A faunistic study of water mites (Hydrachnidia and Halacaridae) from southern Norway

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Targeted sampling of a broad range of freshwater habitats over the past five years, combined with screening of recent records available in online databases, substantially increased the number of water mite species known to Norway. Among the 190 species now recorded (187 Hydrachnidia and 3 Halacaridae), 47 are new to Norway, with 21 of these recorded from Fennoscandia for the first time. Partial COI-sequences (DNA barcodes) of 110 species were generated in our project, and comparative analyses showed indications of cryptic species diversity for ten species. We provide an updated checklist for the Norwegian water mite fauna with comments on distribution and ecology. Included are detailed locality records, ecological habitat characteristics and some important physicochemical parameters for the collecting sites visited by us. For species of particular interest, open taxonomic questions and needs for further research are discussed.

Key words: Water mites, Hydrachnidia, Norway, DNA barcoding, habitat, Thor.

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Introduction

The first water mite described from Norway was published by Strøm (1768) from the area of Borgund (Vestland County) in western Norway. Since then, the lion's share of water mite records from Norway was provided by one author only, Sig Thor (1856–1936); our reference list includes all his papers containing faunistic data from Norway. The few papers published by other authors treat local populations of Hydrachnidia from a spring in Vestland (K. Viets 1928), a lake southwest of Oslo (Økland 1964), a lake in Oslo (Sæther 1965), two lakes near Tromsø (Sæther 1967), Lake Lille Jonsvatnet near Trondheim (Solem 1973) and the river Tana with tributaries in Finnmark (Bagge 2001). Further data is listed in The Norwegian Biodiversity Information Centre's Species Map Service (Artskart) and Olsen (2016), derived from identifications done by J. Stålstedt (Stockholm) and collected by Biofokus, mostly from central and southern Norway. From these data, a record of a halacarid mite was published by Bartsch (2020).

The first national checklist of water mites from

Norway was provided by Mehl (1979), followed by an updated version including the state of knowledge at the end of the past century (Mehl 1996). A few remarks are warranted for the latter paper:

(1) Mehl (1996) did not consider four taxonomic statements proposed by previous authors: *Hydrachna globosa uniscutata* Thor, 1897 = *H. globosa* (Geer, 1778) (Lundblad 1962); *Parathyas valvata*: nomen dubium (K.O. Viets 1987 - see also Di Sabatino *et al.* 2009); *Piona alata* (Thor, 1897): nomen dubium (Gledhill & K.O. Viets 1976); *Atractides spinipes*: nomen dubium (Gledhill & K.O. Viets 1976 – meanwhile redescribed by Gerecke 2003, not found in Norway).

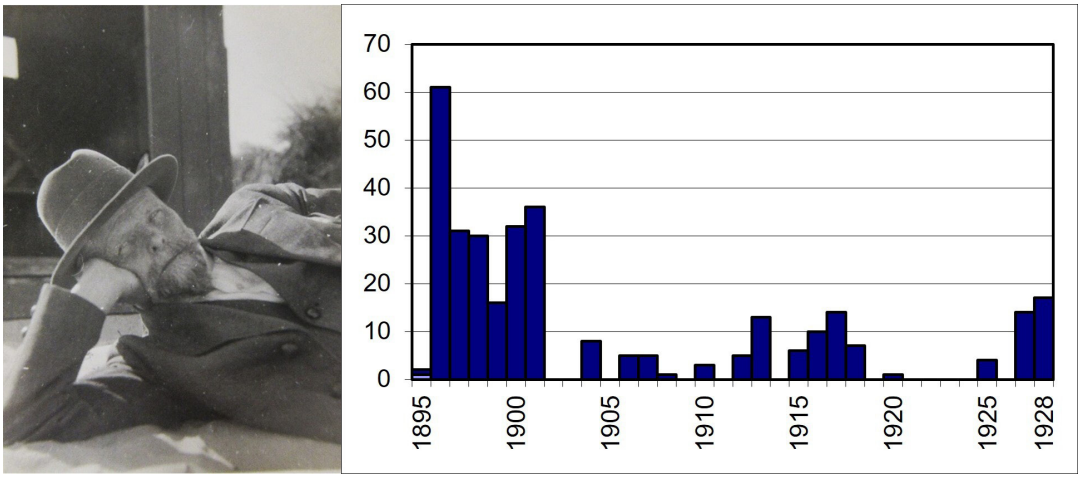
(2) Nine species previously recorded from Norway were not mentioned by Mehl (1996): *Arrenurus coronator* Thor, 1900 (Thor 1900b, 1901a); *Eylais muelleri* Koenike, 1897 (Thor 1897c, Økland 1964); *Hydrachna skorikowi* Piersig, 1900 [Thor sub nom. *H. schneideri* Koenike, 1895] (Thor 1897b); *Lebertia sefvei* Walter, 1911 (Thor 1922b, K.Viets 1928); *Limnesia marmorata* Neuman, 1870 (Thor 1897b); *Neumania deltoides* (Piersig, 1894) (Thor 1897c, Sæther 1965); *Oxus strigatus* (Müller, 1776) (Thor 1897c); *Sperchon hispidus* Koenike, 1895 (Thor 1899c); *Xystonotus willmanni* K. Viets, 1920 (K. Viets 1928). For several of these species, absence from the checklist was probably due to change in taxonomic understanding – *Limnesia marmorata* was for instance regarded as a junior synonym of *L. maculata* (Müller, 1776) for a long time (Van Haaren & Tempelman 2009).

(3) *Lebertia obscura* Thor, 1900 was until recently considered a junior synonym of *L. porosa* Thor, 1900*,* but is re-established (Tyukosova *et al.* 2022). Further recent taxonomic changes concern *Oxus koenikei* Thor, 1899 now a junior synonym of *O. longisetus* Berlese, 1885 and *Pseudothyas trabecula* Thor, 1899 now regarded as a nomen dubium (Di Sabatino et al. 2009).

(4) For four species listed by Mehl (1996) no evidence of records from Norway in previous publications could be found: *Arrenurus affinis* Koenike, 1887 (Sørlandet), *A. bruzelii* Koenike, 1885 (Sørlandet), *A. crenatus* Koenike, 1896 (Sørlandet), and *Neumania limosa* (Koch, 1836) (Østlandet). However, *A. bruzelii* and *N. limosa* were recorded in the present study, and in view of their general distribution, it is highly plausible that *A. affinis* and *A. crenatus* are present in Norway as well.

Sig Thor became famous in water mite research by his eminent taxonomic work, including the description of 170 species and subspecies world-wide and the introduction of numerous genus and family names. However, tragically he also became known as the one who in his last will ordered the destruction of his slide collection (Lundblad 1938, K. Viets 1940). For this reason, his scientific heritage was for a long time considered highly problematic, with many open questions believed to be unresolvable. However, during the past decade, his wet material collection was rediscovered in the Natural History Museum in Oslo. Thus, parallel to the project "Water mites and midges in southern Norway" (Water M&M) generating the results reported here, Gerecke undertook a revision of the Thor heritage in 2017 and 2020. The collection was screened, copying locality data from of all tubes bearing species identifications. Along with scattered data accumulated from collections elsewhere in Europe (Basel, Berlin, Frankfurt, Paris, Stockholm) it was possible to identify original material of a total number of 108 (in Oslo: 106) of Thor's species, with the availability of syntypes for at least 71 (42 % of the species described by Thor).

The hand-written curriculum by the author himself (Thor unpubl. 1928, Senckenberg Museum Frankfurt), allowed further insight of his scientific activities: A first period of particularly intensive fieldwork started in the late nineteenth century and lasted until 1902. Then, this activity decreased drastically in the years preceding the publication of his doctoral thesis in 1905. Thereafter, his limno-faunistic fieldwork in Norway continued to a limited degree, more intense only in the period of difficult international travel during the first World War. An increase in the collecting activity was then observed in the late nineteen twenties (Figure 1). However, Thor changed his focus first to the water mites of other European countries (Denmark, Germany,



FIGURES 1. Sig Thor. Left: Photograph from the heritage K. Viets, taken 1926 in Denmark, Senckenberg Museum Frankfurt. Right: number of Norwegian water mite collecting sites visited per year (unpubl. CV of Sig Thor in Senckenberg Museum Frankfurt, data available 1895–1928).

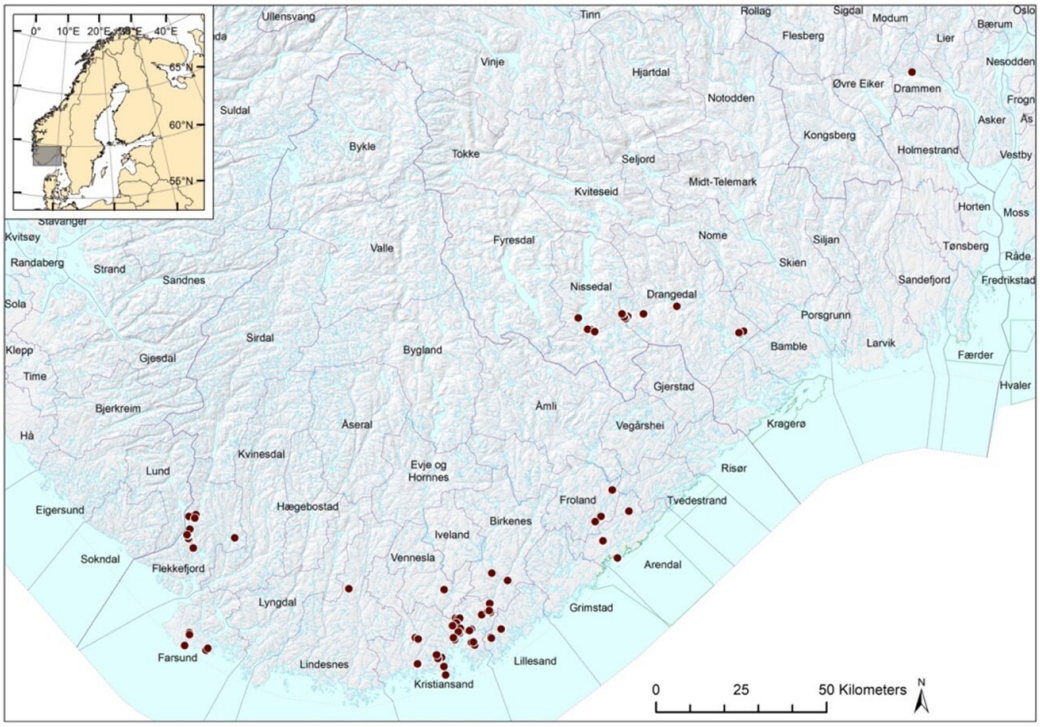
Switzerland, Italy, France, and later also Russia), and then, from 1928 onwards, to terrestrial mites. In summary, before the Water M&M project data were analysed, a total number of 140 species of water mites (2 halacarids, 138 Hydrachnidia) were recorded from Norway. In this count, we do not include 24 species most probably representing junior synonyms or nomina dubia that cannot be recognized based on available information (Table 1). Some of these might become of interest in future revisional work. The present study provides an updated checklist for the Norwegian water mites with regionalized distribution information, detailed locality records and ecological habitat characteristics for the species recorded during the present project, and properties of selected species which are of particular interest. Although the focus is on Norwegian water mites, our results should be of considerable value to regions outside of Norway as it clarifies the identity of numerous species described by Sig Thor that later were considered to have larger geographical distributions. Questions regarding the true distribution and ecology of European water mites can be resolved only "from the roots", starting with the improved taxonomic definitions of water mite species first described from Norway.

Material and methods

Fieldwork was performed in all kinds of inland waters in selected areas in southern Norway from 2019 to 2020 (Figure 2). At all field sites, ecological and physiochemical properties were noted (e.g., water typology, pH, conductivity, trophic state). In addition, we include some previously unpublished material collected from 2013 to 2020 in the course of other projects in central and northern Norway. All material is deposited in the scientific collections of the Museum of the Norwegian University of Science and Technology (NTNU-VM).

For morphological investigation, selected appendages (palps, the whole gnathosoma, and/or selected legs), were detached and investigated under a Leitz Laborlux K microscope. In many cases, dissected specimens (when necessary, keeping the dorsal idiosoma separate from the venter) were slide mounted in Hoyers fluid, or rarely in glycerine jelly. In other occasions, idiosoma and detached appendages were returned into 80% pure ethanol to be further preserved in the wet collection, with a remark about dissected parts on a label.

Morphological identification used the most recent literature (Bartsch 2007, Davids *et al.* 2007, Di Sabatino *et al.* 2010, Gerecke *et al.* 2016) as



FIGURES 2. Collecting sites investigated in the focus area of the Water M&M project.

well as publications with original descriptions. 580 specimens of 119 species were selected for DNA barcoding. DNA was extracted either from dissected tissue (legs) or from whole specimens using the standard protocols for animal tissue at the Canadian Centre for DNA Barcoding (CCDB) at the University of Guelph, Canada. PCR and bi-directional Sanger sequencing were performed with the primer cocktail LepFolF and LepFolR (Hernández-Triana *et al.* 2014) using established protocols at CCDB, edited and uploaded to the Barcode of Life Data Systems (BOLD). All barcode data and metadata are publicly available in the dataset DS-NOHYD Norwegian water mites (DOI: dx.doi.org/10.5883/DS-NOHYD) in BOLD.

Abbreviations: Natural History Museum, University of Oslo, Norway (NHMO); Museum für Naturkunde - Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Berlin, Germany (NHUB).

Results and discussion

Based on our results, the current checklist of the Norwegian water mite fauna totals 190 species (Table 2). For the 133 species recorded in the Water M&M project, we observe that there are both eurytopic and stenotopic species, indicating that some species have a higher potential as environmental indicators (Table 3).

Of the 628 specimens selected for DNA barcoding, partial COI-sequences were successfully generated for 544 records from 109 species.

A total of 47 species (about one fourth of the documented diversity) is recorded for the first time in Norway, 21 of these are new to Fennoscandia. In ten of these cases, previously described species were found to include molecularly divergent lineages, potentially representing cryptic taxa. Among these, the *Lebertia porosa* aggregate of species was recently investigated in detail (Tyukosova *et al.* 2022), while thorough

morphological analysis of the remaining complexes is in progress. Comparing material from outside Norway, we identified at least four cases where central European populations previously attributed to species described from Norway in fact represent different clades, probably species new to science.

The order of taxa in the below treatment follows the traditional taxonomic order (eg, Davids *et al.* 2007, Di Sabatino *et al.* 2010, Gerecke *et al.* 2016); genera and species are listed alphabetically in Tables 1–3. The taxonomic discussion covers species of zoogeographical interest and taxa requiring further taxonomic work.

Superfamily Eylaoidea

Family Eylaidae

Three species of the genus *Eylais* Latreille, 1796 could be distinguished in our material, but all records require further verification. Specimens attributed to *Eylais infundibulifera* Koenike, 1897*, E. koenikei* Halbert, 1903 and *E. rimosa* Piersig, 1899 based on morphological characteristics (Davids *et al.* 2007), do not match with the DNA barcode clustering in BOLD. These discordances suggest that a taxonomic revision of the European species is needed. A future revision should include association of larval stages and the description of their morphology to hopefully find more diagnostic characters in *Eylais*.

Family Piersigiidae

The records of *Piersigia intermedia* Williamson, 1912 are the first findings of this family in Norway. In Scandinavia, this rare species previously was found only in three ponds in southern Sweden (Lundblad 1962).

Superfamily Hydryphantoidea

Family Hydrodromidae

Hydrodroma pilosa Besseling, 1940 was rather recently recognized as a separate species (Gerecke 1991). In the decades prior to this, it was frequently confused with *H. despiciens* (Müller, 1776), and Lundblad (1920) overlooked the coexistence of both taxa in Denmark, *terra typica* of *H. despiciens*. In Norway, the latter is by far the dominant hydrodromid, but a few specimens of *H. pilosa* could be detected at four sites at low elevation, on several occasions coexisting with *H. despiciens*. The presence of the species in Norway was already documented by J. Stålstedt in the online Norwegian Species Map Service (Artskart), but the data has so far not been published in peer-reviewed articles.

Family Hydryphantidae

Subfamily Euthyadinae

The identity of specimens attributed by Thor to *Parathyas stolli* (Koenike, 1895), a species first described from North America and probably restricted to the Nearctic, could not be cleared so far. In Table 2, we follow K. Viets (1956b) and attribute these records to *Parathyas dirempta* (Koenike, 1912). The recent fieldwork in connection with Water M&M produced only two other species of genus *Parathyas* Lundblad, 1926: *P. barbigera* (K. Viets, 1908) and *P. palustris* (Koenike, 1912).

Subfamily Hydryphantinae

The distinction of *Hydryphantes ruber* (Geer, 1778) and the similar *H. clypeatus* Thor, 1899, requires further investigation. The latter was described from Norway and considered by Di Sabatino *et al.* (2009) a nomen dubium. However, DNA barcode data for specimens from southern Norway attributed to *H. ruber* based on Di Sabatino *et al.*'s key (2010) groups in two genetically divergent clusters. Tuzovskij (2014) attributed populations collected in Russia to *H. clypeatus* and was able to distinguish these also in the larval stage from larvae reared from females attributed by him to *H. ruber*. Considering these observations, a review of *H. ruber*-like water mites requires as a first step a redescription of *H. ruber* s. str., at best based on material from the terra typica around Uppsala.

In addition to *Hydryphantes dispar* (Schaub, 1888), already recorded from Norway, *H. hellichi* Thon, 1899 could be identified as a species new to Norway.

Superfamily Lebertioidea

Family Lebertiidae

Lebertia fimbriata Thor, 1899 was described based on specimens from Vestland and Oslo. Gerecke (2009) designated a neotype from one of the type localities (NHUB, in coll. Koenike), but based his redescription widely on a population from S Germany. In Gerecke's concept, *L. fimbriata* had a wide distribution in the West Palaearctic. Molecular data show, however, that *L. fimbriata sensu* Gerecke (2009) consists of at least three distinctly diverging clusters. Considering the genetic variation observed, a re-analysis of the morphological variation is necessary. The name *L. fimbriata* should likely be restricted to the genetically homogenous populations from Norway.

The original description of *Lebertia gibbosa* Lundblad, 1926 was extremely meagre. Shortly after, it was considered a junior synonym of *L. porosa* (Thor 1927c, see also K. Viets 1956b), but later, the author himself synonymized it with *L. inaequalis* (Lundblad 1962). The Water M&M project allowed a reanimation and redescription of the species based both on morphological and molecular data (Tyukosova *et al*. 2022). Based on the structure of the palp, *L. gibbosa* could be a junior synonym of the similar *L. porosa dorsalis* Thor, 1905, but this taxon must be considered a nomen dubium due to its incomplete description and missing type material (Tyukosova *et al.* 2022).

Lebertia inaequalis (Koch, 1837) was the first described species of the genus with a type locality in southern Germany. The species was recorded by Gerecke (2009) as a species with a wide Palaearctic distribution. DNA barcode data in BOLD show the existence of at least three genetic groups in Central Europe. All *L. inaequalis*-like specimens from Norway are found together in one of these clades. A redefinition of the species from Central European material is a prerequisite for discussing the species attribution of the Norwegian populations, as well as the taxonomic state of numerous species listed as synonyms in Gerecke (2009).

In Gerecke's revision of *Lebertia* (Gerecke 2009), *L. porosa* Thor, 1900 was the species with the highest number of junior synonyms (27!). DNA barcode data generated through the Water M&M project indicated at least seven distinct genetic lineages that were confirmed by nuclear genetic markers and small but consistent morphological differences (Tyukosova *et al.* 2022). This allowed the redefinition of *L. porosa* s. str. and *L. obscura* Thor, 1900 from their joint type locality and the reanimation of *L. gibbosa* (see above). The four remaining genetic lineages are so far unnamed as a larger-scale study including populations from other parts of Europe is needed to establish a stable taxonomy for this group.

Lebertia pusilla Koenike, 1911 is here recorded for the first time from Fennoscandia. DNA barcodes cluster in two divergent genetic lineages, suggesting that there might be more than one species hiding under this name. A review of species previously considered to be junior synonyms of *L. pusilla* is necessary.

Family Sperchontidae

DNA barcodes attributed to Norwegian *Sperchon glandulosus* Koenike, 1886 using Di Sabatino *et al.*'s key (2010) group into two distinct lineages. Which genetic lineage belongs to *S. glandulosus* cannot be resolved without revising the whole *S. glandulosus* species complex on a wider geographical scale (studies in progress, Pešić *et al.* pers. comm.). It is possible that a revival of the junior synonym *S. multiplicatus* Thor, 1902, described from northern and eastern Norway, will be one of the results. DNA barcode data show that a sequenced specimen of *Sperchon setiger* Thor, 1898 from Norway is genetically divergent from Central European populations, and the latter represent at least two further genetically distinct barcode clusters. Future studies should include a redefinition of the nominal species restricted to material from Norway (preferably the type locality) with a taxonomically comparative analyses with other European populations including morphological and molecular data. In connection with this the related *S. insignis* Walter, 1906 should be evaluated.

Sperchonopsis verrucosa (Protz, 1896) was a long time considered the only representative of this very characteristic genus in Europe. The

species has not been questioned at all and no synonyms exist in literature (K.O. Viets 1987). DNA barcode data show that there are at least four genetically divergent clusters in Europe, two of these are found in Norway. Thus, *S. verrucosa* must be redefined from type material and at least one of the Norwegian genetic groups represents a species new to science.

Family Torrenticolidae

One of the characteristics of *Torrenticola spinirostris* (Thor, 1897) is the fusion of the dorsal shoulder plates with the main dorsal shield, previously considered diagnostic for *Rusetria* Thor, 1897 (a subgenus now synonymized with *Torrenticola* s.str.). For many decades, *T. spinirostris* (Thor, 1897), the type species of *Rusetria*, remained "in the shadow" of *T. amplexa* (Koenike, 1908) from Germany, and was designated nomen dubium by Di Sabatino *et al.* (2009) due to insufficient morphological information. All specimens collected in the present project agree with the definition of *T. amplexa* in Di Sabatino *et al.* (2010), raising the question if *T. amplexa* is a junior synonym of *T. spinirostris*. The Thor-collection at NHMO holds specimens identified by Thor as *T. spinirostris*, but not types. Mehl (1996) listed both *T. spinirostris* and *T. amplexa* from Norway, perhaps unaware about their possible synonymy. We follow the current taxonomy and only list *T. amplexa*, but suggest that a future integrative analysis of more specimens from a wider range in Norway and Germany might resolve the potential synonymy of these two species.

In view of the rather intense studies done all over Sweden (Lundblad 1968), Finland (Bagge & Bagge 2009) and Norway (data presented here), our first record in Fennoscandia of *Torrenticola brevirostris* Halbert, 1911, a rather characteristic species, is very interesting. We cannot exclude that our finding is the result of a climate-driven northwards dispersal of the species.

Superfamily Hygrobatoidea

Family Aturidae

Subfamily Axonopsinae

The situation for *Brachypoda versicolor* (Müller, 1776) is similar to the one of *Sperchonopsis verrucosa*: It was believed to be easily recognized due to a distinct character combination and therefore never investigated regarding potential morphological patterns and differences between populations. However, Norwegian populations keying to *Brachypoda versicolor* in Gerecke *et al.* (2016), clearly represent two divergent barcode clusters. The typical *B. versicolor* must be redefined and assigned to one of these clusters, the other genetic lineages likely represent a species new to science.

Family Hygrobatidae

Over the past century, a high number of subspecies of *Atractides nodipalpis* (Thor, 1899) have been described (Gerecke 2003). However, the eminent taxonomist O. Lundblad renounced to detailed taxonomic analysis and attributed all his material to *A. nodipalpis* s.l. (Lundblad 1968). Since then, many of these subspecies were either synonymized or elevated to species rank (Gerecke 2003). However, specimens keying to *A. nodipalpis* in Gerecke *et al.* (2016) have DNA barcodes that cluster in two genetically divergent groups, both widely distributed in Norway. Morphological analysis allowed us to associate with certainty one of the two clusters with *A. nodipalpis* s.str., already defined by neotype designation (Gerecke 2003). Included in this cluster are DNA barcodes from specimens collected near the type locality. DNA barcode data in BOLD confirm a wide distribution of this species extending from SE Europe over Fennoscandia up to Greenland. However, as in the case of *Lebertia fimbriata* (see above), diagnostic characters of *A. nodipalpis* were defined by Gerecke (2003) from a population collected in S Germany that has divergent DNA barcodes (unpubl. data). The morphological variability within *A. nodipalpis* s. str. should be redefined based on sequenced specimens from Norway.

The other genetic lineage of *A. nodipalpis*-like specimens show similarity with *A. robustus*

(Sokolow, 1940) in the shape of the male genital field (with an anterior indentation) and palp (second segment with a distoventral projection). *Atractides robustus* was originally described as a subspecies of *A. nodipalpis*. However, specimens of both sexes differ from the two species in relatively longer posterior acetabula (Ac-3) and males have a less distinctly developed projection on the second palp segment. Representatives of this DNA barcode cluster include specimens from Central Europe. Thus, a resolved taxonomy is impossible without a revision of the numerous European taxa that in the past were considered junior synonyms of *A. nodipalpis* (see Gerecke 2003).

Atractides samsoni (Sokolow, 1936) was found in Norway for the first time. Morphological analysis of the newly collected material confirms the synonymy with *A. laetus* Lundblad, 1956 (see Gerecke 2003). At present state of knowledge, the species is restricted to northern Russia, Fennoscandia and Poland.

Hygrobates fluviatilis (Ström, 1768), the oldest species described from Norway, was recently revised using molecular and morphological data (Pešić *et al.* 2017). The identity of this species was redefined and five additional, previously cryptic species in other parts of Europe were discovered (Pešić *et al.* 2017). Our data suggest that *H. fluviatilis* s.str. is the only species in this group present in Norway.

Hygrobates prosiliens Koenike, 1915 was reanimated and separated from *H. longipalpis* (Hermann, 1804) by Pešić *et al.* (2019). As all the numerous specimens from our collections agree with the new definition of *H. prosiliens*, we suggest that all Norwegian records of *H. longipalpis* refer to this species. Whether *H. longipalpis* really is distributed in Fennoscandia is an open question that needs further studies.

Family Limnesiidae

Limnesia curvipalpis Tuzovskij, 1997 is new to the fauna of Norway. Some of the Scandinavian records of the similar *L. polonica* Schechtel, 1910 could refer to this species as well.

Family Pionidae

Subfamily Pioninae

With the detection of the rare *Nautaracha crassa* (Koenike, 1908) the genus *Nauatracha* has been recorded for the first time in Fennoscandia.

Piona carnea (Koch, 1836) is a further case of a species believed to be easily recognized without slide mounting, and therefore not investigated with regard to potential morphological patterns and differences among populations. Norwegian specimens attributed to *P. carnea* when following Gerecke *et al.* (2016) are represented by two divergent genetic lineages. Type material for species described by Carl Ludwig Koch is lost, but as representatives of one of the two clades also were found in southern Germany, from where *P. carnea* was originally described, we suggest basing a redescription of this species on specimens belonging to this lineage. *Piona brevipalpis* (Neuman, 1880), *P. alpina* (Neuman, 1880) and *P. unguiculata* (Neuman, 1880), all described from Sweden, are three species similar to *P. carnea* that were synonymized with the latter by Lundblad (1954). While important morphological data were documented for the types of these species (Museum of Natural History, Göteborg), incomplete specimens (e.g., lack of the name-giving palp in *P. brevipalpis*, only males of *P. alpina*, only females of *P. unguiculata*) leaves analysis of further material necessary to decide if one of these species match specimens of the second lineage.

A male *Piona* found in our study keyed to *Piona dispersa* Sokolow, 1926 and three females to *Piona discrepans* (Koenike, 1895) following Gerecke *et al.* (2016). For the first species, the DNA barcode obtained indicate that it represents a separate lineage. For the second species, sequencing remained unsuccessful. Both species need revision and analysis of more material is required.

Family Unionicolidae

Subfamily Pionatacinae

The DNA barcode of a single deutonymph identified as *Neumania* sp.? show that it belongs to an isolated lineage. Further collecting and analysis of adults should make clear if it is a representative

of *N. callosa* (Koenike, 1895), recorded from Norway by Thor (Troms County, 1900b) and by Stålstedt (Viken County, Norwegian Species Map Service).

Superfamily Arrenuridae

Family Arrenuridae

Arrenurus cuspidifer Piersig, 1894 and *Arrenurus cylindratus* Piersig, 1896 are two widespread species found for the first time in Norway, both only as females so far. For both species, DNA barcodes match data from The Netherlands.

Arrenurus kjerrmanni Neuman, 1880 and *Arrenurus leuckarti* Piersig, 1894 are also new to the Norwegian fauna, but species attribution is based on morphology only as sequencing was unsuccessful.

Arrenurus sp. n. is a morphologically very distinct species (Figure 3) and is represented by one male only. The specimen was collected in a lake in the Flekkefjord area (Agder County) in southern Norway. The attempt to sequence was unsuccessful and we refrain to describe and name the species until more material is available for examination.

Family Mideopsidae

Studies over the past decades suggest that many older records of *Mideopsis orbicularis* (Müller, 1776) in fact were to be assigned to *M. roztoczensis* Biesiadka & Kowalik, 1979, the former mostly being found in larger standing waters, the latter in pools in streams (Smit *et al.* 2000, Tuzovskij 2006). DNA barcode data suggest a yet higher diversity in European *Mideopsis*, with at least two divergent genetic lineages behind each of the two species. In Norway, we have three of these groups and material will be included in a taxonomic analysis that compares specimens and species from continental Europe (in cooperation with A. Zawal, Sczeczin, Poland).

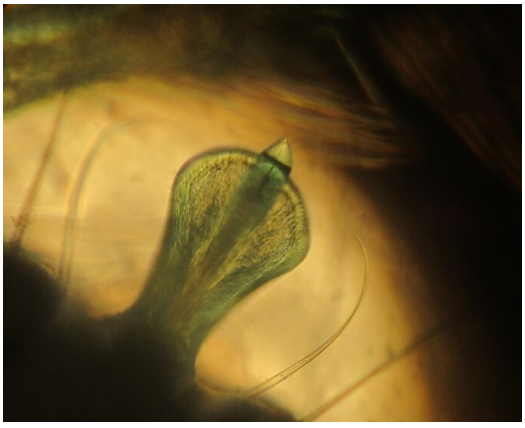


FIGURE 3. The characteristic caudal extension ("petiole") of the male *Arrenurus* sp. n. from southern Norway.

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Note: The alphabetical numbering of Thor's publi-cations is adapted from the bibliographic catalogue by K. Viets (1955) to facilitate consistency with other publications.

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TABLE 1. Species recorded from Norway that cannot be recognized based on available information, representing junior synonyms of other species or nomina dubia. The numbers refer to publications where records were reported: 1) Thor 1897a; 2) Thor 1897b; 3) Thor 1897c; 4) Thor 1898c; 7) Thor 1899a; 8) Thor 1899c; 9) Thor 1900a; 10) Thor 1900b; 11) Thor 1901a; 16) Thor 1906a; 23) Thor 1922b; #) Artskart.

	Northern		**Central**	**Western**		**Eastern**				**Southern**		**Synonymy**
	Troms og Finnmark	**Nordland**	**Trøndelag**	**Møre og Romsdal**	**Vestland**	**Innlandet**	**Viken**	**Oslo**	**Vestfold og Telemark**	**Rogaland**	**Agder**	
Arrenurus angulator Koch, 1837								2			2	
Arrenurus emarginator (Müller, 1776)							10		10			10) "*A. neumani* sensu Piersig" in 2) and 8)
Arrenurus paluster Thor, 1901	10, 11											
Arrenurus primitivus Thor, 1922							23					
Eylais angustipons Thor, 1899										8		
Eylais cornuta Thor, 1901								10				

TABLE 1. *continued*

Eylais infundibulifera pauciseta Thor, 1899										8	
Eylais neglecta Thor, 1899					8		8		8		
Lebertia dorsalis Thor, 1906						16					syn. to *L. porosa/gibbosa*?
Lebertia prolongata Thor, 1922								23			syn. to *L. oudemansi*? Lundblad (1962)
Lebertia tauinsignita (Lebert, 1879)	3	3	2, 3	8	2	2	2	8	8	8	
Limnesia marmoroides Thor, 1897							2				syn. to *L. maculata/undulata*?
Neumania ciliata Thor, 1897			2								syn. to *N. spinipes*?
Oxus koenikei Thor, 1899							8				syn. to *O. longisetus*: Di Sabatino et al. (2009)
Parathyas pustulosa (Thor, 1901)	11										
Parathyas valvata Thor, 1899	10										
Piona alata Thor, 1897			1		1						
Piona bipora Thor, 1922						23					monstrosity
Piona controversiosa (Piersig, 1896)							10				syn. to *P. alpicola*? (many authors)
Piona luteola (Koch, 1836)	10				2, 8	2	2	2		2	
Piona raropalpis Thor, 1901	10, 11										monstrosity
Pseudothyas trabecula Thor, 1899							8				
Sperchon lineatus Thor, 1899					7, 10						syn. to *S. brevirostris*? K.O.Viets (1987)
Sperchon thori Koenike, 1901									9, 10		syn. to *S. clupeifer*?
Teutonia subalpina Thor, 1897	3		2		2, #				8		syn. to *T. cometes*? (data M&M)
Unionicola kochi (Thor, 1898)							4				

TABLE 2. Regional distribution of Norwegian water mite species including the new data presented here. The numbers refer to publications where records were reported: 1) Thor 1897a; 2) Thor 1897b; 3) Thor 1897c; 4) Thor 1898c; 5) Thor 1898d; 6) Thor 1898e; 7) Thor 1899a; 8) Thor 1899c; 9) Thor 1900a; 10) Thor 1900b; 11) Thor 1901a; 12) Thor 1901b; 13) Thor 1901c; 14) Thor 1905d; 15) Thor 1905f; 16) Thor 1906a; 17) Thor 1906d; 18) Thor 1907a; 19) Thor 1907e; 20) Thor 1910b; 21) Thor 1913d; 22) Thor 1914a; 23) Thor 1922b; 24) Thor 1923; 25) Thor 1925b; 26) Thor 1926b; 27) Viets, K. 1928a; 28) Økland 1964; 29) Sæther 1965; 30) Sæther 1967; 31) Mehl 1996; 32) Bartsch 2020; 33) Solem 1973, 34) Bagge 2001; #) Artskart; §) Olsen 2016; $ Thor wet collection, NHMO; *) this paper

	Northern		Central	Western		Eastern				Southern		
	Troms og Finnmark	Nordland	Trøndelag	Møre og Romsdal	Vestland	Innlandet	Viken	Oslo	Vestfold og Telemark	Rogaland	Agder	new to Norway
Porohalacarus alpinus Thor, 1910						20						
Porolohmanella violacea Kramer, 1879			*								32	
Soldanellonyx chappuisi Walter, 1917	*					*						x
Arrenurus affinis Koenike, 1887											31	
Arrenurus albator (Müller, 1776)						10	3	1, 4, 10, 28	3, 8	8	*	
Arrenurus bicuspidator Berlese, 1885					8		3	10, 28	10			
Arrenurus bruzelii Koenike, 1885			*								31	
Arrenurus buccinator (Müller, 1776)			2			6	8, 10, #	2, 8, 10, 25	10, *	8	*	
Arrenurus claviger Koenike, 1885								10			8	
Arrenurus conicus Piersig, 1894							8	8				
Arrenurus compactus Piersig, 1894											*	x
Arrenurus coronator Thor, 1900								10, 11				
Arrenurus crassicaudatus Kramer, 1875						10	3 *	1			*	
Arrenurus crenatus Koenike, 1896											31	
Arrenurus cuspidifer Piersig, 1894									10		*	
Arrenurus cylindratus Piersig, 1896											*	x
Arrenurus forpicatus Neuman, 1880			2, *		8	2, 10	2, 10, *	2, 10	3, 10, *	8	*	
Arrenurus globator (Müller, 1776)			*				8, 10, *	2, 10	3, 10	8	8, *	
Arrenurus integrator (Müller, 1776)							8					
Arrenurus kjermanni Neuman, 1880			*		10	2, 10, #	10	2, 10	10		*	
Arrenurus leuckarti Piersig, 1894			*									x
Arrenurus maculator (Müller, 1776)					8		3		3, 10		*	

TABLE 2. *continued*

	Northern		Central	Western		Eastern				Southern		
	Troms og Finnmark	Nordland	Trøndelag	Møre og Romsdal	Vestland	Innlandet	Viken	Oslo	Vestfold og Telemark	Rogaland	Agder	new to Norway
Arrenurus mediorotundatus Thor, 1898								4			*	
Arrenurus membranator Thor, 1901							13					
Arrenurus neumani Piersig, 1895			*		8	2	3	2, 3, 8	3, *		2, 8, *	
Arrenurus pustulator (Müller, 1776)						2	3, 25	3				
Arrenurus regulator Thor, 1899	10, 11						25	8, 10				
Arrenurus robustus Koenike, 1894					31						31	
Arrenurus stecki Koenike, 1894							8	8				
Arrenurus stjordalensis Thor, 1899	10, 23	*	8								*	
Arrenurus tricuspidator (Müller, 1776)								2				
Arrenurus truncatellus (Müller, 1776)		10						3, 10, 25				
Arrenurus zachariae Koenike, 1886			*								*	x
Arrenurus sp. n.											*	x
Atractides nodipalpis (Thor, 1899)	3, 34, *	3, *	*	*		2	3		8, 25, *	8	*	
Atractides sp. near *nodipalpis*			*	*		*			*		*	x
Atractides ovalis Koenike, 1883									*			x
Atractides samsoni (Sokolow, 1936)			*						*			x
Atractides tener (Thor, 1899)	10, 34, *		*	*		10, *	8	10	*		*	
Aturus scaber Kramer, 1875	10	*	*	*	8	10	8, #	8, 10			#, *	
Bandakia concreta Thor, 1913		*			27				21			
Brachypoda versicolor (Müller, 1776)	3, 10	*				2, 10	2, 8, 10	2, 3, 28, 29	3, 10, *	8	8, *	x
Euthyas truncata (Neuman, 1875)							3		#		*	
Eylais discreta Koenike, 1897								3				
Eylais extendens (Müller, 1776)						2, 8, #	2, 8, #	2,8,28,29,#	2, #		2	
Eylais infundibulifera Koenike, 1897	30					#	#, *	8, 29	#			
Eylais koenikei Halbert, 1903			*									x

TABLE 2. *continued*

	Northern		Central	Western		Eastern				Southern		
	Troms og Finnmark	Nordland	Trøndelag	Møre og Romsdal	Vestland	Innlandet	Viken	Oslo	Vestfold og Telemark	Rogaland	Agder	new to Norway
Eylais muelleri Koenike, 1897		3					3	3, 28	3			
Eylais mutila Koenike, 1897							#	3, 8				
Eylais rimosa Piersig, 1899							§, $				*	x
Eylais setosa Koenike, 1897								28	3, 8			
Feltria minuta Koenike, 1892	3,10,34,#,*	*	*	*		10, *						
Forelia brevipes (Neuman, 1880)										8	8, *	
Forelia liliacea (Müller, 1776)	10	*	3, *					3, 29	10, *	3, 8	8, *	
Forelia longipalpis Maglio, 1924											*	x
Huitfeldtia rectipes Thor, 1898	10, 30	10			4, 8	#		29				
Hydrachna conjecta Koenike, 1895											4	
Hydrachna cruenta Müller, 1776					8	#	#	3, 28	#	4, 8	4, 8	
Hydrachna geographica Müller, 1776						2		3	2			
Hydrachna globosa (Geer, 1778)							2	#	3, *			
Hydrachna goldfeldi Thor, 1916									$			x
Hydrachna processifera Koenike, 1903							$					x
Hydrachna skorikowi Piersig, 1900						2						
Hydrochoreutes krameri Piersig, 1896			*				#	10, #	#, *			
Hydrochoreutes ungulatus (Koch, 1836)	3	*	3		8	2		2, 3, 29, #	3	8, 10	8, *	
Hydrodroma despiciens (Müller, 1776)			2, *		8	2	2, 3, 10, #	2, 10, 28, #	2, 3, 10, *		2, 8, #, *	
Hydrodroma pilosa Besseling, 1940							*	§			*	x
Hydrodroma torrenticola (Walter, 1908)							§					x
Hydryphantes clypeatus Thor, 1899										8	8	
Hydryphantes dispar (Schaub, 1888)									8, #		8, *	
Hydryphantes hellichi Thon, 1899											*	x
Hydryphantes octoporus Koenike, 1896	10											

TABLE 2. *continued*

	Northern		Central	Western		Eastern				Southern		
	Troms og Finnmark	Nordland	Trøndelag	Møre og Romsdal	Vestland	Innlandet	Viken	Oslo	Vestfold og Telemark	Rogaland	Agder	new to Norway
Hydryphantes ruber (Geer, 1778)						2	2	2, 3, 8, 29	3	8	8,*	
Hygrobates calliger Piersig, 1896	34						10, #	8, #	*		#, *	
Hygrobates fluviatilis (Strøm, 1768)	8, 34, *	8	1, *	#, *	8	10	10, #	8, 10, #	3, *	8	8, *	
Hygrobates foreli (Lebert, 1874)	3, 34, *	*	1, *	#, *	3	1, 2, 3, *			25		*	
Hygrobates longiporus Thor, 1898			*				26		*	5, 8	*	
Hygrobates nigromaculatus Lebert, 1879	10, 34	10, *	*			10				8	*	
Hygrobates norvegicus (Thor, 1897)	10	10				2, #					*	
Hygrobates prosiliens Koenike, 1915	3, 10	2, 3	2,3, *			2, 10, #	2, 3, #	2,3,8,28,29	3, 10, #, *	8	8, *	
Hygrobates setosus Besseling, 1942			*								*	x
Hygrobates trigonicus Koenike, 1895							3, 23		3			
Kongsbergia materna Thor, 1899							7, 10, #		13			
Lebertia brevipora Thor, 1899	9, 10, 17		9, 10, 17			7, 9, 10, 17						
Lebertia contracta Thor, 1900			9, 10									
Lebertia dubia Thor, 1899		19					23					
Lebertia fimbriata Thor, 1899			*	*	7	14, *		7, 10	*		*	
Lebertia gibbosa Lundblad, 1926			*								*	x
Lebertia glabra Thor, 1897	3, 18				8							
Lebertia helvetica Thor, 1906		*	*									x
Lebertia inaequalis (Koch, 1837) complex	*		*	*							*	x
Lebertia insignis Neuman, 1880			*			3	#	16	16, *		*	
Lebertia obscura Thor, 1900	16	*	*					16	*	16	9, 16, $, *	x
Lebertia oudemansi Koenike, 1898	16											
Lebertia porosa Thor, 1900	10, #, $	10, $	*	*		$	#	$, #	#, *	$, #	9,10,16,$,*	
Lebertia porosa complex sp. A		*	*	*					*		*	x
Lebertia porosa complex sp. B		*	*									x

TABLE 2. *continued*

	Northern		Central	Western		Eastern				Southern		
	Troms og Finnmark	Nordland	Trøndelag	Møre og Romsdal	Vestland	Innlandet	Viken	Oslo	Vestfold og Telemark	Rogaland	Agder	new to Norway
Lebertia porosa complex sp. D		*	*									x
Lebertia porosa complex sp. E	*	*	*	*								x
Lebertia pusilla Koenike, 1911		*										x
Lebertia sefvei Walter, 1911					27	23, *			23		*	
Lebertia stigmatifera Thor, 1900	9, 10, 19			*	27	*	19		19			
Limnesia connata Koenike, 1895							10	8	3		*	
Limnesia curvipalpis Tuzovskij, 1997							*		*		*	x
Limnesia fulgida Koch, 1836	10	3	2		8		10, #	2, 28, #	10	8, #	2, 8, *	
Limnesia koenikei Piersig, 1894	3, 10	3			8		10			8	8, *	
Limnesia maculata (Müller, 1776)	8	*	2, *	*	#	2	2, 8, 10, #	2,3,#,28,29	3,10,25,#,*	8	8, #, *	
Limnesia marmorata Neuman, 1870							2					
Limnesia undulata (Müller, 1776)			*		#, *		2,8,10,25,#	2, 8, #	#		#	
Limnesia undulatoides Davids, 1997											*	x
Limnochares aquatica (Linnaeus, 1758)			2, 3, 33, *		8, #	2, 10	2, 3, 10, #	2,10,28,29,#	2, 10, #, *	8, #	8, #, *	
Ljania bipapillata Thor, 1898	10		*	*		10	10, #	6, 8, 10			*	
Mesobates forcipatus Thor, 1901		*	*						13			
Midea orbiculata (Müller, 1776)						2	2, 8, 10,	2,3,10,28,#	10, *		*	
Mideopsis crassipes Soar, 1904			*									x
Mideopsis orbicularis (Müller, 1776)						2	2,8,10,#,*		10	8	*	
Mideopsis roztoczensis Biesiadka & Kowalik, 1979									*		*	x
Mixobates processifer (Thor, 1905)	*		*			15						
Nautarachna crassa (Koenike, 1908)											*	x
Neumania callosa (Koenike, 1895)	10						#					
Neumania deltoides (Piersig, 1894)								3, 29				

TABLE 2. *continued*

	Northern		Central	Western		Eastern				Southern		
	Troms og Finnmark	Nordland	Trøndelag	Møre og Romsdal	Vestland	Innlandet	Viken	Oslo	Vestfold og Telemark	Rogaland	Agder	new to Norway
Neumania limosa (Koch, 1836)							31				*	
Neumania spinipes (Müller, 1776)						2	3, 10, #	2, 10	*	8	*	
Neumania vernalis (Müller, 1776)			2		8	2	2, 8, 10	2, 8, 10, 29	10, *	8	*	
Neumania sp. AEF 2878		*										?
Oxus carpenteri (Halbert, 1911)		*	*						*			x
Oxus integer (Thor, 1901)									10			
Oxus longisetus Berlese, 1885		*									*	x
Oxus musculus (Müller, 1776)					8	10	8, 10	2	10, *	8	8, *	
Oxus nodigerus Koenike, 1898								9, 10			*	
Oxus ovalis (Müller, 1776)								8	8	8	*	
Oxus setosus Koenike, 1898								8				
Oxus strigatus (Müller, 1776)	3							3	3		*	
Panisopsis vigilans (Piersig, 1896)					27							
Panisus michaeli Koenike, 1896	10											
Parathyas barbigera (Viets, 1908)								28			*	
Parathyas pachystoma (Koenike, 1914)								28				
Parathyas palustris (Koenike, 1912)											*	x
Parathyas dirempta (Koenike, 1912)	10						10, 25	3, 10				
Parathyas thoracata (Piersig, 1896)							10					
Piersigia intermedia Williamson, 1912											*	x
Piona alpicola (Neuman, 1880)	10										*	
Piona annulata (Thor, 1900)							10, 11					
Piona carnea (Koch, 1836) s.l.	3, 10, 30	3, #	1, 3, *		#	2, 3, 10, #	#	1, 10, #	1, 25, #, *		8, *	x
Piona clavicornis (Müller, 1776)							10					
Piona coccinea (Koch, 1836)						2, 10, #	2, 3, #, *	2, 10, 28, #				

TABLE 2. *continued*

	Northern		Central	Western		Eastern				Southern		
	Troms og Finnmark	Nordland	Trøndelag	Møre og Romsdal	Vestland	Innlandet	Viken	Oslo	Vestfold og Telemark	Rogaland	Agder	new to Norway
Piona coccinoides (Thor, 1897)	3, 10, 25				8	3, 10		10			8, *	
Piona conglobata (Koch, 1836)						2	2, 8, 10, *	2,3,10,28,29	3, 15	8	2, 8, *	
Piona discrepans (Koenike, 1895)											*	x
Piona disparilis (Koenike, 1895)								3				
Piona dispersa Sokolow, 1926											*	x
Piona laminata (Thor, 1900)	10, 11, 25											
Piona longipalpis (Krendowskij, 1878)	10, #	3	1, 3		8, #	1, 10	1, 3, 10, #	1,3,10,29,#	1, 3, 10, #	8	1, 8, *	
Piona neumani (Koenike, 1883)								2		8	8, *	
Piona nodata (Müller, 1776)	10		2			2, 10	3	2, 3, 29, #	2, 3, 10		2, 8, *	
Piona paucipora (Thor, 1897)	10						10	10		3, 8	*	
Piona pusilla (Neuman, 1875)	34		*			2	2, #		*		*	
Piona rotundoides (Thor, 1897)	3, 10	3	3, *		8				3	8	8, *	
Piona stjordalensis (Thor, 1897)			1		8					8	8	
Piona variabilis (Koch, 1836)	3	3	*			10		3, 10, 29	3, 10, #	8	8, *	
Pionacercus leuckarti Piersig, 1894	3, 10							4, 8		4	4	
Pionacercus norvegicus Thor, 1898		10				*	10	4, 8			*	
Pionacercus uncinatus (Koenike, 1885)								8			*	
Pionides ensifer (Koenike, 1895)							10	8, 10				
Pionopsis lutescens (Hermann, 1804)						2	10, #	2, 3, 29, #	3		*	
Sperchon brevirostris Koenike, 1895	3, 34, *	3, 10, #, *	*	*	8	10, #, *	8, #	10			*	
Sperchon clupeifer Piersig, 1896							22, #	4, 8, 10	22	9, 10	*	
Sperchon compactilis (Koenike, 1911)											*	x
Sperchon glandulosus Koenike, 1886 s.l.	10, 34, *		*	*	8, #	2, 10	8, #		25, *		*	x
Sperchon hispidus Koenike, 1895										8		
Sperchon insignis Walter, 1906			*									x

TABLE 2. *continued*

	Northern		Central	Western		Eastern				Southern		
	Troms og Finnmark	Nordland	Trøndelag	Møre og Romsdal	Vestland	Innlandet	Viken	Oslo	Vestfold og Telemark	Rogaland	Agder	new to Norway
Sperchon papillosus Thor, 1901									13			
Sperchon setiger Thor, 1898							#	10		5, 8, 15	*	
Sperchon squamosus Kramer, 1879	3, 10, 23		2		23, 27	10, 23, *		3			*	
Sperchonopsis verrucosa (Protz, 1896) s.l.	34	*	*	*	8		8, 10, #	8			*	x
Teutonia cometes (Koch, 1837)	3, 10, 34, #	3	2, 3, *			2, 10	10	3, 28	10, *	8	*	
Thyasides dentatus (Thor, 1897)								3				
Tiphys bullatus (Thor, 1899)								8				
Tiphys latipes (Müller, 1776)								8				
Tiphys ornatus Koch, 1836								10, 28, #			*	
Tiphys scaurus (Koenike, 1892)							10	8			*	
Tiphys torris (Müller, 1776)			*					3, 29	3		*	
Torrenticola amplexa (Koenike, 1908)			*	*		8	8, 10, 24, #	8, 10, 24		8	*	
Torrenticola brevirostris Halbert, 1911											*	x
Unionicola crassipes (Müller, 1776)	3, #	*	*		8	2, 10, #	2, 8, 10, *	2, 3, 10, #	2, 3, 10, *	8	2, 8, *	
Unionicola gracilipalpis (Viets, 1908)											*	x
Unionicola intermedia (Koenike, 1882)								28				
Unionicola minor (Soar, 1900)							§		*		*	x
Xystonotus willmanni K. Viets, 1920			*		27							
Zschokkea oblonga Koenike, 1892					8			8				

Remarks

- *Arrenurus affinis* Koenike, 1887 not in Lundblad 1968: NOR; 31) Recorded from southern Norway
- *Arrenurus albator* (Müller, 1776) 1) 3) 4) 8) 10) *A. errator* Thor, 1897
- *Arrenurus bruzelii* Koenike, 1885 not in Lundblad 1968: NOR; 31) Recorded from southern Norway
- *Arrenurus crenatus* Koenike, 1896 not in Lundblad 1968: NOR; 31) Recorded from southern Norway
- *Arrenurus robustus* Koenike, 1894 also in Lundblad 1968: NOR; 31) Recorded from southern Norway
- *Arrenurus stjordalensis* Thor, 1899 23) *A. finmarchicus* Thor, 1922
- *Arrenurus tricuspidator* (Müller, 1776) 2) *A. dubius* Koenike 1885

TABLE 2. *continued*

Remarks *continued*

- *Arrenurus truncatellus* (Müller, 1776) 10) *A. castaneus* Neuman, 1880
- *Atractides nodipalpis* (Thor, 1899) 2), 3), 8) partim *A. spinipes* Koch, 1837
- *Bandakia concreta* Thor, 1913 21) partim *B. elongata* Thor, 1913, *B. crassipalpis* Thor, 1913
- *Eylais mutila* Koenike, 1897 3) *E. foraminipons* Thor, 1897; 8) *E. duplex* Thor, 1899
- *Hydrachna conjecta* Koenike, 1895 4) *H. koenikei* Thor, 1898
- *Hydrachna cruenta* Müller, 1776 4) *H. propinqua* Koenike, 1898; §) 8) *H. binominata* Thor, 1899
- *Hydrachna globosa* (Geer, 1778) 2) *H. uniscutata* Thor, 1897
- *Hydrachna skorikowi* Piersig, 1900 2) *H. schneideri* Koenike, 1885
- *Hydrochoreutes krameri* Piersig, 1896 10) *H. incertus* Piersig, 1897
- *Hydrochoreutes ungulatus* (Koch, 1836) 8) partim, 10) *H. acutus* Thor, 1899
- *Hygrobates fluviatilis* (Strøm, 1768) 1) *H. borealis* Thor, 1897; 8) 10) *H. reticulatus* Koenike, 1892
- *Hygrobates foreli* (Lebert, 1874) 1) 2) 3) 25) *H. albinus, albinus epimerosus, albofasciatus* Thor, 1897
- *Hygrobates longiporus* Thor, 1898 5) 26) *H. squamifer* Thor, 1898
- *Hygrobates nigromaculatus* Lebert, 1879 8) 10) publ. data could also refer to *H. setosus*
- *Hygrobates prosiliens* Koenike, 1915 2) 3) 8) 10) 28) 29) #) sub nom. *H. longipalpis* (Hermann, 1804)
- *Hygrobates trigonicus* Koenike, 1895 23) partim *H. walteri* Thor, 1922
- *Kongsbergia materna* Thor, 1899 13) *K. runcinata* Thor, 1901
- *Lebertia dubia* Thor, 1899 19) *L. angulata* Thor, 1907; *L. theodorae* Thor, 1907; 23) *L. vietsi* Thor, 1922
- *Lebertia glabra* Thor, 1897 8) Vestland: Record with a question mark
- *Lebertia helvetica* Thor, 1906 possibly *L. oudemansi* sensu Thor
- *Lebertia inaequalis* (Koch, 1837) complex probably not *L. inaequalis* s.str.
- *Lebertia oudemansi* Koenike, 1898 possibly *L. helvetica*
- *Lebertia porosa* Thor, 1900 10) partim: *L. vigintimaculata* Thor, 1900; all publ.records except for type locality in Agder might refer to other species of the *L. porosa* complex
- *Limnesia fulgida* Koch, 1836 2) 3) 8) 10) *L. histrionica* Bruzelius, 1854; 2) also *L. venustula* Koch, 1836
- *Limnesia undulata* (Müller, 1776) published records might also refer to *L. undulatoides*
- *Mideopsis orbicularis* (Müller, 1776) published records might comprise also *M. roztoczensis*
- *Neumania deltoides* (Piersig, 1894) 3) *N. mirabilis* (Croneberg, 1899)
- *Neumania limosa* (Koch, 1836) 31) Recorded from "Østlandet"
- *Neumania* sp. AEF 2878 evt. *N. callosa/deltoides*?
- *Oxus nodigerus* Koenike, 1898 9) 10) *O. plantaris* Thor, 1900
- *Parathyas barbigera* (Viets, 1908) see *P. dirempta*
- *Parathyas palustris* (Koenike, 1912) see *P. dirempta*
- *Parathyas dirempta* (Koenike, 1912) 3) 10) 25) *P. stolli* (Koen. 1912), attributed to *P. dirempta* by K. Viets (1956) - evtl ident. with *P. barbigera* or/and *P. palustris*?
- *Piona alpicola* (Neuman, 1880) 10) *P. uncatoides* (Thor, 1901)
- *Piona carnea* (Koch, 1836) s.l. 2) 3) 8) 1) 25) *P. alpinus* Neuman, 1880; 1) *P. niger* Thor, 1897
- *Piona neumani* (Koenike, 1883) 2) *P. neumani bygdoensis* Thor, 1897
- *Piona nodata* (Müller, 1776) 2) *P. dubia* (Koch, 1841); 2) 3) 10) *P. fuscata* (Bruzelius, 1854)
- *Piona pusilla* (Neuman, 1875) 2) *P. rotunda* (Kramer, 1879)
- *Piona stjordalensis* (Thor, 1897) 1) *P. brevipalpis, alpina* sensu Neuman?
- *Piona variabilis* (Koch, 1836) 10) *P. rufa* (Koch, 1836)
- *Pionacercus leuckarti* Piersig, 1894 4) 10) *P. scutatus* (Thor, 1898); 4) 8) *P. sinuosus* (Thor, 1898)
- *Sperchon clupeifer* Piersig, 1896 4) 8) 10) 22) *S. elegans* Thor, 1898, 9) 10) *S. tenuabilis* Koenike, 1900
- *Sperchon glandulosus* Koenike, 1886 s.l. 10) 25) *S. multiplicatus* Thor, 1901
- *Teutonia cometes* (Koch, 1837) 2) 3) 8) 10) *T. primaria*; 3) also *T. comica* Thor, 1897 [monstrosity]
- *Torrenticola amplexa* (Koenike, 1908) 8) 10) #) *T. spinirostris*, 24) *T. wolgaensis*

TALBE 3. Habitat characteristics for the water mite species recorded in the Water M&M project.

Species	elevation [m asl] mean (range)	typology (st = stream, r = river, l = lake, p = pond)	pH range	conductivity [µS/cm] mean (range)	trophic state (o =oligotrophic, m =mesotrophic, e = eutrophic)
Porolohmanella violacea Kramer, 1879	219	l	-	-	o-m
Soldanellonyx chappuisi Walter, 1917	605 (64-1032)	r	-	-	o-m
Arrenurus albator (Müller, 1776)	17-35	st, l	6.6-7.3	46 (40-55)	m-e
Arrenurus bruzelii Koenike, 1885	216	l	-	-	o-m
Arrenurus buccinator (Müller, 1776)	70 (10-464)	st, l, p	5.6-6.9	79 (40-174)	o-m-e
Arrenurus compactus Piersig, 1894	83 (3-179)	r, l, p	6,97	197	o-m-e
Arrenurus crassicaudatus Kramer, 1875	16 (1-28)	l	7.3-9.5	45 (43-51)	m-e
Arrenurus cuspidifer Piersig, 1894	1	l	7	1581	m
Arrenurus cylindratus Piersig, 1896	25	st	-	-	m
Arrenurus forpicatus Neuman, 1880	176 (1-666)	l, p	5.8-9.5	86 (41-174)	o-m-e
Arrenurus globator (Müller, 1776)	50 (1-219)	l, p	6.1-9.5	71 (41-174)	m-e
Arrenurus kjermanni Neuman, 1880	109 (10-196)	st, l	-	-	o-m
Arrenurus leuckarti Piersig, 1894	216	l	-	-	o-m
Arrenurus maculator (Müller, 1776)	3	p	6.97	197	e
Arrenurus mediorotundatus Thor, 1898	1	p	6,2	774	e
Arrenurus neumani Piersig, 1895	139 (3-666)	st, l, p	5.4-6.9	46 (40-54)	o-m
Arrenurus sp. nov.	293	l	4.58	27	o
Arrenurus stjordalensis Thor, 1899	106 (38-174)	st,l	-	-	o-m
Arrenurus zachariae Koenike, 1886	70 (1-245)	st,p	5,6	52	o-m-e
Atractides nodipalpis (Thor, 1899)	46 (3-182)	r	6.9-7.4	48 (23-73)	o-m
Atractides ovalis Koenike, 1883	66	l	6,9	30	o-m
Atractides samsoni (Sokolow, 1936)	68 (65-71)	r	6.97	23	o-m
Atractides sp. near *nodipalpis*	117 (1-720)	st, r	5,73	25	o-m
Atractides tener (Thor, 1899)	186 (2-720)	st, r	5,82	39	o-m
Aturus scaber Kramer, 1875	71 (2-205)	st, r	5,73	25	o-m
Bandakia concreta Thor, 1913	33 (30-35)	r	-	-	o-m
Brachypoda versicolor (Müller, 1776)	40 (1-175)	st, r, l	6.9-7.3	68 (51-80)	o-m-e
Euthyas truncata (Neuman, 1875)	5 (1-12)	l, p	7.70	248 (197-298)	m-e
Eylais infundibulifera Koenike, 1897	1	l	9,5	44	e
Eylais koenikei Halbert, 1903	282	l	-	-	o-m
Eylais rimosa Piersig, 1899	36 (28-42)	l,p	6.9-7.3	83 (51-114)	o-m
Feltria minuta Koenike, 1892	193 (10-1032)	st,r	-	-	o-m
Forelia brevipes (Neuman, 1880)	17	l	6,6	74	m-e
Forelia liliacea (Müller, 1776)	161 (19-294)	st,r,l	6,3	46	o-m
Forelia longipalpis Maglio, 1924	28	l	7,3	51	m-e
Hydrachna globosa (Geer, 1778)	66	l	6,9	30	o-m
Hydrochoreutes krameri Piersig, 1896	183 (66-288)	l	6,9	30	o-m
Hydrochoreutes ungulatus (Koch, 1836)	43 (38-48)	l	-	-	o-m
Hydrodroma despiciens (Müller, 1776)	120 (1-557)	st,r,l,p	5.6-7.3	231 (19-1558)	o-m

TABLE 3. *continued*

Species	elevation [m asl] mean (range)	typology (st = stream, r = river, l = lake, p = pond)	pH range	conductivity [µS/cm] mean (range)	trophic state (o =oligotrophic, m =mesotrophic, e = eutrophic)
Hydrodroma pilosa Besseling, 1940	21 (1-39)	l	6.9-9.5	555 (14-1581)	m-e
Hydryphantes dispar (Schaub, 1888)	30 (21-39)	l	-	-	o-m
Hydryphantes hellichi Thon, 1899	12	l	6,1	55	e
Hydryphantes ruber (Geer, 1778)	7 (1-12)	l,p	6,1	55	m-e
Hygrobates calliger Piersig, 1896	37 (3-71	r	6,9	73	o-m-e
Hygrobates fluviatilis (Ström, 1768)	92 (1-557)	r,l	5.8-7.4	46 (19-89)	o-m-e
Hygrobates foreli (Lebert, 1874)	300 (11-1220)	st,r,l	6,7	19	o-m
Hygrobates longiporus Thor, 1898	47 (2-240)	st,r,l	6.7-6.9	48 (12-89)	o-m-e
Hygrobates nigromaculatus Lebert, 1879	157 (1-543)	st,l	-	-	o-m-e
Hygrobates norvegicus (Thor, 1897)	38 (1-109)	st,l	-	-	o-m-e
Hygrobates prosiliens Koenike, 1915	105 (1-462)	st,r,l,p	6.6-9.5	48 (30-73)	o-m-e
Hygrobates setosus Besseling, 1942	14 (1-45)	st,l,p	7,3	80	o-m-e
Lebertia fimbriata Thor, 1899	45 (1-720)	st,r	5.8-6.9	71 (39-89)	o-m-e
Lebertia gibbosa Lundblad, 1926	39 (2-175)	st,r, p	6.9-6.9	84 (73-98)	m-e
Lebertia helvetica Thor, 1906	97 (38-205)	st,l	-	-	o-m
Lebertia inaequalis (Koch, 1837) complex	80 (3-330)	st,r,l	-	-	o-m
Lebertia insignis Neuman, 1880	59 (2-175)	st,r	6.9-7.4	48 (23-73)	o-m-e
Lebertia obscura Thor, 1900	77 (2-464)	st,r,l,p	5.6-7.4	57 (23-89)	o-m
Lebertia porosa Thor, 1900	33 (1-99)	st,r,l	5.8-6.9	69 (39-89)	o-m-e
Lebertia pusilla Koenike, 1911	38	l	-	-	o
Lebertia sefvei Walter, 1911	583 (26-1140)	st,r	-	-	o-m
Lebertia stigmatifera Thor, 1900	600 (60-1140)	st,r	-	-	o-m
Limnesia connata Koenike, 1895	14	l	7,3	43	m-e
Limnesia curvipalpis Tuzovskij, 1997	21 (1-66)	l	6.6-9.5	46 (44-51)	m-e
Limnesia fulgida Koch, 1836	21 (10-39)	l	5,8	174	m-e
Limnesia koenikei Piersig, 1894	16 (2-53)	st,r,l,p	6.1-7.3	68 (55-80)	m-e
Limnesia maculata (Müller, 1776)	60 (1-219)	r,l	6.3-9.5	169 (30-1549)	o-m-e
Limnesia undulata (Müller, 1776)	160 (66-219)	l	6,9	30	o-m
Limnesia undulatoides Davids, 1997	1	l	7,43	1549	o-m
Limnochares aquatica (Linnaeus, 1758)	107 (3-219)	st,l,p	6.3-6.9	63 (55-89)	o-m-e
Ljania bipapillata Thor, 1898	70 (2-205)	st,r	5,73	25	o-m
Mesobates forcipatus Thor, 1901	60 (4-175)	r,l	-	-	o-m
Midea orbiculata (Müller, 1776)	20 (1-66)	l,p	6.6-6.9	43 (30-54)	o-m-e
Mideopsis crassipes Soar, 1904	175	st	-	-	m
Mideopsis orbicularis (Müller, 1776)	57 (1-174)	st,l	7.3-9.5	43 (30-54)	m-e
Mideopsis roztoczensis Biesiadka & Kowalik, 1979	48 (2-174)	st,r,l	6.6-7.4	49 (19-89)	o-m-e
Mixobates processifer (Thor, 1905)	82 (64-99)	r	-	-	o-m
Nautarachna crassa (Koenike, 1908)	12 (6-18)	st	6,9	89	m-e
Neumania limosa (Koch, 1836)	20 (14-28)	l	6.4-7.3	50 (43-55)	m-e

TABLE 3. *continued*

Species	elevation [m asl] mean (range)	typology (st = stream, r = river, l = lake, p = pond)	pH range	conductivity [µS/cm] mean (range)	trophic state (o =oligotrophic, m =mesotrophic, e = eutrophic)
Neumania sp. AEF 2878	47	l	-	-	o
Neumania spinipes (Müller, 1776)	137(1-294)	r,l,p	6,2	774	o-m-e
Neumania vernalis (Müller, 1776)	56 (17-175)	r,l,p	6.4-6.9	46 (30-55)	o-m
Oxus carpenteri (Halbert, 1911)	164 (38-282)	l	6,9	30	o-m
Oxus longisetus Berlese, 1885	37 (17-48)	l	5.4-6.6	49 (44-54)	o-m
Oxus musculus (Müller, 1776)	49 (17-174)	st,l	6.3-7.3	40 (30-46)	o-m
Oxus nodigerus Koenike, 1898	1	p	6,2	774	m-e
Oxus ovalis (Müller, 1776)	16 (1-40)	r,l,p	5.8.6.9	114 (54-274)	m-e
Oxus strigatus (Müller, 1776)	140 (19-121)	st	6,3	46	o-m
Parathyas barbigera (Viets, 1908)	27 (11-42)	p	6,9	114	m-e
Parathyas palustris (Koenike, 1912)	7 (1-12)	st,l	-	-	m-e
Piersigia intermedia Williamson, 1912	3	p	7	197	e
Piona alpicola (Neuman, 1880)	26 (12-39)	l	-	-	m-e
Piona carnea (Koch, 1836) s.l.	187 (1-666)	l,p	7	1581	o-m-e
Piona coccinea (Koch, 1836)	1		9,5	44	e
Piona coccinoides (Thor, 1897)	91 (48-174)	r,l	-	-	o-m
Piona conglobata (Koch, 1836)	24 (1-47)	st,l	5.4-9.5	385 (40-1581)	m-e
Piona discrepans (Koenike, 1895)	17	p	6,6	44	m-e
Piona dispersa Sokolow, 1926	224	l	-	-	o-m
Piona longipalpis (Krendowskij, 1878)	87 (40-174)	r,l	-	-	o-m
Piona neumani (Koenike, 1883)	63 (14-174)	st,l,p	6,9	114	o-m
Piona nodata (Müller, 1776)	28	l	7,3	51	o-m
Piona paucipora (Thor, 1897)	27 (1-48)	st,l	6.6-7-4	1256 (40-1581)	o-m
Piona pusilla (Neuman, 1875)	41 (3-185)	st,l,p	6.3-7.3	42 (30-54)	o-m-e
Piona rotundoides (Thor, 1897)	137 (14-543)	l	6.4-7.3	50 (44-55)	o-m-e
Piona variabilis (Koch, 1836)	110 (1-282)	st,l	6.6-7.4	549 (40-1581)	o-m
Pionacercus norvegicus Thor, 1898	209 (1-1140)	r,l,p	6.1-7.6	157 (55-298)	o-m-e
Pionacercus uncinatus (Koenike, 1885)	19	st	6,34	46	o-m
Pionopsis lutescens (Hermann, 1804)	12 (1-42)	st,l,p	5.7-9.5	110 (46-774)	m-e
Sperchon brevirostris Koenike, 1895	230 (3-1220)	st,r	5,73	25	o-m
Sperchon clupeifer Piersig, 1896	19 (2-45)	st,r	6.9-6.9	78 (73-89)	o-m-e
Sperchon compactilis (Koenike, 1911)	2	r	-	-	m-e
Sperchon glandulosus Koenike, 1886 s.l.	141 (1-1140)	st,r	5.8-7.4	31 (23-39)	o-m
Sperchon insignis Walter, 1906	99	r	-	-	o-m
Sperchon setiger Thor, 1898	43	st	5,8	39	o-m
Sperchon squamosus Kramer, 1879	571 (1-1140)	st,r	-	-	o-m
Sperchonopsis verrucosa (Protz, 1896) s.l.	59 (2-182)	st,r	5,7	25	o-m
Teutonia cometes (Koch, 1837)	114 (1-557)	st,l	5.6-7.3	66 (52-80)	o-m
Tiphys ornatus Koch, 1836	1	p	6,2	774	m-e
Tiphys scaurus (Koenike, 1892)	12 (11-12)	p,l	6,1	55	m-e

TABLE 3. *continued*

Species	elevation [m asl] mean (range)	typology (st = stream, r = river, l = lake, p = pond)	pH range	conductivity [µS/cm] mean (range)	trophic state (o =oligotrophic, m =mesotrophic, e = eutrophic)
Tiphys torris (Müller, 1776)	119 (19-219)	st,l	6,3	46	o-m
Torrenticola amplexa (Koenike, 1908)	67 (2-182)	st,r	6.7-6.9	64 (19-89)	o-m-e
Torrenticola brevirostris Halbert, 1911	2	r	6,9	73	m-e
Unionicola crassipes (Müller, 1776)	88 (1-294)	r,l,p	6.9-9.5	50 (44-54)	o-m-e
Unionicola gracilipalpis (Viets, 1908)	24 (3-35)	st,l,p	6.6-6.6	41 (40-41)	o-m-e
Unionicola minor (Soar, 1900)	30 (14-66)	st,l	6.3-7.3	49 (46-51)	o-m-e
Xystonotus willmanni K. Viets, 1920	185	l	-	-	o-m