

The first earthworm records from Batanta Island, West Papua, Indonesia (Megadrili: Acanthodrilidae, Megascolecidae)

T. SZEDERJESI

*Tímea Szederjesi, Department of Zoology, Hungarian Natural History Museum, Budapest.
E-mail: t.szederjesi@gmail.com*

Abstract. Identification of a small but valuable earthworm material collected on Batanta and the neighbouring small Birie Island in 2014 and 2019 resulted in recording five species. The only acanthodrilid species in the sample, *Dichogaster annae* (Horst, 1893), is a widely introduced circumtropical peregrine worm. The two closely related *Polypheretima* species, *P. annulata* (Horst, 1883) and *P. fakfakensis* (Cognetti, 1908), bear a typical West Papuan distribution. *Amyntas halmaherae* (Michaelsen, 1896) is found from North Maluku to New Britain. *A. hendersonianus* (Cognetti, 1914) was most probably introduced to its type locality, the Henderson Island, and its natural range covers New Guinea and the neighbouring islands.

Keywords. Clitellata, Oligochaeta, *Amyntas*, *Polypheretima*, distribution.

INTRODUCTION

Batanta, with its 453 km² area, is the smallest member of the Raja Ampat island group located in West Papua, Indonesia. Almost untouched rainforest covers the island. Its highest point is 1184 m (Kovács *et al.* 2015a).

Its invertebrate fauna is only partially studied; there are published data just on certain groups, *e.g.*, Decapoda (Wowor & Ng 2009), Heteroptera (Polhemus & Polhemus 2000, 2011), Hymenoptera (Nugroho *et al.* 2010) and Coleoptera (Baehr 2011, Shaverdo *et al.* 2016). Systematic surveys, initially of the aquatic insect fauna, began in 2010 (Kovács *et al.* 2015a), and were later extended to other animal groups as well. These researches provided a huge amount of new data and resulted in descriptions of several new species (Oláh 2012, 2013, 2014, Oláh & Kovács 2015, 2018, Kovács *et al.* 2015b, Varga & Páll-Gergely 2017).

Regarding its earthworm fauna, Batanta is totally unknown. Moreover, we have only sporadic data from the whole West Papuan region (Horst 1883, Cognetti 1908, 1911, 1912, 1913a,

1913b, 1914b, 1915, 1922, Michaelsen 1910, 1923, 1938, Ude 1905, 1932, Easton 1979). During the expeditions in 2014 and 2019, as a by-product of other collecting activities, a small amount of earthworm material was also collected for the first time from Batanta and the neighbouring small Birie Island. The results are herein presented.

MATERIAL AND METHODS

Earthworms were collected by hand-sampling *i.e.*, searching under fallen logs, *etc.* The specimens were killed and fixed in 75% ethanol and deposited in the earthworm collection of the Hungarian Natural History Museum (HNHM/AF). In the descriptions, the segment positions are indicated with Roman numerals and intersegments with Arabic numerals.

TAXONOMY

Family Acanthodrilidae Claus, 1880

Dichogaster annae (Horst, 1893)

Benhamia annae Horst, 1893: 32.

Dichogaster (Diplotheodrilus) annae: Csuzdi 2010: 194.

Material examined. HNHM/AF5686 1 ex., Indonesia, West Papua, Batanta Island, valley of Weras stream, S00°49'42.05" E130°38'12.23", 27.01.2014, leg. P. Juhász, T. Kovács.

Family Megascolecidae Rosa, 1891

***Amyntas halmaherae* (Michaelsen, 1896)**

(Figures 1–4)

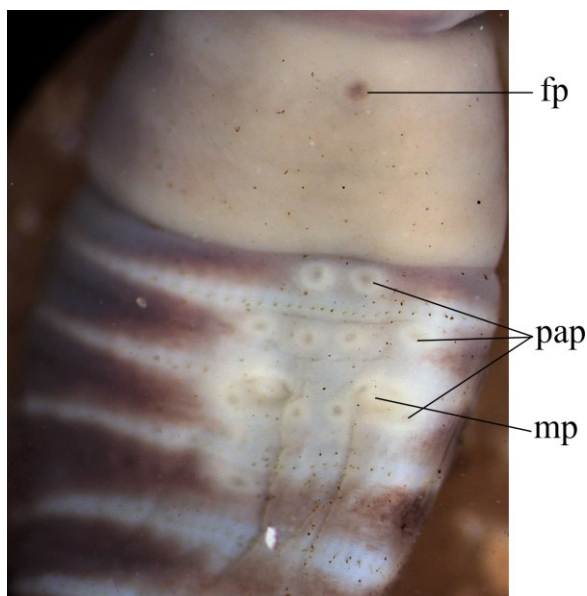
Perichaeta halmaherae Michaelsen, 1896: 208.

Pheretima halmaherae: Ude 1905: 461.

Pheretima (Pheretima) halmaherae: Ude 1932: 147.

Amyntas halmaherae halmaherae: Sims & Easton 1972: 234, Blakemore 2007: 45.

Material examined. HNHM/AF5708 1 ex., Indonesia, West Papua, Batanta Island, valley of Warmon stream, between the lower and upper waterfall, S00°50'04.50" E130°42'54.01" and S00°50'23.5" E130°42'35.18", under fallen log, 09.02.2019, leg. R. Horváth, P. Juhász, E. Kondorosy, T. Kovács.



Figures 1. *Amyntas halmaherae* (Michaelsen, 1896). Ventral view of the clitellar region. *fp* = female pore, *pap* = papillae, *mp* = male pore

Description. External characters. Body length 157 mm, diameter 5 mm. Segment number 110. Colour stripy purple brown dorsally, paler ventrally. Prostomium epilobous. First dorsal pore in 130

11/12. Setae perichaetine, setal number on segment II=20, V=31, X=51, XIII=55, XX=53, XXVI=57. Clitellum annular on XIV–XVI. Spermathecal pores ventral, two pairs in 7/8/9, five setae between them. Female pore on XIV. Male pores superficial on XVIII on an oval porophore, with a 10 setae hiatus between them. Genital markings in XVII: one pair presetal ventrally, one pair postsetal ventrally and one pair postsetal laterally; in XVIII: one papilla posteromedial and the other posterolateral to each male porophore; in XIX: one single postsetal laterally (Fig. 1).

Internal characters. Septa 5/6–7/8 and 10/11–12/13 thickened. Gizzard in VIII–X. Intestinal caeca paired in XXVII, simple, extending anteriorly to XXIV (Fig. 2). Last hearts paired in XIII. Spermathecae two pairs in VIII and IX. Ampulla sac-shaped with a stout duct, diverticulum with a curved stalk and an oval seminal chamber (Fig. 3). Holandric, testes in paired testis sacs in X, XI. Seminal vesicles paired in XI, XII. Prostatic glands paired in XVII–XIX, racemose. Ducts muscular, straight (Fig. 4). Accessory glands present, small, sessile and round. Excretory system meric.

Remarks. Our specimen somewhat differs from the original description in the distribution of the genital markings, and has fewer setae after segment XIII.

***Amyntas hendersonianus* (Cognetti, 1914)**

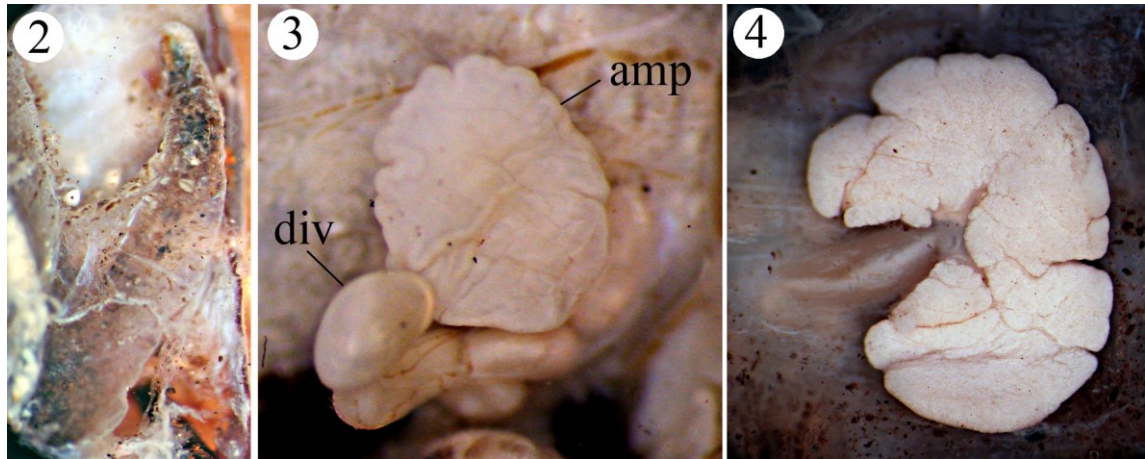
(Figures 5–7)

Pheretima hendersoniana Cognetti, 1914a: 255.

Amyntas hendersonianus hendersonianus: Sims & Easton 1972: 234, Blakemore 2007: 46.

Material examined. HNHM/AF5705 2 ex., Indonesia, West Papua, Birie Island, Papua Paradise Eco Resort, marsh, under fallen log, S00°46'14" E130°44'51", 16.02.2019, leg. T. Kovács. HNHM/AF5707 2 ex., Indonesia West Papua, Batanta Island, valley of Warai stream, from soil, between S00°50'25.19" E130°34' 59.19" and S00°50'59.3" E130°35'18.0", 22.02. 2019, leg. R. Horváth, P. Juhász, E. Kondorosy, T. Kovács.

Description. External characters. Body length 90–96 mm, diameter 3.5–4 mm. Segment number



Figures 2-4. *Amynthes halmaherae* (Michaelsen, 1896). 2 = intestinal caecum. 3 = Spermatheca. 4 = prostate gland. *amp* = spermathecal ampoule, *div* = spermathecal diverticulum.

104–116. Colour purple brown dorsally, pale ventrally. Prostomium epilobous. First dorsal pore in 11/12. Setae perichaetine, setal number on segment III=28, VI=39, X=52, XIII=54, XVII=61, XXVI=64. Clitellum annular on XIV–XVI. Spermathecal pores ventral, two pairs in 7/8/9, four setae between them. Female pore on XIV. Male pores superficial on XVIII, with an 8 setae hiatus between them. Genital markings one pair presetal in IX and X, one or two pairs presetal in XVII ventrally, one pair ventrally in 17/18 and one or two laterally, one pair between male pores in XVIII, one pair postsetal laterally in XVIII, two pairs in 19/20 ventrally, one pair in 20/21 (Fig. 5), one single on left in 21/22 in one specimen.

Internal characters. Septa 10/11–13/14 slightly thickened. Gizzard in VIII–X. Intestinal caeca paired in XXVII, simple, extending anteriorly to XXIII. Last hearts paired in XIII. Spermathecae two pairs in VIII and IX. Ampulla heart-shaped with a stout duct, diverticulum with a curved stalk and an oval seminal chamber (Fig. 6). Holandric, testes in paired testis sacs in X, XI. Seminal vesicles paired in XI, XII. Prostatic glands paired in XVI–XIX, racemose. Ducts muscular, slightly S-shaped (Fig. 7). Accessory glands present, small, sessile and round. Excretory system meroic.

Remarks. Our specimens differ slightly from the original description in the position of the first dorsal pore (11/12 vs. 12/13), the setal numbers

and the genital markings, but are similar in any other characteristics. Due to the bad conditions of the preserved specimens, setal counts were taken from one specimen only.

Cognetti (1914b) described *Pheretima henderstoniana* var. *coelogaster* (now treated as subspecies) based on the differences in the distribution of the genital markings and the presence of a concave connection ventrally on segment XVIII. Regarding these characters, it is questionable whether *coelogaster* represents an independent taxon.

Polypheretima annulata (Horst, 1883)

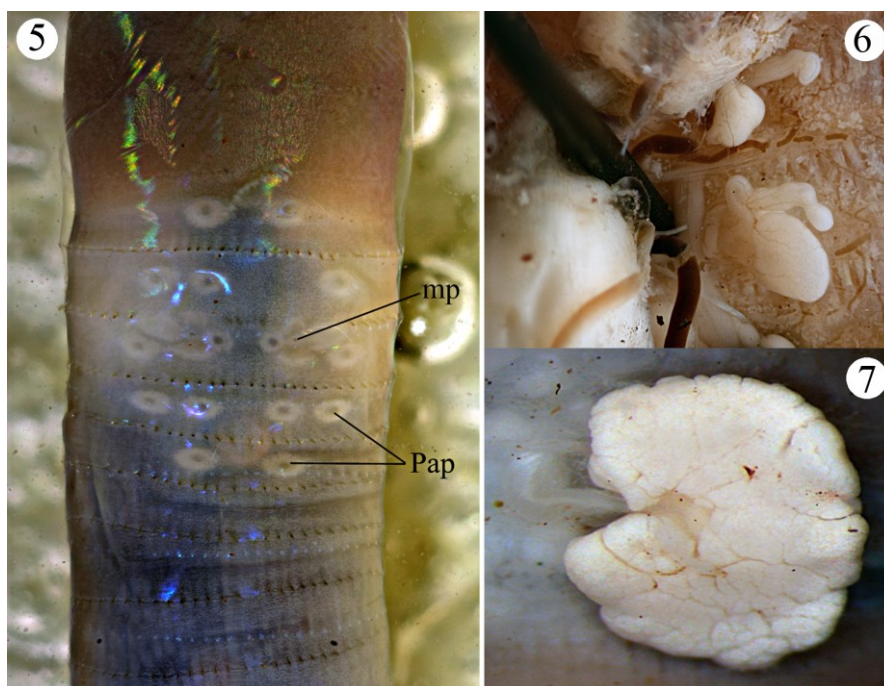
(Figures 8–9)

Megascolex annulatus Horst, 1883: 195.

Polypheretima annulata: Easton 1979: 35, Blakemore 2007: 7.

Material examined. HNHM/AF5706 1 ex., Indonesia, West Papua, Batanta Island, valley of Tanjung Lampu River, under bark, between S00°54'18.6" E130°36'48.6" and S00°53'43.0" E130°36'38.5", 12.02.2019, 12.02.2019, leg. R. Horváth, P. Juhász, E. Kondorosy, T. Kovács.

Description. External characters. Preadult specimen. Body length 117 mm, diameter 5 mm. Segment number 131. Colour dark purple dorsal



Figures 5-7. *Amynthes hendersonianus* (Cognetti, 1914). 5 = ventral view of the clitellar region. *Pap* = papillae, *mp* = male pore. 6 = spermathecae, 7 = prostate gland.

ly, pale ventrally. Prostomium epilobous. First dorsal pore in 11/12. Setae perichaetine, setal number on segment VII=44, XX=59. Clitellum annular on XIV–XVI. Spermathecal pores two pairs in segment VII and VIII, presetal, 0.5 body circumference apart. Female pore on XIV. Male pores superficial on XVIII on a small porophore, with 19 setae between them. Genital markings preclitellar presetal one pair on VII and VIII, postsetal one pair on VII ventrally to the spermathecal pores.

Internal characters. Septa 5/6–7/8 and 9/10–13/14 thickened. Tufted nephridia in V and VI. Gizzard in VIII–IX. Intestinal origin in XV, caeca absent. Last hearts paired in XIII. Spermathecae two pairs in VII and VIII. Ampulla sac-shaped, diverticulum *ca.* half as short as the ampulla, with a slightly bent thin stalk (Fig. 8). Holandric, testes in paired testis sacs in X, XI. Seminal vesicles paired in XI, XII, pseudovesicles in XIII. Prostatic glands paired in XVII–XIX, racemose. Ducts muscular, hook-shaped (Fig. 9). Accessory glands absent. Excretory system meroic.

Polypheretima fakfakensis (Cognetti, 1908)

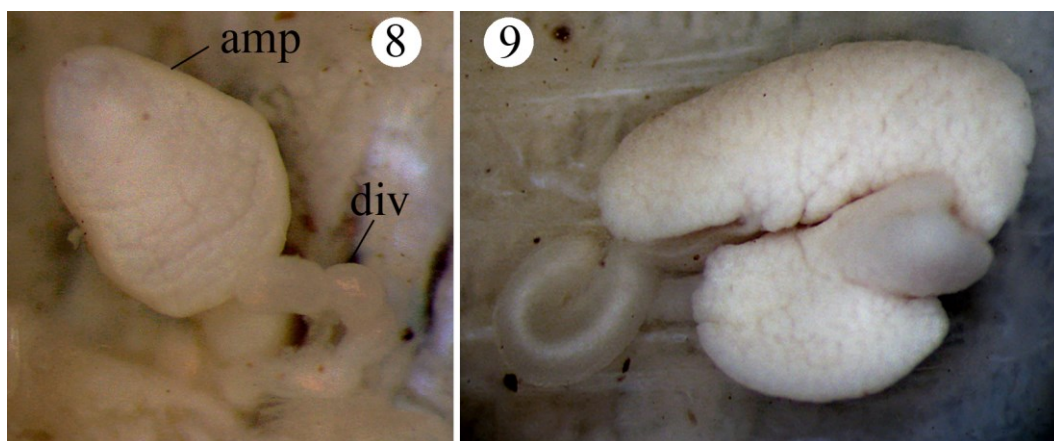
(Figures 10–11)

Pheretima fakfakensis Cognetti, 1908: 1.

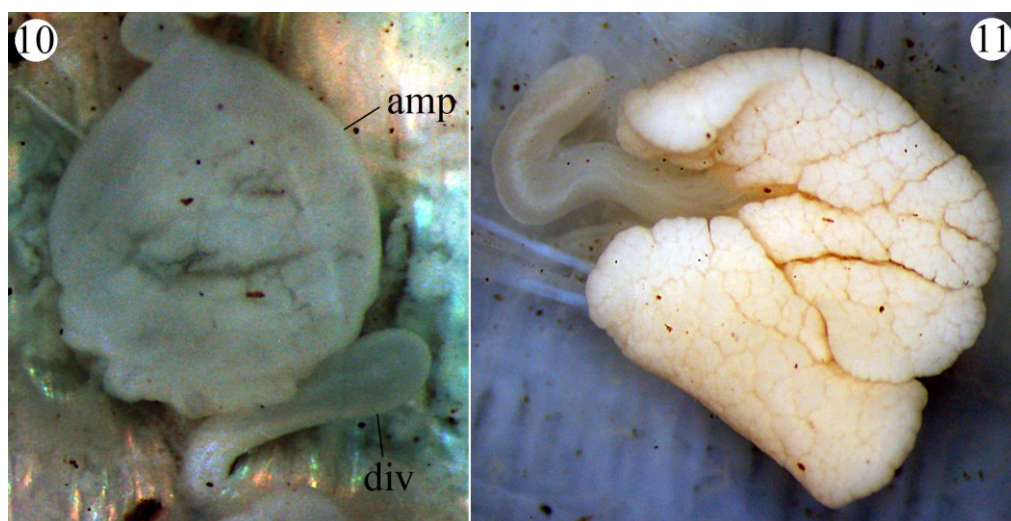
Polypheretima fakfakensis: Easton 1979: 36, Blake-more 2007: 35.

Material examined. HNHM/AF5685 1 ex., Indonesia, West Papua, Batanta Island, valley of Waridor River, under fallen log, between S00° 50'30.55" E130°31'30.54" and S00°52' 09.66" E130°32'11.54", 18.01.2014, leg. R. Horváth, P. Juhász, T. Kovács.

Description. External characters. Body length 169 mm, diameter 7 mm. Segment number 136. Colour stripy dark purple dorsally, pale ventrally. Prostomium epilobous. First dorsal pore in 11/12. Setae perichaetine, setal number on segment VII=51, XX=61. Clitellum annular on XIV–XVI. Spermathecal pores three pairs in segment VII, VIII and IX, presetal, 0.4 body circumference apart. Female pore on XIV. Male pores superficial on XVIII on a circular porophore, with 24 setae



Figures 8-9. *Polypheretima annulata* (Horst, 1883). 8 = spermatheca. 9 = prostate gland.
amp = spermathecal ampoule, div = spermathecal diverticulum



Figures 10-11. *Polypheretima fakfakensis* (Cognetti, 1908). 10 = spermatheca. 11 = prostate gland.
amp = spermathecal ampoule, div = spermathecal diverticulum.

between them. Preclitellar genital markings presetal on VII and VIII, ventrally to the spermathecal pores. Postclitellar genital markings on XVIII, one pair presetal and one pair postsetal, both ventrally to the male pore.

Internal characters. Septa 5/6–7/8 and 10/11–12/13 thickened, 8/9 absent. Tufted nephridia in V and VI. Gizzard in VIII–IX. Intestinal origin in XV, caeca absent. Last hearts paired in XIII. Spermathecae three pairs in VII, VIII and IX. Ampulla sac-shaped, diverticulum *ca.* third as

short as the ampulla, with a basally bent thin stalk (Fig. 10). Holandric, testes in paired testis sacs in X, XI. Seminal vesicles paired in XI, XII, pseudovesicles in XIII. Prostatic glands paired in XVIII–XIX, racemose. Ducts muscular, hook-shaped (Fig. 11). Accessory glands absent. Excretory system meroic.

Remarks. Our specimen differs from the observations of Easton (1979) in the position of the preclitellar markings, which are on segment VII and VIII similarly to *P. annulata*.

DISCUSSION

The recent earthworm surveys carried out on Batanta Island resulted in recording the presence of five species. Among them, *Dichogaster annae* is a widely introduced circumtropical peregrine species, but the other four seem to possess more restricted ranges.

Michaelsen (1896) described *Amyntas halmaherae* from Halmahera Island, North Maluku, Indonesia together with six subspecies. The differences among these subspecies are very scanty, including mostly the size, colouration and the genital markings. Moreover, some of them were described on the basis of a single preadult specimen. Therefore, a thorough revision is needed to clarify the taxonomic status of these subspecies.

Ude (1905, 1932) recorded *A. halmaherae* from New Britain, Nissan Island and a small island near the Mussau Island, which suggests that it has a wider range stretching from North Maluku east to New Britain.

Amyntas hendersonianus was originally described from the Henderson Island (Cognetti 1914a). Later, Cognetti (1914b) described the varietas *coelogaster* – now treated as subspecies – from Sungai Sermowai, West Papua. However, the slight differences raise the question whether it could be regarded as a separate taxon. Besides, as the Henderson Island is a relatively young atoll island emerged between 855–540 kyr (Blake 1995), the probability of occurrence of an endemic earthworm species there is quite low. Therefore, it was much likely to be introduced to the Henderson Island and has its origin elsewhere, covering the island of New Guinea and possibly Batanta as well.

There are a couple of species very close to *A. hendersonianus* and also to each other: *A. omtrekensis* (Cognetti, 1911), *A. misellus* (Cognetti, 1913), *A. miserus* (Cognetti, 1913) and *A. keianus* (Michaelsen, 1924). Unfortunately, some of them were described on the basis of a single specimen (*A. misellus*, *A. miserus*) so, their validity remains

in question. Nevertheless, a revision cannot be accomplished without further collections from the type localities.

The two *Polypheretima* species, *P. annulata* and *P. fakfakensis*, are well recognizable by their segmental presetal spermathecal pores. The main difference between the two species is the number of spermathecae (2 pairs in *annulata* and 3 pairs in *fakfakensis*). According to Easton (1979), *P. fakfakensis* is the western species with its distribution covering Misool Island, Kepala Burung and the Fakfak region. *P. annulata* was previously found on the Aru Islands and Southwest New Guinea. Now the new data show that the two species' distributions overlap on Batanta Island.

Earthworms weren't the focal animal group of the recent surveys on Batanta and the collections were made in only a few parts of the island. A more thorough and focused sampling would probably result in finding more earthworms species. For comparison, the much smaller Lanyu (45.7 km²), Kinmen (146.3 km²) and Matsu islands (29.5 km²) near Taiwan have much more species present and among them several are endemics (Chang *et al.* 2012, Shen 2018, Shen & Tsai 2002, Shen *et al.* 2013, 2014, 2015, Tsai *et al.* 2009).

Acknowledgement – I am grateful to Tibor Kovács for the valuable material collected, to Huei-Ping Shen and Csaba Csuzdi for the constructive comments that greatly helped improving the manuscript, and to Zoltán Soltész for helping in the photography work.

REFERENCES

- BAEHR, M. (2011): Two new species of the genus *Agastus* Schmidt-Goebel from New Guinea and the Moluccas (Coleoptera, Carabidae, Zuphiini). *Tijdschrift voor Entomologie*, 154: 291–297. doi: [10.1163/22119434-900000326](https://doi.org/10.1163/22119434-900000326)
- BLAKE, S.G. (1995): Late Quaternary history of Henderson Island, Pitcairn Group. *Biological Journal of the Linnean Society*, 56(1–2): 43–62. doi: [10.1111/j.1095-8312.1995.tb01077.x](https://doi.org/10.1111/j.1095-8312.1995.tb01077.x)
- BLAKEMORE, R.J. (2007): *Updated checklists of Pheretimidoids (Oligochaeta: Megascolecidae: Pheretima*

- auct.) taxa. <http://www.annelida.net/earthworm/Pheretimoids.pdf> (accessed 20 September 2019).
- CHANG, C-H., LI, C-L., SHEN, H-P., CHIH, W-J., YANG, S-H. & CHEN, J-H. (2012): Survey of earthworm species and distribution in Kinmen. *Journal of National Park*, 22: 58–67. [in Chinese]
- COGNETTI DE MARTIIS, L. (1908): Contributo alla conoscenza della drilofauna papuasica. *Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, 23(584): 1–4.
- COGNETTI DE MARTIIS, L. (1911): Nuove specie dei generi *Pheretima* e *Dichogaster* (Diagnosi preliminari). *Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, 26(641): 1–7.
- COGNETTI DE MARTIIS, L. (1912): Oligochaeta recueillis pendant la “Nederl. Nieuw-Guinea-Expeditie” (1903). *Nova Guinea*, 5: 543–564.
- COGNETTI DE MARTIIS, L. (1913a): Oligochètes (de Ceram et de Waigeu). *Bijdragen tot de Dierkunde*, 19: 37–41.
- COGNETTI DE MARTIIS, L. (1913b): Oligochètes recueillis pendant les expéditions a la Nouvelle-Guinée méridionale conduites par Mr. H. A. Lorentz en 1907 et 1909–1910 et par Mr. J. W. R. Koch, medecin de l'expédition en 1904. *Nova Guinea*, 9: 289–304.
- COGNETTI DE MARTIIS, L. (1914a): On a small collection of earthworms from Henderson Island. *Annals and Magazine of Natural History*, Ser. 8, 13: 255–257. doi: [10.1080/00222931408693472](https://doi.org/10.1080/00222931408693472)
- COGNETTI DE MARTIIS, L. (1914b): Descrizione di alcuni Oligocheti della Nuova Guinea settentrionale. In: Zur Fauna von Nord-Neuguinea, nach den Sammlungen von Dr. P. N. van Kampen und K. Gjellerup aus den Jahren 1910 und 1911. *Zoologische Jahrbücher, Abteilung für Systematik, Geographie und Biologie der Tiere*, 37: 351–364.
- COGNETTI DE MARTIIS, L. (1915): Report on the Vermes (Oligochaeta) collected by the British ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea. *Transactions of the Zoological Society of London*, 20: 493–496. doi: [10.1111/j.1469-7998.1912.tb07844.x](https://doi.org/10.1111/j.1469-7998.1912.tb07844.x)
- COGNETTI DE MARTIIS, L. (1922): Descrizione di tre nuovi Megascolecini. *Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, 37(744): 1–6.
- CSUZDI, Cs. (2010): A monograph of the Paleotropical Benhamiinae earthworms (Annelida: Oligochaeta, Acanthodrilidae). In: CSUZDI, Cs. & MAHUNKA, S. (Eds.) *Pedozoologica Hungarica* 6. Hungarian Natural History Museum, Budapest, 348 pp.
- EASTON, E.G. (1979): A revision of the 'acaecate' earthworms of the *Pheretima* group (Megascolecidae: Oligochaeta): *Archipheretima*, *Metapheretima*, *Planapheretima*, *Pleionogaster* and *Polypheretima*. *Bulletin of the British Museum (Natural History)*, *Zoology*, 35(1): 1–126. doi: [10.5962/bhl.part.20451](https://doi.org/10.5962/bhl.part.20451)
- HORST, R. (1883): New species of the genus *Megascolex* Templeton (*Perichaeta* Schmarda) in the collections of the Leyden Museum. *Notes from the Leyden Museum*, 5: 182–196.
- HORST, R. (1893): Earthworms from the Malay Archipelago. In: WEBER, M. (Ed.) *Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien*, 3: 28–77.
- KOVÁCS, T., HORVÁTH, R. & JUHÁSZ, P. (2015a): Szitakötők és tegezések (Insecta: Odonata, Trichoptera) kutatása Batanta szigeten (Indonézia, Nyugat-Pápua). *Annales Musei Historico-Naturalis Hungarici*, 107: 269–288.
- Kovács, T., Theischinger, G., Juhász, P. & Danyik, T. (2015b): Odonata from Batanta (Indonesia, West Papua) with description of three new species. *Folia historico-naturalia Musei Matraensis*, 39: 17–29.
- MICHAELSEN, W. (1896): Oligochaeten. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 23: 193–243.
- MICHAELSEN, W. (1910): Oligochäten von den Aru- und Kei-Inseln. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 33: 251–261.
- MICHAELSEN, W. (1923): Oligochäten von Holländisch-Neuguinea. *Nova Guinea*, 14: 18–27.
- MICHAELSEN, W. (1924): Oligochäten von Niederländisch-Indien. *Treubia*, 5: 379–401.
- MICHAELSEN, W. (1938): Einige interessante Pheretimen von Holländisch-Neuguinea. *Zoologischer Anzeiger*, 121: 161–181.
- NUGROHO, H., UBADILLAH, R. & KOJIMA, J-I. (2010): Potter wasps of the genus *Eumenes* Latreille (Hymenoptera: Vespidae: Eumeninae) in the western part of the Papuan region, with description of two

- new species and taxonomic notes on *E. inconspicuus* Smith. *The Raffles Bulletin of Zoology*, 58(2): 179–187.
- OLÁH, J. (2012): New species and records of Trichoptera from Batanta and Waigeo Islands (Indonesia, Raja Ampat Archipelago, Papua (Irian Jaya). *Braueria (Lunz am See, Austria)*, 39: 39–57.
- OLÁH, J. (2013): On the Trichoptera of Batanta Island (Indonesia, West Papua, Raja Ampat Archipelago). *Folia entomologica hungarica*, 74: 21–78.
- OLÁH, J. (2014): On the Trichoptera of Batanta Island (Indonesia, Papua, Raja Ampat Archipelago), III. *Folia entomologica hungarica*, 75: 91–131.
- OLÁH, J. & KOVÁCS, T. (2015): On the Trichoptera of Batanta Island (Indonesia, West Papua, Raja Ampat Archipelago) IV. *Folia historico-naturalia Musei Matraensis*, 39: 131–141.
- OLÁH, J. & KOVÁCS, T. (2018): On the Trichoptera of Batanta Island (Indonesia, West Papua, Raja Ampat Archipelago) VI. *Folia historico-naturalia Musei Matraensis*, 42: 163–195.
- POLHEMUS, D.A. & POLHEMUS, J.T. (2000): New species of Microveliinae (Heteroptera: Veliidae) from the Raja Ampat Islands. *Tijdschrift voor Entomologie*, 143: 279–289. doi: [10.1163/22119434-99900049](https://doi.org/10.1163/22119434-99900049)
- POLHEMUS, D.A. & POLHEMUS, J.T. (2011): Seven new species of *Rhagovelia* (Heteroptera: Veliidae) from the Raja Ampat Islands, eastern Indonesia. *Aquatic Insects*, 33(1): 41–74. doi: [10.1080/01650424.2011.574638](https://doi.org/10.1080/01650424.2011.574638)
- SHAVERDO, H.V., PANJAITAN, R. & BALKE, M. (2016): A new, widely distributed species of the *Exocelina ekari*-group from West Papua (Coleoptera, Dytiscidae, Copelatinae). *ZooKeys*, 554: 69–85. doi: [10.3897/zookeys.554.6065](https://doi.org/10.3897/zookeys.554.6065)
- SHEN, H-P. (2018): Biogeography meets taxonomy: Distribution-based inferences on the accuracy of identification and synonymization of East Asian earthworms. *Zootaxa*, 4496(1): 313–336. doi: [10.11646/zootaxa.4496.1.26](https://doi.org/10.11646/zootaxa.4496.1.26)
- SHEN, H-P. & TSAI, C-F. (2002): Earthworm fauna of the Lanyu Island (Botel Tobago). *Endemic Species Research*, 4 (2): 1–8.
- SHEN, H-P., CHANG, C-H., LI, C-L., CHIH, W-J. & CHEN, J-H. (2013): Four new earthworm species of the genus *Amyntas* (Oligochaeta: Megascolecidae) from Kinmen, Taiwan. *Zootaxa*, 3599(5): 471–482. doi: [10.11646/zootaxa.3599.5.4](https://doi.org/10.11646/zootaxa.3599.5.4)
- SHEN, H-P., CHANG, C-H. & CHIH, W-J. (2014): Five new earthworm species of the genera *Amyntas* and *Metaphire* (Megascolecidae: Oligochaeta) from Matsu, Taiwan. *Journal of Natural History*, 48(9–10): 495–522. doi: [10.1080/00222933.2013.826742](https://doi.org/10.1080/00222933.2013.826742)
- SHEN, H-P., CHANG, C-H. & CHIH, W-J. (2015): Earthworms from Matsu, Taiwan with descriptions of new species of the genera *Amyntas* (Oligochaeta: Megascolecidae) and *Drawida* (Oligochaeta: Moniligastridae). *Zootaxa*, 3973(3): 425–450. doi: [10.11646/zootaxa.3973.3.2](https://doi.org/10.11646/zootaxa.3973.3.2)
- SIMS, R.W. & EASTON, E.G. (1972): A numerical revision of the earthworm genus *Pheretima* auct. (Megascolecidae: Oligochaeta) with the recognition of new genera and an appendix on the earthworms collected by the Royal Society North Borneo Expedition. *Biological Journal of the Linnean Society*, 4(3): 169–268. doi: [10.1111/j.1095-8312.1972.tb00694.x](https://doi.org/10.1111/j.1095-8312.1972.tb00694.x)
- TSAI, C-F., SHEN, H-P., TSAI, S-C., LIN, K-J., HSIEH, H-L. & YO, S-P. (2009): A checklist of oligochaetes (Annelida) from Taiwan and its adjacent islands. *Zootaxa*, 2133: 33–48. doi: [10.11646/zootaxa.2133.1.3](https://doi.org/10.11646/zootaxa.2133.1.3)
- UDE, H. (1905): Terricole Oligochäten von den Inseln der Südsee und von verschiedenen andern Gebieten der Erde. *Zeitschrift für wissenschaftliche Zoologie*, 83: 405–501.
- UDE, H. (1932): Beiträge zur Kenntnis der Gattung *Pheretima* und ihrer geographischen Verbreitung. *Archiv für Naturgeschichte*, 1: 114–190.
- VARGA, A. & PÁLL-GERGELY, B. (2017): A review of *Bellardiella* Tapparone-Canefri, 1883, with descriptions of a new subgenus and two new species (Gastropoda: Cyclophoroidea: Pupinidae). *Raffles Bulletin of Zoology*, 65: 386–394.
- WOWOR, D. & NG, P.K.L. (2009): Two new species of *Holthuisana* Bott, 1969 (Crustacea: Decapoda: Brachyura: Gecarcinucidae) from West Papua, Indonesia. *Zootaxa*, 2071(1): 50–60. doi: [10.11646/zootaxa.2071.1.4](https://doi.org/10.11646/zootaxa.2071.1.4)