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Authors: Erséus, Christer, Martin, Patrick, Martinsson, Svante, and Timm, Tarmo

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Case 3826 – *Propappus* Michaelsen, 1905 and PROPAPPIDAE Coates, 1986 (Annelida, Clitellata): proposed conservation by suppression of *Propappus* Seeley, 1888 (Vertebrata, Reptilia)

Christer Erséus*

Department of Biological and Environmental Sciences, University of Gothenburg, Box 463, SE-495 39 Göteborg, Sweden
(christer.erseus@bioenv.gu.se)

Patrick Martin

Royal Belgian Institute of Natural Sciences, OD Taxonomy and Phylogeny, Rue Vautier 29, B-1000 Brussels, Belgium
(patrick.martin@naturalsciences.be)

Svante Martinsson

Department of Biological and Environmental Sciences, University of Gothenburg, Box 463, SE-495 39 Göteborg, Sweden
(svante.martinsson@bioenv.gu.se)

Tarmo Timm

Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Centre for Limnology, Rannu 61117, Tartumaa, Estonia
(tarmo.timm@emu.ee)

*Corresponding author

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Abstract. The purpose of this application, under Article 23.9.3 of the Code, is to conserve the well-used names *Propappus* Michaelsen, 1905 and PROPAPPIDAE Coates, 1986 (Annelida) by suppression of the senior homonym *Propappus* Seeley, 1888 (Reptilia), a junior subjective synonym of *Pareiasaurus* Owen, 1876.

Keywords. Nomenclature; taxonomy; homonymy; Annelida; Clitellata; Oligochaeta; PROPAPPIDAE; *Propappus* Michaelsen; Palaearctic; Vertebrata; Reptilia; Pareiasauria; *Propappus* Seeley; Southern Africa; Permian.

1. The genus-group name *Propappus* Seeley, 1888 was established for a Permian pareiasaurian reptile, *Propappus omocratus* Seeley, 1888, collected at Brak River, Fort Beaufort, South Africa. According to Watson (1914), the holotype specimen of this pareiasaur in the Natural History Museum in London (BMNH R4064; A.G. Bain collection) consists of a sacrum, an os innominatum, a femur, a tibia, a part of a humerus, and caudal vertebrae. However, the original description, given in a brief abstract (Seeley, 1888), was based on a single fossilized bone (from the above-mentioned specimen), first mistaken by the author for a humerus but later re-interpreted as a femur (Seeley, 1892, figs. 10–11; Broom, 1908). Seeley's main reason for establishing a new genus was that he considered the bone to indicate an intermediate stage between reptiles and early mammals. Lee (1997), who reviewed this case in detail, noted that Seeley had intended to write a full paper on his new taxon but soon realized that he had been on the wrong track. Seeley (1892: 354) suggested that *Propappus* was a junior synonym of *Pareiasaurus* Owen, 1876, yet he retained the name *Propappus*, by suggesting that “until other parts of the skeleton justify the revival of the name *Propappus*, that type may be referred to as *Pareiasaurus (Propappus) minor*”; although the impression of subgeneric rank for *Propappus* was possibly unintentional. His new nominal species *Pareiasaurus (Propappus) minor* was thus an objective junior synonym of *Propappus omocratus*. Lee (1997: 268) commented, “This (illegitimate) change was proposed in a brief sentence buried in the detailed description of ‘*Pareiasaurus baini*’ and has either been overlooked or disregarded by most subsequent workers.” Also, to be noted is that Seeley himself (1891: 519), while discussing the characters that distinguish *Anthodon* Owen, 1876 from *Pareiasaurus*, had earlier stated “that the genus *Propappus* apparently has no existence, being founded on a femur.” Despite all this, two additional taxa of fossil reptiles were subsequently described by other authors as separate species of *Propappus*, *Pr. rogersi* Broom, 1912 and *Pr. parvus* Haughton, 1913.

2. Lee (1997: 233) summed up most 20th-century authors' work on pareiasaurs by stating, “The plethora of invalid names and constant, illegitimate reshuffling of taxa has caused the existing literature on pareiasaurs to be almost impenetrable to the uninitiated.” During the 1900s, *Propappus* Seeley, 1888 was mentioned repeatedly in the paleontological literature but over the years was increasingly regarded as a junior synonym of *Pareiasaurus* Owen, 1876. Some of the earlier authors (e.g., Broom, 1908, 1912; Haughton, 1913; Watson, 1914) evidently regarded *Propappus* as valid (see para. 1 above), although Broom (1936), in a late phase of his career, was prepared to synonymize Seeley's *Pr. omocratus* with Owen's *Pareiasaurus serridens* (see Findlay, 1970). Early revisions of pareiasaurian taxonomy (Haughton & Boonstra, 1929; Boonstra, 1934) retained the genus *Propappus*, and as late as 1963, Young & Yeh (1963: 212) did “not think it is all right to consider the genus *Propappus* as a synonym of *Pareiasaurus*”, but their discussion dealt only with *Propappus rogersi*, without mentioning the type species *Propappus omocratus*. The comparison by Young & Yeh (1963) of a Chinese fossil with *Propappus* and other South African pareiasaurian genera was referred to by Benton (2016), but without any further comment. In more recent taxonomic revisions of pareiasaurs, *Propappus* came to be explicitly regarded as a junior synonym of *Pareiasaurus* (Kuhn, 1969; Kitching, 1977; Ivakhnenko, 1987; Lee, 1997). Lee (1997: 265, table 1) regarded *Propappus omocratus*, *Pareiasaurus (Propappus) minor* and *Propappus rogersi* as junior synonyms of the type species of *Pareiasaurus (Pa. serridens* Owen, 1876), whereas Kuhn (1969) and Ivakhnenko (1987) regarded *Pa. omocratus* as a species separate from

Pa. serridens. *Propappus parvus* was regarded as a distinct species of *Pareiasaurus* by Kuhn (1969) and Ivakhnenko (1987), as a junior synonym of *Pa. serridens* by Kitching (1977) and as a junior synonym to *Anthodon serrarius* Owen, 1876 by Lee (1997). In short, pareiasaurian taxonomy has been in a state of confusion and instability for at least a century, but now it seems that *Propappus* Seeley, 1888 finally has become a redundant name, returning to the status given it by the original author about 130 years ago (Seeley, 1891; see para. 1).

3. The genus-group name *Propappus* Michaelsen, 1905 (for a genus of Eurasian worms in Annelida, Clitellata/Oligochaeta), with *Propappus glandulosus* Michaelsen, 1905 as the type species, is a junior homonym of *Propappus* Seeley, 1888. *Propappus* Michaelsen and the more recently established family name PROPAPPIDAE Coates, 1986 have both been in continuous use in the taxonomic literature of Clitellata (or Oligochaeta) up until the present day. We have recognized about 200 scientific publications (mostly journal articles, some textbooks) dealing with *Propappus* in one way or another. Over 80 different first authors are involved, and in the Appendix we list 50 references as representative examples of the wealth of such studies during a period of more than 100 years.

4. Michaelsen (1916) described a second species of *Propappus*, *P. volki* Michaelsen, 1916, which subsequently has been recorded from several parts of Eurasia and possibly also from Canada (see Torii, 2006: 359). Most of the literature on Michaelsen's *Propappus* quoted above deals with this taxon, and there is molecular evidence that it refers to a species complex rather than a single panmictic metapopulation (Erséus et al., unpublished data). Michaelsen (1916: 52) mentioned that earlier in 1916 he had reported this taxon as a member of another (and new) genus: "*Palpenchytraeus volki*, n. gen., n. sp." He was referring to a brief report of the annual meeting of the "Naturwissenschaftlicher Verein zu Hamburg" held on 26 January 1916, which was published in a newspaper ("Hamburger Nachrichten"; Anonymous, 1916) on 30 January 1916. Unfortunately, the exact publication date of Michaelsen's description of *Propappus volki* is unknown. His paper was included in a volume that served as the annual report of Naturwissenschaftlicher Verein zu Hamburg for 1915, published in 1916, and the conclusion must be that it was distributed after 30 January. By courtesy of the State Archives of Belgium, we obtained a copy of the newspaper report (Anonymous, 1916), which gives a brief account of Michaelsen's presentation of the new taxon named *Palpenchytraeus volki*, describing it as a "winzig kleinen Wurm, dessen Kopfplatten zum Unterschiede von seinen Verwandten zu einem Rüssel ausgebildet ist" [our translation: tiny little worm that, unlike its relatives, has its head lobe formed into a trunk]. Although Michaelsen (1916) had changed his mind about using the name *Palpenchytraeus volki* when he gave his more comprehensive description of *Propappus volki*, we find the former to be an available name in the meaning of the Code. Under Article 8.1 of the Code, the publication establishing the name "must be obtainable, when first issued, free of charge or by purchase", and "in an edition containing simultaneously obtainable copies by a method that assures numerous identical and durable copies". Moreover, the description of *Palpenchytraeus volki* complies with Art. 12.1, requiring the name to "be accompanied by a description or a definition of the taxon that it denotes". In this case, the newspaper report was not signed, but Art. 50.2 states that "if the name of a taxon is made available by publication in a report or minutes of a meeting, the person responsible for the name, not the Secretary or other reporter of the meeting, is the author of the name". Regardless of all this, we have only found

two works mentioning the name *Palpenchytraeus* in the taxonomic literature after 1916. Welch (1920) merely reiterated Michaelsen's (1916) own account concerning this name, while Coates (1986) regarded *Palpenchytraeus volki* as a *nomen nudum*, assuming that it lacked a formal description (Coates, pers. comm.).

5. We thus conclude that *Palpenchytraeus* Michaelsen, 1916 is a junior synonym of *Propappus* Michaelsen, 1905, and therefore eligible to be proposed as a replacement name for the junior homonymy *Propappus* Michaelsen, 1905. We argue, however, that if this name is adopted, its etymology, which suggests an affinity to *Enchytraeus* and ENCHYTRAEIDAE (PROPAPPIDAE would be replaced by "PALPENCHYTRAEIDAE" [see para. 9 below]) may unnecessarily add to confusion surrounding the taxonomy of these taxa.

6. *Propappus* Michaelsen has a unique position within Clitellata, although it comprises a mere handful of known species. It was originally included in the family ENCHYTRAEIDAE, but on morphological grounds Coates (1986) elevated its status, making it the type genus of a separate family within Clitellata, PROPAPPIDAE Coates, 1986. This separation from ENCHYTRAEIDAE has been reinforced by recent ultrastructural and molecular studies, but while the evidence from a genome-level analysis of transcriptomic data supports a sister-group relationship between PROPAPPIDAE and ENCHYTRAEIDAE (Erséus et al., 2020), the exact systematic position of PROPAPPIDAE among other clitellates is less resolved in other phylogenetic studies (Gustavsson et al., 2008; Marotta et al., 2008; Gorgoñ et al., 2015). Thus, the systematics of PROPAPPIDAE as a worm family is highly relevant to more general questions of clitellate evolutionary history.

7. We argue that maintaining the precedence of the senior homonym of *Propappus* would serve no purpose for stability in the taxonomy of pareiasaurian reptiles. Given the taxonomic history of *Propappus* Seeley, 1888, the probability that this name might be subsequently revalidated in pareiasaur taxonomy is low. As was noted in para. 1 above, even the original author soon realized that the name was redundant (Seeley, 1891, 1892). Moreover, applying the Principle of Priority would cause confusion and instability in the well-established taxonomy associated with the junior homonym, the worm genus *Propappus* Michaelsen, 1905. This name is in wide use and the genus is unambiguously defined, not being associated with issues of synonymy or splitting/lumping other than those possibly engendered by cryptic speciation (Erséus et al., unpublished work in progress). Moreover, both this genus and the family-group name PROPAPPIDAE are today well-established in the classificatory infrastructure of Clitellata (or Oligochaeta), e.g., in web-based databases, such as WoRMS, GBIF, Encyclopedia of Life, Catalogue of Life and Wikipedia.

8. For reversal of precedence without an appeal to the International Commission on Zoological Nomenclature, two conditions must be fulfilled according to Art. 23.9. First, the senior homonym must not have been used as a valid name after 1899 (Art. 23.9.1.1), and second, the junior homonym must have been used for a particular taxon, as its presumed valid name, in at least 25 works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of no less than 10 years. In the present case, the second condition applies to the junior homonym (para. 3). However, the senior homonym has been regarded as valid after 1899 (e.g., *Propappus rogersi* and *Pr. parvus* were both described after 1899; see para. 1). Thus, the conditions for reversal of precedence stipulated by Art. 23.9.1.1 are only partly fulfilled.

9. Conservation of *Propappus* Michaelsen, 1905 is clearly desirable, also with respect to the family-group name based on it. The long-term prevailing usage of both

names suggests that complete suppression of the senior homonym *Propappus* Seeley, 1888 is both desirable and necessary.

10. The International Commission on Zoological Nomenclature is accordingly asked:

- (1) to use its plenary power to rule that the generic name *Propappus* Seeley, 1888 be suppressed for the purposes of both the Principle of Priority and the Principle of Homonymy;
- (2) to place on the Official List of Generic Names in Zoology the name *Propappus* Michaelsen, 1905 (gender: masculine), type species: *Propappus glandulosus* by original designation by Michaelsen, 1905 (Annelida, Clitellata); and
- (3) to place on the Official Index of Rejected and Invalid Generic Names in Zoology the name *Propappus* Seeley, 1888 (Vertebrata, Reptilia), as suppressed in (1) above.

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References

- Anonymous (1916) Naturwissenschaftlicher Verein in Hamburg. Hamburger Nachrichten Sunday 30 January 1916, Morning Edition, No 53, Beilage 3: 1.
- Benton MJ (2016) The Chinese pareiasaurs. *Zoological Journal of the Linnean Society* 177 (4): 813–853.
- Boonstra LD (1934) Pareiasaurian studies. Part IX. The cranial osteology. *Annals of the South African Museum* 31: 1–38.
- Broom R (1908) Contributions to South African vertebrate palaeontology. 2. On the pareiasaurian genus *Propappus*. *Annals of the South African Museum* 4: 351–359, 345 pls.
- Broom R (1912) On a new species of *Propappus*, and on the pose of the pareiasaurian limbs. *Annals of the South African Museum* 7: 323–331.
- Broom R (1936) Notes on pareiasaurians. *Annals of the Transvaal Museum* 18: 407–413.
- Coates KA (1986) Redescription of the oligochaete genus *Propappus*, and diagnosis of the new family Propappidae (Annelida: Oligochaeta). *Proceedings of the Biological Society of Washington* 99 (3): 417–428.
- Erséus C, Williams BW, Horn KM, Halanych KM, Santos SR, James SW, Creuzé des Châtelliers MC, Anderson FE (2020) Phylogenomic analyses reveal a Paleozoic radiation and support a freshwater origin for clitellate annelids. *Zoologica Scripta* 49: 614–640. doi: 10.1111/zsc.12426.
- Findlay GH (1970) Skin structure of small pareiasaurs. With comments on their taxonomy in the *Cistecephalus* zone. *Palaeontologica Africana* 13: 15–23.
- Gorgoń S, Krodziewska M, Świątek P (2015) Ovary ultrastructure and oogenesis in *Propappus volki* Michaelsen, 1916 (Annelida: Clitellata). *Zoologischer Anzeiger* 257: 110–118.
- Gustavsson LM, Ferraguti M, Marotta R (2008) Comparative ultrastructural study of the cuticle and spermatozoa in *Propappus volki* Michaelsen, 1916 (Annelida: Clitellata). *Zoologischer Anzeiger* 247 (2): 123–132.
- Haughton SH (1913) On a new species of *Propappus*. *Annals of the South African Museum* 12: 43–45.

- Haughton SH, Boonstra LD (1929) Pareiasaurian studies. Part I. - An attempt at a classification of the Pareiasauria based on skull features. *Annals of the South African Museum* 28 (1): 79–87.
- Ivakhnenko MFI, M.F.] (1987) Permian parareptiles of the USSR. *Trudy Paleontologicheskogo Instituta Akademii Nauk SSSR* 233: 1–159. [In Russian.]
- Kitching JW (1977) The distribution of the Karoo vertebrate fauna. *Memoir - Bernard Price Institute for Palaeontological Research, University Witwatersrand* 1: 1–131.
- Kuhn O (1969) *Cotylosauria*. Gustav Fischer Verlag, Stuttgart, 86 pp.
- Lee MSY (1997) A taxonomic revision of Pareiasaurian reptiles: implications for Permian terrestrial palaeoecology. *Modern Geology* 21: 231–298.
- Marotta R, Ferraguti M, Erséus C, Gustavsson LM (2008) Combined-data phylogenetics and character evolution of Clitellata (Annelida) using 18S rDNA and morphology. *Zoological Journal of the Linnean Society* 154 (1): 1–26.
- Michaelsen W (1905) Die Oligochaeten des Baikalsees. *Wissenschaftliche Ergebnisse einer zoologischer Expedition nach dem Baikalsee unter Leitung des Professors Alexis Korotneff in den Jahren 1900–1902. Erste Lieferung*. R. Friedländer und Sohn, Kiev and Berlin, 69 pp.
- Michaelsen W (1916) Ein eigentümlicher neuer Enchytraeide der Gattung *Propappus* aus der Niederelbe. *Verhandlungen des Naturwissenschaftlichen Vereins zu Hamburg* 23: 51–55.
- Owen R (1876) Descriptive and illustrated catalogue of the fossil Reptilia of South Africa in the collection of the British Museum of Natural History. *British Museum, London*, xii + 88 pp, 70 pls.
- Seeley HG (1888) Researches on the structure, organization, and classification of the fossil Reptilia. IV. On a large humerus from the East Brak River, South Africa, indicating a new order of fossil animals which was more nearly intermediate between reptiles and mammals than group hitherto known. *Proceedings of the Royal Society London* 44: 142.
- Seeley HG (1891) Researches on the structure, organisation, and classification of the fossil reptilia. VII. Further observations on *Pareiasaurus*. *Proceedings of the Royal Society of London* 49 (296–301): 518–520.
- Seeley HG (1892) VIII. Researches on the structure, organization, and classification of the fossil Reptilia.— VII. Further observations on *Pareiasaurus*. *Philosophical Transactions of the Royal Society of London (B)* 183: 311–370.
- Torii T (2006) New record of *Propappus volki* (Annelida: Clitellata: Propappidae) from Japan. *Species Diversity* 11 (4): 359–365.
- Watson DMS (1914) XV. On the nomenclature of the South-African pareiasaurians. *Annals and Magazine of Natural History* (8) 14: 98–102.
- Welch PS (1920) The genera of the Enchytraeidae (Oligochaeta). *Transactions of the American Microscopical Society* 39 (1): 25–50.
- Young C-c, Yeh H-k (1963) On a new pareiasaur from the Upper Permian of Shansi, China. *Vertebrata Palasiatica* 7 (3): 195–214.

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Comments on this case are invited for publication (subject to editing) in the Bulletin; they should be sent to the Secretariat, International Commission on Zoological Nomenclature, c/o Lee Kong Chian Natural History Museum, 2 Conservatory Drive, Singapore 117377, Republic of Singapore (e-mail: iczn@nus.edu.sg).

Appendix

The following references are significant evidence of the prevailing usage of *Propappus* Michaelsen. The papers span a period of over a century, from 1916 to the present day. Most publications are articles in scientific journals whereas those with an asterisk (*) are identification keys and those with two asterisks (**) are textbooks or large monographs.

- Baturina M (2007) Oligochaeta of the Pechora River Basin, Russia. *Acta Hydrobiologica Sinica* 31 (suppl.): 36–46.
- Baturina M (2012) Distribution and diversity of Oligochaeta in small streams of the middle taiga. *Turkish Journal of Zoology* 36: 75–84.
- Behning A (1924) Einige Ergebnisse qualitativer und quantitativer Untersuchungen der Bodenfauna der Wolga. *Internationale Vereinigung für Theoretische und Angewandte Limnologie: Verhandlungen* 2 (1): 71–94.
- Behning A (1926) Das Leben der Wolga. Nach dem am 31. August in Saratow gehaltenen Vortrag. *Internationale Vereinigung für Theoretische und Angewandte Limnologie: Verhandlungen* 3 (1-2): 157–164.
- Berg LS (1934) О предполагаемых морских элементах в фауне и флоре Байкала. [About the alleged marine elements in the fauna and flora of Lake Baikal] *Bulletin de l'Académie des Sciences de l'URSS* 2-3: 303–326. [In Russian]
- Bird GJ (1982) Distribution, life cycle and population dynamics of the aquatic enchytraeid *Propappus volki* (Oligochaeta) in an English chalkstream. *Holarctic Ecology* 5 (1): 67–75.
- *Brinkhurst RO (1971) A guide for the identification of British aquatic Oligochaeta. Kendal, Wilson, 53 pp.
- Brinkhurst RO (1992) Evolutionary relationships within the Clitellata. *Soil Biology and Biochemistry* 24 (12): 1201–1205.
- **Brinkhurst RO, Jamieson BGM (1971) Aquatic Oligochaeta of the world. Oliver and Boyd, Edinburgh, 860 pp.
- Caramelo C, Martinez-Ansemil E (2010) External sense receptors in microdrile oligochaetes (Annelida, Clitellata) as revealed by scanning electron microscopy: Typology and patterns of distribution in the main taxonomic groups. *Journal of Morphology* 271 (12): 1482–1492.
- Cellot B, Juget J (1998) Oligochaete drift in a large river (French Upper Rhône): the effect of life cycle and discharge. *Hydrobiologia* 389: 183–191.
- **Chekanovskaya OV (1981) Aquatic Oligochaeta of the USSR. Amerind Publishing Co. Pvt. Ltd., New Delhi, 513 pp.
- Coates KA (1986) Redescription of the oligochaete genus *Propappus*, and diagnosis of the new family Propappidae (Annelida: Oligochaeta). *Proceedings of the Biological Society of Washington* 99 (3): 417–428.
- Dumnicka E (1994) Communities of oligochaetes in mountain streams of Poland. *Hydrobiologia* 278: 107–110.
- Dumnicka E (2006) Composition and abundance of oligochaetes (Annelida : Oligochaeta) in springs of Kraków-Częstochowa upland (Southern Poland): Effect of spring encasing and environmental factors. *Polish Journal of Ecology* 54 (2): 231–242.
- Dumnicka E, Wojtan K (1989) L'influence du milieu et des paramètres physico-chimiques de l'eau sur les peuplements des Oligochètes et la variabilité des populations de *Propappus volki* (Enchytraeidae) dans la grotte Wodna (Tatras Montagnes, Pologne) *Mémoires de Biospéologie*, 16: 225–232.
- Erséus C, Källersjö M (2004) 18S rDNA phylogeny of Clitellata (Annelida). *Zoologica Scripta* 33 (2): 187–196.
- Erséus C, Rota E, Timm T, Grimm R, Healy B, Lundberg S (2005) Riverine and riparian clitellates of three drainages in southern Sweden. *Annales de Limnologie* 41 (3): 183–194.
- Erséus C, Williams BW, Horn KM, Halanych KM, Santos SR, James SW, Châtelliers MC, Anderson FE (2020) Phylogenomic analyses reveal a Paleozoic radiation and support a freshwater origin for clitellate annelids. *Zoologica Scripta* 49 : 614–640. doi: 10.1111/zsc.12426.

- Fomenko NV (1980) Ecological groups of Oligochaeta worms in the Dnieper Basin. Aquatic Oligochaeta Worms. Amerind Publishing Co. Pvt. Ltd., New Delhi, pp. 105–118.
- Gerd SV (1950) Олигохеты водоемов Карелии. [Aquatic Oligochata from Karelia] Известия Карело-Финского филиала Академии наук СССР [Notices from the Karel-Finnish Branch of the Academy of Sciences of the USSR] 1: 56–71. [In Russian.]
- Gorgoń S, Krodkiewska M, Świątek P (2015) Ovary ultrastructure and oogenesis in *Propappus volki* Michaelsen, 1916 (Annelida: Clitellata). Zoologischer Anzeiger 257: 110–118.
- Gustavsson LM, Ferraguti M, Marotta R (2008) Comparative ultrastructural study of the cuticle and spermatozoa in *Propappus volki* Michaelsen, 1916 (Annelida: Clitellata). Zoologischer Anzeiger 247 (2): 123–132.
- Horn KM, Williams BW, Erséus C, Halanych KM, Santos SR, Creuze des Chatelliers M, Anderson FE (2019) Na(+)/K(+) -ATPase gene duplications in clitellate annelids are associated with freshwater colonization. Journal of Evolutionary Biology 32 (6): 580–591.
- Ladle M (1971) Studies on the biology of oligochaetes from the phreatic water of an exposed gravel bed. International Journal of Speleology 3 (3/4): 311–316.
- Lafont M, Durbec A, Ille C (1992) Oligochaete worms as biological describers of the interactions between surface and groundwaters: A first synthesis. Regulated Rivers: Research & Management 7 (1): 65–73.
- Lafont M, Malard F (2001) Oligochaete communities in the hyporheic zone of a glacial river, the Roseg River, Switzerland. Hydrobiologia 463 (1/3): 75–81.
- Lastochkin DA (1935) LXV.— Two new river *Æolosomatidæ* (Oligochæta limicola). Annals and Magazine of Natural History (series 10) 15: 636–645.
- Marotta R, Ferraguti M, Erséus C, Gustavsson LM (2008) Combined-data phylogenetics and character evolution of Clitellata (Annelida) using 18S rDNA and morphology. Zoological Journal of the Linnean Society 154 (1): 1–26.
- Martin P, De Broyer C, Fiers F, Michel G, Sablon R, Wouters K (2009) Biodiversity of Belgian groundwater fauna in relation to environmental conditions. Freshwater Biology 54 (4): 814–829.
- Michaelsen W (1916) Ein eigentümlicher neuer Enchytraide der Gattung *Propappus* aus der Niederelbe. Verhandlungen des Naturwissenschaftlichen Vereins zu Hamburg 23: 51–55.
- Michaelsen W, Vereščagin G (1930) Oligochaeten aus dem Selenga-Gebiete des Baikalsees. Travaux de la Commission pour l'étude du lac Bajkal 3: 213–226.
- Omodeo P (1998) History of Clitellata. Italian Journal of Zoology 65 (1): 51–73.
- Römbke J, Schmidt M (1990) Setal morphology of some species of terrestrial Enchytraeidae (Oligochaeta). Transactions of the American Microscopical Society 109 (1): 44–51.
- **Semernoy VP (2004) Oligochaeta of Lake Baikal. Nauka, Novosibirsk, 527 pp.
- Sokolskaya NL (1983) Freshwater Oligochaeta of Kamchatka and the Koryak upland. Sbornik Trudov Zoologicheskogo Muzeya MGU 20: 22–119. [In Russian]
- Särkkä J, Mäkelä J (1999) Meiofauna of esker groundwaters in Finland. Hydrobiologia 405: 25–37.
- Taş M, Elipek BÇ, Kırgız T, Arslan N, Yıldız S (2012) The aquatic and semi-aquatic Oligochaeta fauna of Turkish Thrace. Journal of FisheriesSciences.com 6 (1): 26–31.
- Timm T (1970) On the fauna of the Estonian Oligochaeta. Pedobiologia 10: 52–78.
- Timm T (1994) Propappidae and aquatic Enchytraeidae (Oligochaeta) from the farthest southeast of Russia. Hydrobiologia 278 (1-3): 67–78.
- Timm T (1997) Freshwater Oligochaeta of some urban watercourses in the Russian Far East. Internationale Revue der Gesamten Hydrobiologie und Hydrographie 84 (4): 437–467.
- Timm T (1999) Oligochaeta of the Edinka Stream, Russian Far East. Species Diversity 4: 1–7.
- *Timm T (2009) A guide to the freshwater Oligochaeta and Polychaeta of Northern and Central Europe. Lauterbornia 66: 1–235.
- Timm T (2012) Life forms in Oligochaeta: a literature review. Zoology in the Middle East 58 (supplement 4): 71–82.
- *Timm T, Martin P (2019) Phylum Annelida: Class Clitellata: Subclass Oligochaeta. Thorp and Covich's Freshwater Invertebrates: Volume 4: Keys to Palaeartic Fauna. Elsevier, London, pp. 364–483.

- Timm T, Vvedenskaya TL (2006) Oligochaeta (Annelida) of Lake Kurilskoe, Kamchatka Peninsula. *Species Diversity* 11: 225–244.
- Torii T (2006) New Record of *Propappus volki* (Annelida: Clitellata: Propappidae) from Japan. *Species Diversity* 11 (4): 359–365.
- *van Haaren T, Soors J (2013) Aquatic Oligochaeta of the Netherlands and Belgium. KNNV Publishing, Zeist, 304 pp.
- Welch PS (1920) The genera of the Enchytraeidae (Oligochaeta). *Transactions of the American Microscopical Society* 39 (1): 25–50.
- Verdonschot PFM (2006) Beyond masses and blooms: the indicative value of oligochaetes. *Hydrobiologia* 564 (1): 127–142.