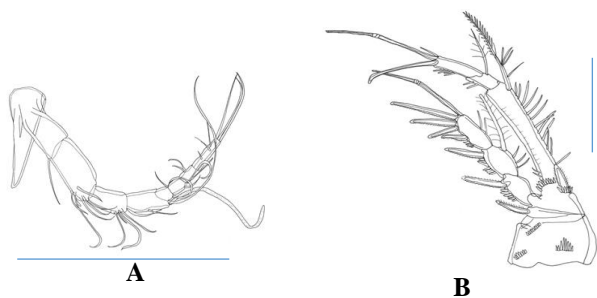


FIGURE 2 *Typhlamphiascus typhloides* (♀) A.A1 B. P1. C.P2 D.P3.

Scale bar (mm): A=0.03, B=0.017, C=0.03, D= 0.014.

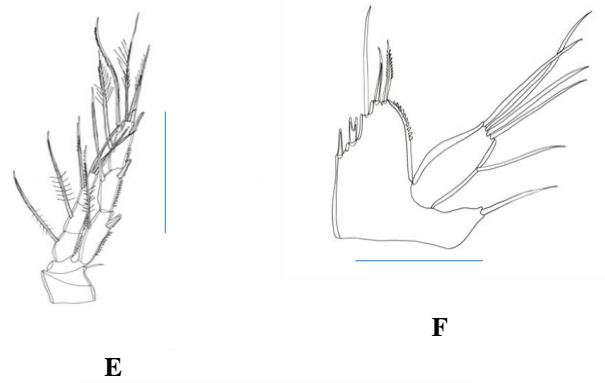
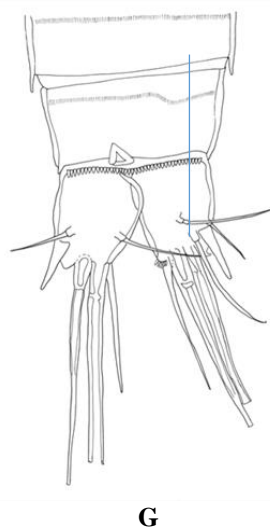


FIGURE 2 *Typhlamphiascus typhloides* (♀) E.P4 F. P5. G. Caudal rami.

Scale bar (mm): E=0.025, F=0.006, G= 0.018.



C. SYSTEMATICS

Genera *Typhlamphiascus* Sars G.O 1905  
 Species *luticola* soyer 1963  
 Material examined: 1♀  
 Type of locality: Soyak (2°52'29.35"N104° 8'51.93"E)

1) Description

Female. Body slender and prehensile. The size from rostrum towards the posterior of caudal rami is 750 mm. Cephalotorax shorter than three succeeding somites.



Caudal rami is longer than broad.

Antennule (FIGURE 3A 4) consists of eight segmented. Aesthetacs bears at fourth segment. Segment is the longest.

Antenna (FIGURE 3B) a row of spine at the inner lateral basis. Exopod three segmented. Exp-1 and Exp-2 with one lateral setae whereas Exp-3 with three setae at the apical. Endopod one segmented with seven apical setae: four are geniculate setae and two spine at the outer lateral margin.

P1 (FIGURE 3C) Coxa widened with two separate rows of spinules on the anterior surface and a row of spinules at the distal. Basis is smaller with strong spine at the outer distal corner and a unipinnate setae at the inner lateral margin. Exopod three segmented and each segment are subequal in size. Exp-1 and Exp-2 has one outer unipinnate setae an ornamented with spine at the lateral margin. Exp-2 has one inner spinulose setae. Exp-3 has three outer lateral strong unipinnate setae and two apical setae: one unipinnate setae and one spinulose setae.

P2 (FIGURE 3D) Coxa widened with a rows of spinules on the anterior surface. Basis small with a short row of spinules on distal internal surface and a strong spine at the outer lateral margin. Presence of minute hairs at the distal margin of basis. Exopod three segmented. Exp- 1 and Exp-2 has one outer unipinnate spine and one inner plumose setae. Presence of spinules at the distal margin of Exp-1. Exp-3 is the longest segment with two outer unipinnate setae, two apical setae: one 2/3 pectinate setae and one medial pinnate setae. Endopod three segmented. Enp-1 has one inner spinulose setae. Enp-2 has two inner spinulose setae. Enp-3 is the longest segment with one inner spinulose, two spinulose setae at the distal and one outer unipinnate setae.

P3 (FIGURE 3E) Coxa widened with a row of spinules on the anterior surface and a short row of spinules near the diatal corner. Basis short with a slender setae at the external lateral margin and a row of spinules at the corner of inner margin. Exopod three segmented. Exp-1 and Exp 2 has one outer setae and one inner spinulose setae. Exp-3 has three outer setae:two smooth setae and one unipinnate setae, one long inner spinulose setea and two distal setae: one long spinulose setae and one with half side pectinate and another side spinulose. Endopod three segmented. Enp-1 and Enp-2 has one inner spinulose setae. Enp-3 has two spinulose setae, two distal setae: both half side pectinate and the other side spinulose, and one outer unipinnate setae.

P4 (FIGURE 3F) Coxa widened with five rows of spinules on the anterior surface. Basis short with minute hairs near the distal of endopod. Exopod three segmented. Exp-1 has one outer smooth setae, one inner spinulose setae and a row of spine at the distal. Exp-2 has one outer smooth setae, one inner spinulose setea and a minute hairs at the distal. Exp-3 has three outer unipinnate setae, two apical setae: one smooth setae and one spinulose setae; and two inner long medial unipinnate setae. Endopod three segmented. Enp-1 and Enp-2 has one inner spinulose setae. Enp-3 has two long inner setae: one spinulose setea and one pectinate setae, two spinulose apical setae and one smooth outer setae.

Setal formula

	Exopod	Endopod
P2	1.2.121	1.1.123
P3	0.1.221	1.1.123
P4	0.1.221	1.1.223

P5 (FIGURE 3G) Inner extension of baseoendopod extended halfway of exopod. Presence of inner bifid setae, two median setae and one outer setae. Exopod oval shaped which three times as long as width with five bare setae and one spinulose setae.

## 2) Remarks

Typhlamphiascus lutincola Soyer bears two setae on Enp-3 P4, therefore it belongs to Por's (1963) group 1 along with T. confusus erythraeicus Por, T. confusus gullmaricus Por, T. higginsi, T. lamillifer lamellifer Sars, T. latifurca Por, T. longifurcatus Rouch, T. ovale Wells & Rao, T. pectinifer, T. typhlops Sars and T.unisetosus. T. lutincola differs from the rest of the group members except T. longifurcatus due to the presence of five setae on Enp-3 of P4 instead of four setae. It is also different from its congener, T. pectinifer because of Exp-1 P1 of T. pectinifer extends to about the end of Enp-2. T. lutincola can also be distinguished from T. longifurcatus since P5 exopod (T. longifurcatus) has 4 setae instead of 6 setae.

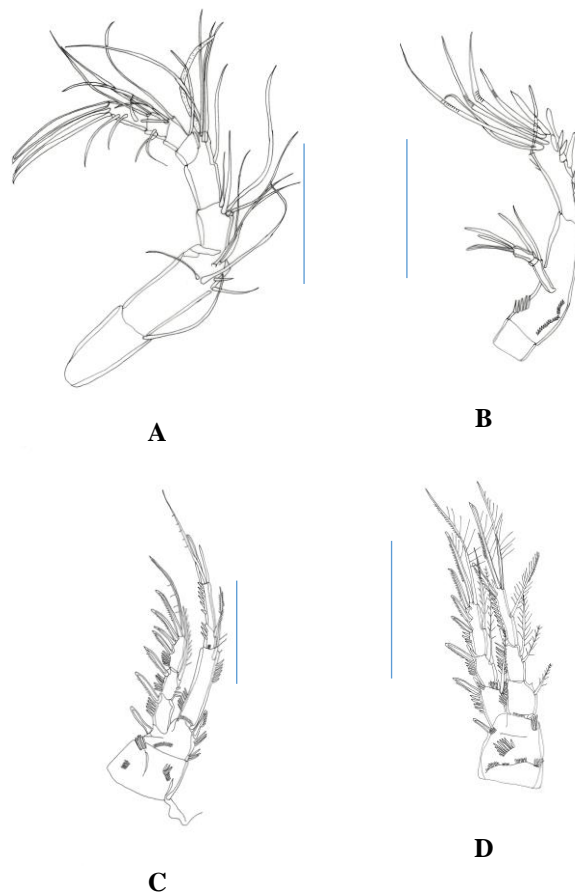


FIGURE 3 *Typhlamphiascus lutincola* (♀) A.A1 B. A2. C.P1 D.P2.

Scale bar (mm): A=0.03, B=0.02, C=0.018, D= 0.017.

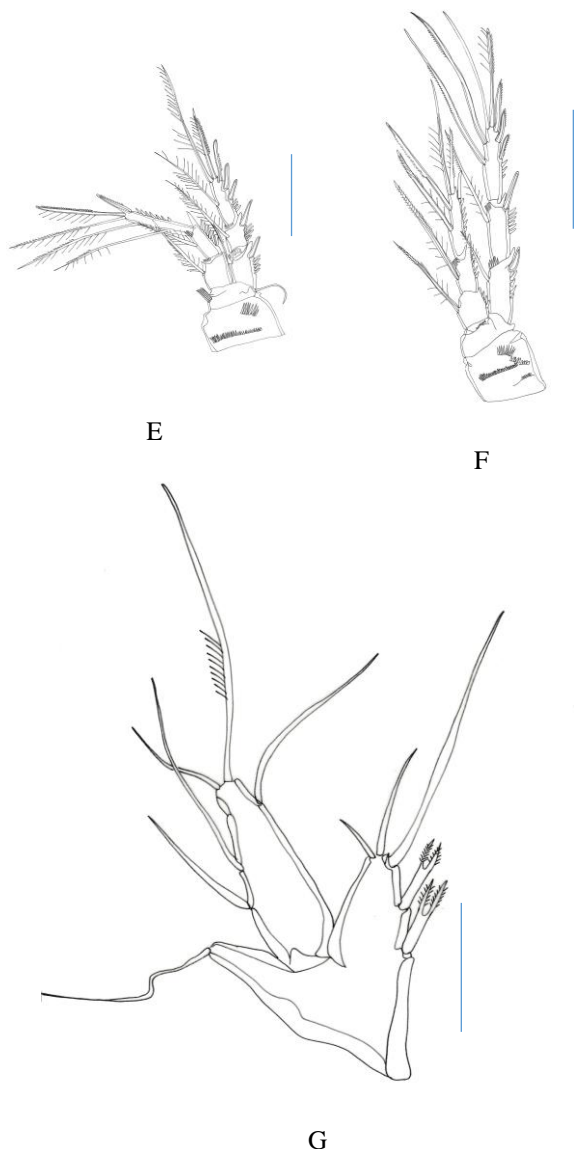


FIGURE 3 *Typhlamphiascus lutincola* (♀) E.P3 F. P4. G.P5  
Scale bar (mm): E=0.018, F=0.019, G=0.017

#### D. SYSTEMATICS

Genera *Delavalia* Brady 1869

Species *clavus* Wells&Rao1987

(Original name: *Stenhelia clavus* Wells & Rao, 1987)

Type of locality. Renggis, Pulau Tioman  
(2°48'34.23"N104° 8'6.70"E)

##### 1) Description

Female. The size of the adult is 456  $\mu$ m. Rostrum bell-shaped with a sensillae at both side of cephalic shield. Cephalotorax slightly broad than long, thoracic and urosomal gradually tapering towards the posterior. Caudal rami (FIGURE 4H) are 2.5 times elongated than broad and ornamented with 6 setae. Presence of minute hairs at the penultimate somites.

Antennule (FIGURE 4A) 8 segmented. Aesthetacs bears on 4th segment.

Antenna (FIGURE 4B) Exopod three segmented. Two setae at the apical and three setae at the lateral of exopod. Endopod one segmented with 2 outer spines and six apical setae.

P1 (FIGURE 4C) Coxa widened with a row of long spinules on anterior surface. Basis with bipinnate setae on the

inner and outer lateral margin and presence of row of spine at the articulation of Enp-1. Endopod 2 segmented. Enp-2 longer than Enp-1. Presence of spinules one the distal of anterior surface and distal margin. Enp-2 with two inner plumose setae and whereby at the apical presence of one setae ornamented with setules at the outer margin and one unipinnate spine. Along the outer lateral margin of Enp-2 ornamented with spinules. Exopod 3 segmented. Exp-1 with one outer strong unipinnate spine at the corner. Exp-2 with one outer distal unipinnate spine and one small setae at the inner. Exp-3 have two outer spine and two unipinnate setae at the apical. Both Exp-2 and Exp-3 ornamented with spinules along the outer lateral and apical margin.

P2 (FIGURE 4D) Coxa widened with an arched of long spinules on the distal anterior surface. Basis with one slender setae on outer lateral margin and long spinules at the inner lateral margin. Endopod 3 segmented. Enp-1 with 1 inner slender setae. Enp-2 with 2 inner setae and Enp-3 has 1 long inner setae and three setae at the apical: two plumose setae and one bipinnate setae. Exopod 3 segmented. Exp-1 with one strong bipinnate setae at the corner of distal margin. Exp-2 has one strong bipinnate setae at the corner of distal margin and one long plumose setae at the inner margin. Exp-3 has two bipinnate setae at the outer margin, one bipinnate setae at the subapical, two plumose setae at the apical and one inner plumose setae.

P3 (FIGURE 4E) Coxa widened with an arched of long spinules on the distal anterior surface. Basis with one slender setae on outer lateral margin and a row of spinules at the inner lateral margin. Both exopod and endopod are 3 segmented. Enp-1 and Enp-2 have one inner plumose setae whereby Enp-3 has a strong plumose setae at the inner margin. Enp-3 has three setae at the terminal: one setae ornamented with spinules at the inner and setules at the outer, one setae ornamented with spinules at the outer and setules at the inner and one bipinnate setae. Exp-1 has one outer unipinnate setae and minute hairs at the inner corner. Exp-2 has one outer unipinnate setae at the outer and one slender plumose setae at the inner. Exp-3 has two outer unipinnate setae at the outer, one unipinnate setae at the subapical and two setae at the terminal which both ornamented with spinules at the outer and setules at the inner.

P4 (FIGURE 4F) Coxa is widened and a row of spinules at the distal of anterior surface. Presence of one slender setae at the outer lateral margin of basis. Both exopod and endopod are 3 segmented. Enp-1 has a long and slender inner setae which unipinnate at the one third of the setae. Enp-3 has 2 long plumose setae and 1 bipinnate setae at the apical. Each of endopod segment ornamented with spine. Exp-1 has an outer unipinnate setae with the anterior surface ornamented with spinules near the distal edge. Exp-2 has 1 inner plumose setae and one outer unipinnate setae. Exp-3 has two inner setae: one small plumose setae at the middle lateral and one strong bipinnate setae, two setae ornamented with spinules at the outer and setules at the inner and two bipinnate setae at the outer lateral margin.



Setal formula

	Exopod	Endopod
P2	1.2.121	0.1.123
P3	1.1.112	0.1.123
P4	1.0.012	0.1.223

P5 (FIGURE 4G) Baseoendopod is small and separated from exopod with presence of fracture plane. Baseoendopod has 4 setae of different size. Exopod has 2 long slender setae, 1 long strong setae and 2 small setae.

2) Remarks

Sars (1906) transferred *Delavalia* as a junior synonym of *Stenhelia* Boeck. Monard (1927, 1928) returned *Delavalia* as a subgenus of *Stenhelia*. Based on Wells (2007), the diagnostics characters Tioman *Delavalia clavus* are the same with *Delavalia clavus* (Wells &Rao) from Andaman Sea of India. However, there are differences between *D. clavus* (Wells & Rao) and the species found in present studies are: a) Spinules align laterally along Enp-2 and Enp-3 and more spinules on the anterior surface of Exp-1 of P1, b) spinules align laterally along the exopod of P1-P4, c) presence of hyline field on P5 baseoendopod. It can be distinguished from its congeners as *D. incerta* on Exp-3 (seven setae on P2, eight setae on P3 and seven setae on Exp-3 *D. unisetosa* (five setae on P4). *D. clavus* is also differs from *D. incerta* and *D. palustris* as both has 6 setae on Enp-3 P3. *D. palustris*, *D. schminkei*, *D. paraclavus* and *D. unisetosa* has four setae on P4 Enp-3 whereby *D. incerta*, five setae. *D. incerta* and *D. palustris* has three and two setae on P1 Enp-2 respectively. Both *D. palustris* and *D. unisetosa* has three setae on P5 endopod whereby *D. valens*, *D. unisetosa*, *D. schminkei* and *D. incerta* has five setae on P5 exopod. *D. palustris* has three setae on endopod and six setae exopod of P5.

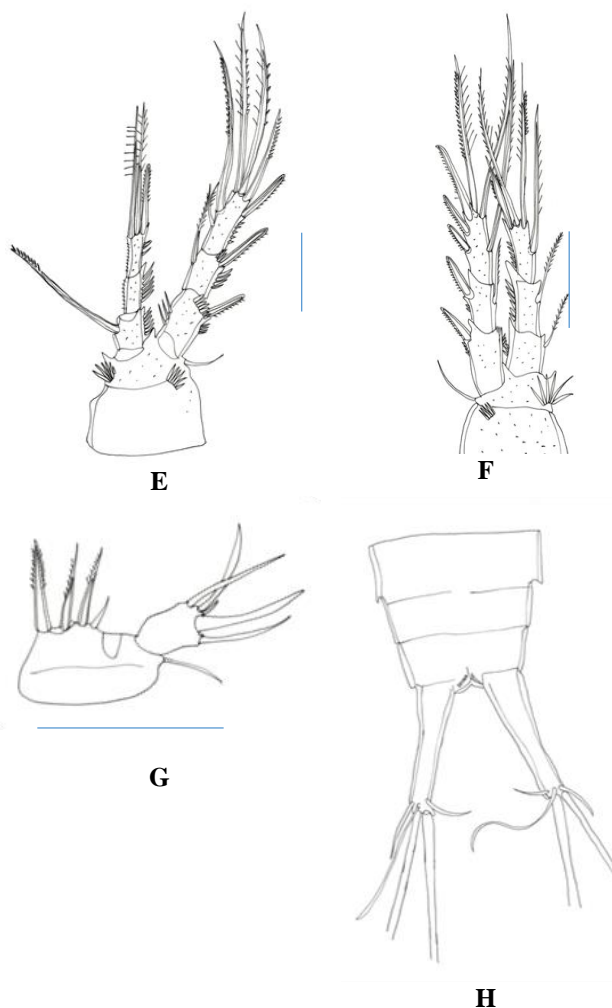


FIGURE 4 *Delavalia clavus* (♀) E.P3 F. P4. G.P5 H.Caudal rami

Scale bar (mm): E=0.014, F=0.014, G=0.001, H= 0.017

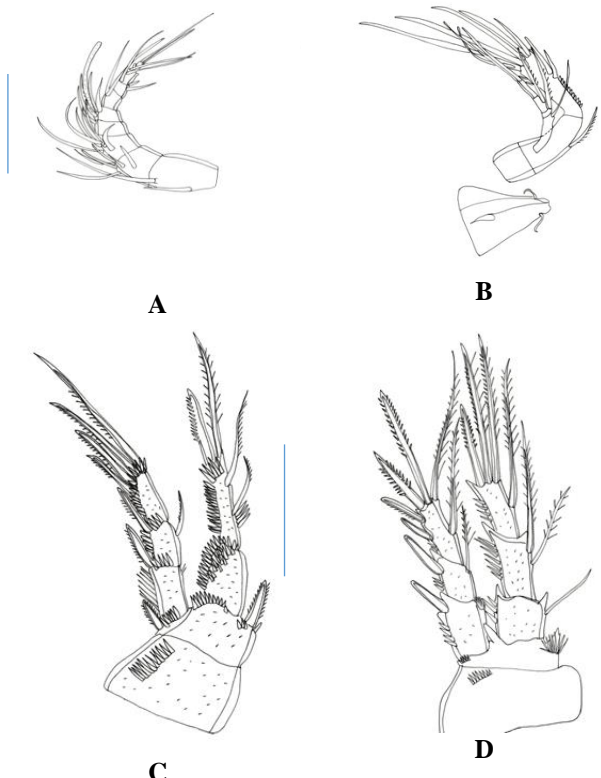


FIGURE 4 *Delavalia clavus* (♀) A.A1 B. A2 C.P1. D.P2  
Scale bar (mm): A= 0.013, B: 0.011, C= 0.011, D= 0.013

V. DISCUSSION AND CONCLUSION

Temperature rising which lead to lower pH may affect the corals life. Acidification process which occurs in coral area in Tioman Island is in progress as a result of climate change and global warming (Zuhairi et. al, 2016). Indeed, among Earth's ecosystems, coral reefs are one of the most severely threatened by global warming (Donner et al. 2005). Although benthic harpacticoid had a very high impact in the marine ecological ecosystem, the taxonomy works on benthic harpacticoid are still barely in tropics region (Gheerardyn, 2010) and this including Malaysia (Zaleha, 2011). There are a few number of studies on identifying the species of harpacticoid from the South China Sea. Data on the harpacticoid fauna are lacking for this area, as well as for the other tropical seas (Chertopruda et. al, 2009). Thus the latest data will add to the knowledge on the distribution of harpacticoid copepods and increase the concern on conservation and the importance of Tioman corals.

This information are useful in providing the knowledge of diet and feeding of fishes, shrimp and larvae molluscs of Tioman corals. Four species of Miraciidae obtained from this studies which from three



different genera: *Robertgurneya*, *Typhlampiascus* and *Delavalia*. Each species shows different and unique morphologies which shows adaptation for preference habitat. Further study need to be conducted to provide details distributions of harpacticoid in corals area as to increase concern and awareness of protecting corals ecosystem.

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