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Article

A checklist of deep-sea halacarid mites (Acari, Halacaridae) found from more than 1000 m depth

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ABSTRACT
A compilation of deep-sea halacarid mite species found from more than 1000 m depth has been carried out based on published records. Altogether 57 species belong to genera *Agaue* (6 species), *Agauides* (1 species), *Atelopsalis* (1 species), *Bathyhalacarus* (11 species), *Bradyagaue* (3 species), *Colobocerasides* (1 species), *Copidognathus* (16 species), *Halacarellus* (2 species), *Halacarus* (3 species), *Lohmannella* (5 species), *Pelacarus* (1 species), *Thalassarachna* (2 species), *Werthella* (4 species) and *Werthelloides* (1 species) are enlisted from deep-sea more than 1000 m depth. Forty-eight species are determined up to species level while 9 species determined up to generic level only. The richness of halacarid mites from more than 1000 m depth in different marine provinces is most likely related to the intensity of faunistic surveys.

KEY WORDS: 1000 m depth or more; deep-sea; marine; halacarid mites; Prostigmata.

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INTRODUCTION

Halacarids are primarily the denizens of marine environment but may also be found in brackish and freshwater habitats. Halacarids attained their zenith of speciation and biodiversity in the marine environments. They thrive on an array of benthic substrata ranging from fronds, holdfasts, tufts of algae, in and on colonies of sponges, hydrozoans, bryozoans, barnacles, mussels, polychaetes, etc. to sediments, flocculent ooze, coarse and fine sands (Chatterjee and Sarma 1991; Bartsch 2006, 2008a, 2009). A checklist of halacarid mites found associated with decapod crustaceans was given in Chatterjee (2021). Some species are associated with mangroves (Chatterjee *et al*. 2018). There are a few parasitic forms or suspected to be parasitic species (Chatterjee 2020).

The family Halacaridae includes more than 1000 marine and about 60 freshwater species globally (Bartsch 2004, 2008a, 2009). The family is one of the broadest altitudinal ranges among animals, inhabiting from the abyssal depths to alpine snow melting streams and high altitude lakes (Roger *et al*. 2020). Chatterjee and Durucan (2021) published a checklist of halacarid mites found from more than 900 m above sea level altitudes.

The halacarids have their main distribution area in the littoral, but several species are also known from the deep-sea. The first report of halacarid mites from more than 1000 m depth was made by Trouessart (1896a) in which several species were listed from more than 1000 m depth in the Bay of Biscay. Subsequently several halacarid mites were reported in deep-sea more than 1000

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m depth (e.g. Newell 1967, 1971; Sokolov and Jankovskaja 1968, 1970; Jankovskaja 1978; Krantz 1982; Bartsch 1978, 1982a, b, 1989, 1994, 2005, 2010, 2011). A list of deep-sea halacarid mites reported from more than 1000 m depth was given in Bartsch (1988), which is in need of being updated. The present paper provides an updated checklist of deep-sea halacarid mites found from more than 1000 m depth.

METHODS

The present checklist is prepared based on published records by the end of February 2021. The species are listed alphabetically within the genera. The division of marine provinces used in this manuscript follows Bartsch (2009), which has been modified from Hedgpeth (1957), Lüning (1985) and Briggs (1995). The marine provinces are: ANE, Atlantic Ocean, North-East; ANT, Antarctica and sub-Antarctic region; ANW, Atlantic Ocean, North-West; ARC, Arctic region; ASE, Atlantic Ocean, South-East; ASW, Atlantic Ocean, South-West; ATE, Atlantic Ocean, Tropical East; ATW, Atlantic Ocean, Tropical West; ISE, Indian Ocean, South-East; ISW, Indian Ocean, South-West; ITE, Indian Ocean, Tropical East; ITW, Indian Ocean, Tropical West; MDB, Mediterranean Sea , Black Sea, Caspian Sea and Aral Sea; PNE, Pacific Ocean, North-East; PNW, Pacific Ocean, North-West; PSE, Pacific Ocean, South-East; PSW, Pacific Ocean, South-West; PTE, Pacific Ocean, Tropical East; PTW, Pacific Ocean, Tropical West.

The positions, latitude and longitude are given in degrees (approximate) with nearby whole number (without including the minute and second count).

RESULTS

Genus *Agaue* Lohmann, 1889

Agaue abyssorum (Trouessart, 1896)

Syn.: *Halacarus abyssorum* Trouessart, 1896

Record from more than 1000 m depth – ANE - Bay of Biscay, 46º N 6º W, 1410 m depth — Trouessart (1896a).

Record from other depth (less than 1000 m depth) – ANE - Bay of Biscay, 400 m depth — Trouessart (1896a).

Agaue corollata Bartsch, 1978

Record from more than 1000 m depth – ANW - Labrador Basin, 59° N 53° W, 3610 m depth — Bartsch (1978); ANE - Azores threshold, 37° N 27° W, 3663 m depth — Bartsch (1978); ANE - Bay of Biscay, 44° N 4° W, 2006 m depth — Bartsch (1978); ATE - Northern edge of the Angola Basin, 9° S 10° E, 4223 m depth — Bartsch (1978). ATE - Eastern Angola Basin,15° S 10° E, 3797 m depth — Bartsch (1982a); ATE - 9° S 12° E, 1427–1643 m depth — Bartsch (1982a); ATW - Guayana Basin, 10° N 56° W, 3392–3429 m depth — Bartsch (1982a); ANW - North American Basin, 38° N 70° W, 3264–3356 m — Bartsch (1982a).

Agaue obscura Bartsch, 1987

Record from more than 1000 m depth – ANT - Amundsen Sea, 74° S 106° W, 1479–1486 m depth — Bartsch (2010).

Record from other depth (less than 1000 m depth) – ANT - Ross Sea, 72° S 172° E, 344–351 m depth — Bartsch (1987); Ross Sea, 76° S 170° W, 71–87 m depth — Bartsch (1987); off South Shetland Islands, 61° S 57° W, 300 m depth — Bartsch (1987); Amundsen Sea, 71°–74° S 105°–110° W, 477–507 m depth — Bartsch (2010).

Agaue parva (Chilton, 1883)

Syns.: *Halacarus parvus* Chilton, 1883
Halacarus (*Polymela*) *occultus* Lohmann, 1907
Leptospathis bouvieri Trouessart, 1907
Leptospathis (*Polymela*) *occultus* (Lohmann, 1907) Trouessart 1914
Halacarus (*Polymela*) *pilosus* Gimbel, 1919
Agaue occultus var. *setifera* Womersley, 1937
Agaue parva womersleyi Viets, 1950;
Agaue affinis Sokolov, 1962
Thalassarachna sokolovi Newell, 1984

Record from more than 1000 m depth – PSW - 55° S 130° W; 1061 m depth — Newell (1984).

Record from other depth (less than 1000 m depth) – ANT - Weddell Sea (Vestkapp, Halley Bay), off South Georgia, South Orkney Islands, Elephant Island, South Shetland Islands, Wiencke Island, King George Island, Anvers Island, Ross Sea, Georg V Coast (Common-wealth Bay), Terre Adélie, Wilkes Land, *Gauss* Station, Davis Sea, Admiralty Bay — Lohmann (1907), Trouessart (1907, 1914), Womersley (1937), Sokolov (1962), Newell (1984), Bartsch (1990a, 2016); PSW- New Zealand, South Pacific — Chilton (1883), Newell (1984).

Remarks – This species reported from intertidal to deep sea, epibenthic, epizoic on various substrate.

Bartsch (2004) doubted the report of Newell (1984) of *Agaue parva* which may belong to a different species. Bartsch (2004) commented that *Agaue parva* from tidal zone (Chilton 1983) was not identical with the species described by Newell (1984).

Agaue verrucosa Bartsch, 1982

Record from more than 1000 m depth – ASW - Argentine Basin, Rio de la Plata 37° S 53° W, 2707 m depth — Bartsch (1982a); ANT - 60° S 27° W, 1200–1450 m depth — Bartsch (1990a); ANT- South Sandwich Trench, 60° S 27° W, 1190–1469 m depth — Bartsch (1990a).

Record from other depth (less than 1000 m depth) – ANT - Scotia Sea, off Shag Rock, 54° S 41° W, 201 m depth — Bartsch (2010).

Agaue sp. (in Bartsch, 2005)

Record from more than 1000 m depth – ANT - Drake passage, off the South Shetland Islands, 61° S 54° W, 2893 m depth reported as *Agaue* sp. (aff. *A. verrucosa* Bartsch 1982) — Bartsch (2005).

Genus *Agauides* Bartsch, 1988

Agauides cryosi Bartsch, 1988

Record from more than 1000 m depth – ANE - Off Portugal, Ibero-Moroccan bay (Gulf of Cadiz), 37° N 10° W, 1505–1540 m depth, sediment rich in foraminiferan and pteropod shells — Bartsch (1988).

Genus *Agauopsis* Viets, 1927

Agauopsis bathyalis Bartsch, 1989

Record from more than 1000 m depth – PTW - South west of Lifou, off New Caledonia, 21° S 167° E, 1380 m depth — Bartsch (1989).

Remarks – This species lacks cornea and eye pigment but other characters like outline of idiosoma, gnathosoma, legs, sculpturing of integuments do not suggest that this species is specialised to life in deep sea abyssal zone (Bartsch 1989).

Genus *Atelopsalis* Trouessart, 1896

Atelopsalis tricuspis Trouessart, 1896

Record from more than 1000 m depth – ANE - Bay of Biscay, 46° N 6° W, 1410 m depth — Trouessart (1896a).

Record from other depth (less than 1000 m depth) – ANE - Josephine Bank Seamount, 37° N 14° W, 256–291 m depth — Bartsch (1973).

Genus *Bathyhalacarus* Sokolov & Jankovskaja, 1968

Bathyhalacarus abyssiculus Bartsch 1982

Record from more than 1000 m depth – ANW - Newfoundland Basin, 41° N 46 ° W, 4400 m depth — Bartsch (1982b).

Bathyhalacarus acanthophorus Bartsch, 1982

Record from more than 1000 m depth – ATE - East edge of Angola Basin, 9° S 12° E, 1427–1643 m depth — Bartsch (1982b).

Bathyhalacarus aculifer Bartsch, 1982

Record from more than 1000 m depth – ASW - 44° S 49° W, 5208–5223 m depth — Bartsch (1982b).

Bathyhalacarus acutus Bartsch, 1982

Record from more than 1000 m depth – ASW- 4° S 53° W, 2195–2323 m depth; 37° S 53° W, 2707 m depth; 36° S 53° W, 2041–2048 m depth; 36° S 52° W, 2440–2480 m depth — Bartsch (1982b).

Bathyhalacarus anomalus Bartsch, 2005

Record from more than 1000 m depth – ANT - Western Antarctica - Drake passage, off the South Shetland Islands - 62° S 61° W, 2900 m depth — Bartsch (2005).

Bathyhalacarus atlanticus Bartsch, 1982

Record from more than 1000 m depth – ANW - 38° N 70° W, 3264–3356 m depth — Bartsch (1982b).

Bathyhalacarus dictyotus Bartsch, 1989

Record from more than 1000 m depth – PTW - North east of New Caledonia, 21° S 166° E, 1410 m depth — Bartsch (1989).

Bathyhalacarus humboldti (Newell, 1967)

Syns.: *Thalassarachna humboldti* Newell, 1967
Halacarellus humboldti (Newell, 1967) Bartsch 1978a

Record from more than 1000 m depth – PSE - Midway between San Felix and Juan Fernandez Islands, and approximately 700 km west of the coast of Chile, 29° S 80° W, 3680–4100 m depth — Newell (1967); 22° S 82° W, 1830–1760 m depth — Newell (1971).

Remarks – It was described on the basis of juveniles.

Bathyhalacarus quadricornis Sokolov & Jankovskaja, 1968

Record from more than 1000 m depth – PNW - Kuril-Kamchatka Trench, 45° N 154–155° E, 5090–5200 m depth — Sokolov & Jankovskaja (1968, 1970); PNW - Japan Trench, 28° N 143° E, 6770–6850 m depth — Jankovskaja (1978).

Bathyhalacarus sordidus Bartsch, 1989

Record from more than 1000 m depth – PTW - South west of Lifou, off New Caledonia, 21° S 167° E, 1380 m depth — Bartsch (1989).

Remarks – This species has a very podgy idiosoma and long slender legs - longer than idiosoma, posterior legs longer than anterior.

Bathyhalacarus sp. (in Bartsch, 1994)

Record from more than 1000 m depth – ANE - Mid-Atlantic Ridge, 23° N 45° W, 3520 m depth — Bartsch (1994).

Remarks – This species was reported from hydrothermal vent area.

Genus *Bradyagaue* Newell, 1971

Bradyagaue aspidionis Newell, 1984

Record from more than 1000 m depth – ANT - Near Victoria Land, 67° S 164° E, 1442–1444 m depth — Newell (1984).

Remarks – The elongate idiosoma with leg IV present near the end of idiosoma, curve tarsi and enlarged median claw indicate inhabitants of stolonaceous hydrozoans (Bartsch 1993).

Bradyagaue drygalskii (Lohmann, 1907)

Syns.: *Halacarus* (*Polymela*) *drygalskii* Lohmann, 1907
Leptospathis alberti antarctica Trouessart, 1907

Record from more than 1000 m depth – ANT - Near Cape Hallett, 71° S 172° E, 1565–1674 m depth — Newell (1984).

Record from other depth (less than 1000 m depth) – ANT- Macquarie and Kerguelen Islands, off South Sandwich Island, off Elephant Island, South Shetland Island King George Island, Admiralty Bay, Ross Sea, Victoria Land (Cape Hallett), Georg V Land (Common wealth Bay), Terre Adelie, *Gauss* Station (Lohmann 1907; Viets 1952; Newell 1984; Bartsch 1993, 2008b, 2016).

Remarks – This species was reported from littoral to abyssal on various substrata, abundantly found clingling to stolons of hydroids.

Bradyagaue stocki Bartsch, 1992

Record from more than 1000 m depth – ANE - Off Cape Verde Islands, south of Raso, 17° N 25° W, 1200 m depth — Bartsch (1992).

Genus *Colobocerasides* Viets, 1950

Colobocerasides koehleri (Trouessart, 1896)

Syn.: *Coloboceras koehleri* Trouessart, 1896a

Record from more than 1000 m depth – ANE - Bay of Biscay, Gulf of Gascogne, 45° N 6° W, 1410 m depth — Trouessart (1896a, b), Bartsch (1998).

Remarks – Bartsch (1998) redescribed this species and thought to be temporary ectoparasitic in habit.

Genus *Copidognathus* Trouessart, 1888

Copidognathus abyssiculus Bartsch, 1982

Record from more than 1000 m depth – ASW - Argentine Basin, 44° S 49° W, 5208–5233 m depth — Bartsch (1982c).

Copidognathus abyssorum Bartsch, 1982

Record from more than 1000 m depth – ASW - Argentine Basin, 44° S 49° W, 5208–5233 m depth — Bartsch (1982c).

Copidognathus alvinus Bartsch, 1994

Record from more than 1000 m depth – ANE - Mid-Atlantic Ridge, Lucky Strike vent site, 37° N 32° W, 1636–1685 m depth — Bartsch (1994, 1996).

Remarks – The species has been reported from a hydrothermal vent site. Besides lack of cornea on OC, other characters do not reflect specialization to life in deep sea habitat (Bartsch 1994).

Copidognathus anops Newell, 1971

Record from more than 1000 m depth – PSE - 13° S 78° W, rocky bottom, 1565 m depth — Newell (1971).

Copidognathus atlanticus Bartsch, 1982

Record from more than 1000 m depth – ASW - Argentine Basin, 37° S 53° W, 1011 m depth — Bartsch (1982c).

Record from other depth (less than 1000 m depth) – ASW - Argentine Basin, 37° S 53° W, 993 m depth — Bartsch (1982c).

Copidognathus bruuni Newell, 1967

Record from more than 1000 m depth – PSE - Midway between San Felix and Juan Fernandez Islands, and approximately 700 km west of the coast of Chile, 29° S 80° W, 3680–4100 m depth — Newell (1967).

Copidognathus flabellifents Bartsch, 2011

Record from more than 1000 m depth – ATW - Gulf of Mexico, Alaminos Canyon, 26–27° N 88–94° W, 2744–2190 m depth; amongst *Batllymodiolus brooksi;* Gulf of Mexico, Atwater Valley, 28° N 88° W, 2190 m depth amongst *Bathymodious brooksi* — Bartsch (2011); Gulf of Mexico, Minos Canyon, 26° N 95° W, 2743 m depth, upper 0–2 cm of undisturbed muddy sediment with the spatangoid sea urchin *Sarsiaster griegi*; Gulf of Mexico, Atwater Valley, 28° N 88° W, 2192 m depth; tubeworms *Escarpia lnrninaia, Lamellibrach* sp. — Bartsch (2011).

Remarks – This species was collected from gas seep areas of the northern Gulf of Mexico. External characters of this species do not reflect at specialization to a life in gas seep areas and the species is most likely also found outside seep communities (Bartsch 2011).

Copidognathus inusitatus Bartsch, 1989

Record from more than 1000 m depth – PSE - 21° S, 167° E, 1508 m depth, southwest of Lifou — Bartsch (1989).

Remarks – This species has elongated tubular (prolonged) anal cone, legs are very slender and much longer than idiosoma.

Copidognathus nautilei Bartsch, 1997

Record from more than 1000 m depth – ATE - Mid-Atlantic Ridge, Irina, 15° N 45° W, 3049 m depth — Bartsch (1997); Mid Atlantic Ridge, Ashadze, 13° N 45° W, 4087–4090 m depth — Bartsch and Dovgal (2010).

Remarks – This species was reported from hydrothermal vent area.

Copidognathus papillatus Krantz, 1982

Record from more than 1000 m depth – PTE - Among a mussel clump collected in a submarine vent in the Galapagos Rift 1° N 86° W, 2482 m depth — Krantz (1982); PTW - North Fiji Basin, White Lady, 19° S 173° W, 2750 m depth — Bartsch (1991); PTW - Falu Fa Ridge, Lau Basin, 23° S 177° W, 1914 m depth — Bartsch (1991); PNE - Gorda Ridge, 43° N 127° W, 2701 m depth found on the echinoderm *Xyloplax janetae* from margin of a hydrothermal vent field with a few polychaeta tubeworms *Ridgeia piscesae* Jones, 1985 (Voight 2005, referred in Bartsch 2011); PNE - Juan de Fuca Ridge, 48° N 129° W, 2220 m depth — Bartsch (2011).

Remarks – This species was mostly reported from hydrothermal vent area.

Copidognathus posticus Newell, 1971

Record from more than 1000 m depth – PSE - 18° S 79° W, 3200 m depth — Newell (1971).

Record from other depth (less than 1000 m depth) – 33° S 72° W, 485 m depth — Newell (1971).

Copidognathus tritoni Bartsch 2013

Record from more than 1000 m depth – PTE - East Pacific Rise, 10° N 104° W, 2500–4580 m depth, among sponges, dead tubeworms, dead mussels — Bartsch (2013).

Remarks – This species was reported from hydrothermal deep sea vent area.

Copidognathus uniareolatus Newell, 1971

Record from more than 1000 m depth – PSE - 13° S 78° W, 1565 m depth — Newell (1971).

Record from other depth (less than 1000 m depth) – PSE- 26° S 80° W, 550–600 m depth — Newell (1971)

Copidognathus sp. (in Bartsch, 1989 as *Copidognathus* sp. B)

Record from more than 1000 m depth – PTW - Northeast of Lifou 21° S 167° E, 1420 m depth based on protonymph reported as *Copidognathus* sp. B — Bartsch (1989).

Remarks – The quiescent protonymph contained a male. This *Copidognathus* sp. might be ectoparasitic in habit (Bartsch 1989).

Copidognathus sp. (in Bartsch, 2011 as *Copidognathus* sp. A)

Record from more than 1000 m depth – ATW - Gulf of Mexico, Atwater Valley, 28° N 88° W, 2185 m depth; amongst tubeworms *Escarpia lnrninaia, Lamellibrach* sp. - reported as *Copidognathus* sp. A — Bartsch (2011).

Remarks – This species was collected from gas seep areas on the continental slope of the northern Gulf of Mexico. Bartsch (2011) commented that this species has distinct eye pigment and it was most likely a shallow water species.

Copidognathus sp. (in Bartsch, 2011 as *Copidognathus* sp. B)

Record from more than 1000 m depth – ATW - Gulf of Mexico, Atwater Valley, 28° N 88° W, 2185 m depth; amongst tubeworms *Escarpia lnrninaia, Lamellibrach* sp. - reported as *Copidognathus* sp. B — Bartsch (2011).

Record from other depth (less than 1000 m depth) – This species has been also reported from Gulf of Mexico, Upper Louisana slope, Green Canyon, 28° N 91° W, 571 m depth; among *Lamellibrachia luamesi* and *Seepiophila jonesi*.

Remarks – This species was collected from gas seep areas on the continental slope of the northern Gulf of Mexico. Bartsch (2011) commented that this species has distinct eye pigment and it was most likely a shallow water species.

Genus *Halacarus* Gosse, 1855

Halacarus longior Bartsch, 1981

Record from more than 1000 m depth – ATE - Angola Basin, 10° S 11° E, 2644–2754 m depth — Bartsch (1981); ASW - Argentine Basin, 37° S 53°W, 2707–3343 m depth— Bartsch (1981); ANW - Northwestern Atlantic Basin 38° N 70° W, 3264–3356 m depth — Bartsch (1981); ANT - Off the South Shetland Islands, 61° S 54° W, 2893 m depth — Bartsch (2005); ANE – Mid-Atlantic Ridge, 36° N 34° W, 2275 m depth — Bartsch (2010); ANE – Mid-Atlantic Ridge, 15° N 45° W, 3014 m depth — Bartsch (2010).

Halacarus peregrinus Bartsch, 1981

Record from more than 1000 m depth – ASW- Argentine Basin, 37° S 53° W, 1011–2707 m depth — Bartsch (1981).

Record from other depth (less than 1000 m depth) – ASW - 37° S 53° W, 993 m depth — Bartsch (1981).

Halacarus profundus Newell, 1984

Record from more than 1000 m depth – ANT - Ross Sea, 79° S 176° W, 2212–2306 m depth — Newell (1984).

Genus *Halacarellus* Viets, 1927

Halacarellus auzendei (Bartsch, 1990)

Syn.: *Agauopsis auzendei* Bartsch, 1990

Record from more than 1000 m depth – ANE - 23°N 45°W, 3878 m depth, sediment from the base of an active chimney, hydrothermal vent, a volcanic ridge in the mid-Atlantic Ridge — Bartsch (1990b); ANE - Mid-Atlantic Ridge, 23° N 45° W, 3478–3520 m depth — Bartsch (1990b, 1994); ANE - Mid-Atlantic Ridge, Lucky Strike, 37° N 32° W, 1700 m depth — Cuvelier *et al*. (2014).

Remarks – This species was reported from hydrothermal vent area. *Halacarellus auzendei* described first as *Agauopsis auzendei* by Bartsch (1990b) based on female and deautonymph. Bartsch (1994) transferred this species to the genus *Halacarellus* after observing the perigenital setae of male specimens. Bartsch (2009) mentioned this species in the checklist as *Halacarellus auzendei*.

Halacarellus bandyi (Newell, 1967)

Syn.: *Thalassarachna bandyi* Newell, 1967

Record from more than 1000 m depth – PSE - Midway between San Felix and Juan Fernandez Islands, and approximately 700 km west of the coast of Chile, 29° S 80° W, 3680–4100 m depth — Newell (1967).

Remarks – Bartsch (2009) mentioned this species in the checklist as *Halacarellus bandyi*.

Genus *Lohmannella* Trouessart, 1901

Lohmannella abyssalis Bartsch, 2005

Record from more than 1000 m depth – ANT - Off the south Shetland Islands, 61° S 54° W, 2893 m depth — Bartsch (2005).

Lohmannella cygna Bartsch, 1988

Record from more than 1000 m depth – ATE - Angola Basin, 9° S 12° E, depth, 1427–1463 m depth — Bartsch (1988).

Lohmannella fukushimai Imamura, 1968

Record from more than 1000 m depth – ANT - Amundsen Sea, 71° S 110° W, 1041–1047 m — Bartsch (2010).

Record from other depth (less than 1000 m depth) – ANT - Prince Harald Coast, 69° S 31° E, 190 m depth - Imamura (1968); Ross Sea, 72° S 172–173°E, 342–360 m depth — Bartsch (1993); Weddell Sea, 71°–72° S 12–13°W 193–211 m depth — Bartsch (1993); Weddell Sea, 75° S 30° W, 820 m depth — Bartsch (1993); Amundsen Sea, 74° S 105° W, 490–504 m — Bartsch (2010); 74° S 105° W, 496–509 m depth — Bartsch (2010).

Remarks – This species is circum-Antarctic from depth 190 m to 1047 m. Presence of spots of eye pigment beneath the corneae and in the middle of the AD indicates that this species shallow water rather than a deep water inhabitant (Bartsch 2010).

Lohmannella sp. (in Bartsch, 2013 as *Lohmannella* sp. 1)

Record from more than 1000 m depth – PTW - North Fiji Basin, 17° S 175° W, 2000 m depth — Bartsch (2013).

Remarks – This species was reported from hydrothermal vent area.

Lohmannella sp. (in Bartsch, 2013 as *Lohmannella* sp. 2)

Record from more than 1000 m depth – PTE - East Pacific Rise, 2500 m depth — Bartsch (2013).

Remarks – This species was reported from hydrothermal vent area.

Genus *Pelacarus* Bartsch, 1986

Pelacarus aculeatus (Trouessart, 1896)

Syns.: *Agaue aculeata* Trouessart, 1896
Agauopsis aculeate (Trouessart, 1896) Viets 1927

Werthella aculeate (Trouessart, 1896) Morselli & Mari 1985

Record from more than 1000 m depth – ANE - Bay of Biscay, 46°N 6° W, 1220–1410 m depth — Trouessart (1896a, b).

Record from other depth (less than 1000 m depth) – MDB - Gulf of Marseilles, 11 m depth; Port Miou, 20 m depth, Subtidal — Bartsch (1986).

Remarks – This species was reported from shallow waters to 1410 m depth. Bartsch (1986) erected the genus *Pelacarus* Bartsch, 1986 based on type species *Agaue aculeata* Trouessart, 1896. This is the only species reported so far under the genus *Pelacarus*.

Genus *Thalassarachna* Packard, 1871

Thalassarachna alvina (Bartsch, 1994)

Syn.: *Halacarellus alvinus* Bartsch, 1994

Record from more than 1000 m depth – ANE - Mid-Atlantic Ridge, Lucky Strike, 37° N 32° W, 1636–1727 m depth, and the sites Isabel and Pagode, 37° N 32° W, 1629–1685 m depth — Bartsch (1994, 1996).

Remarks – This species was reported from hydrothermal vent area. Ocular plates reduced to pair of minute platelates. This species was thought to be a deep sea species and not bound to hydrothermal vent area (Bartsch 1994).

Thalassarachna caecoides (Bartsch, 1978)

Syn.: *Halacarellus caecoides* Bartsch, 1978

Record from more than 1000 m depth – ANE - Norwegian Basin, Sea of Norway 64° N 2° E, 2615 m depth, associated with sponges and hydrozoans — Bartsch (1978)

Genus *Werthella* Lohmann, 1907

Werthella atlantica Bartsch, 1986

Record from more than 1000 m depth – ASW- Argentinian Basin, 37° S 53° W, 2195–2323 m depth — Bartsch (1986); ATE - Angola Basin, 9° S 12° E, 1427–1643 m depth — Bartsch (1986).

Werthella plumifera Newell, 1971

Record from more than 1000 m depth – PSE - 13° S 78° W, 1565 m depth — Newell (1971); 16° S 78° W, 2640–2780 m depth — Newell (1971).

Record from other depth (less than 1000 m depth) – PSE - 33° S 72° W, 485 m depth — Newell (1971).

Werthella sp. (in Bartsch, 1986)

Record from more than 1000 m depth – ATE - Angola Basin, 9° S 12° E, 1427–1643 m depth — Bartsch (1986).

Werthella sp. (in Bartsch, 2005)

Record from more than 1000 m depth – ANT - Off the South Shetland Islands – 61° S 54° W, 2893 m depth — Bartsch (2005).

Genus *Werthelloides* Bartsch, 1986

Werthelloides bathyalis Bartsch, 1986

Record from more than 1000 m depth – ITW - In front Reunion Island, 20–21° S 55–56° E, 1050–1600 m depth — Bartsch (1986).

DISCUSSION

Trouessart (1896a) reported six species viz. *Copidognathus oculatus*, *Maracarus gracilipes* (syn.: *Arhodeoporus gracilipes*), *Colobocerasides koehleri*, *Agaue abyssorum*, *Agauopsis aculeata* and *Atelopsalis tricuspis* from Bay of Biscay from more than 1000 m depth (1410 m). Trouessart (1896b) cited *Maracarus gracilipes* (syn.: *Arhodeoporus gracilipes*) as a variety of *quadricostata*. Bartsch (2009) commented that reports of *Copidognathus oculatus* and *Maracarus gracilipes* (syn.: *Arhodeoporus gracilipes*) need confirmation (Bartsch 2009). *Lohmannella falcata* (Hodge, 1863) was reported from Norway Basin at 2538–2992 m. depth (Bartsch 1978). Bartsch (2009) opined that the deep sea records of *Lohmannella falcata* by Trouessart (1896c) and Bartsch (1978) need confirmation. Therefore, deep sea records of *Copidognathus oculatus*, *Maracarus gracilipes* (syn.: *Arhodeoporus gracilipes*) and *Lohmannella falcata* have been excluded from the present list.

In this paper altogether 57 species belonging to genera *Agaue* (6 species), *Agauides* (1 species), *Atelopsalis* (1 species), *Bathyhalacarus* (11 species), *Bradyagaue* (3 species), *Colobocerasides* (1 species), *Copidognathus* (16 species), *Halacarellus* (2 species), *Halacarus* (3 species), *Lohmannella* (5 species), *Pelacarus* (1 species), *Thalassarachna* (2 species), *Werthella* (4 species), *Werthelloides* (1 species) are enlisted from deep-sea more than 1000 m depth, of which 48 species determined up to species level while 9 species determined up to generic level only (undetermined species: viz. *Agaue* sp. – 1 species, *Bathyhalacarus* sp. – 1 species, *Copidognathus* spp. – 3 species, *Lohmannella* spp. – 2 species, *Werthella* spp. – 2 species).

Table 1 provides species names (including undetermined species) of deep-sea halacarid mites found from more than 1000 m depth in different marine provinces of the world. The number of species (including undetermined species) present from more than 1000 m depth in each marine province is shown in Figure 1. Most species (13 species) are known from the North-East Atlantic Ocean region followed by 11 species from Antarctica and sub-Antarctic region, nine species in South West Atlantic Ocean and eight species in South-East Pacific Ocean. The richness of halacarid mites from more than 1000 m depth in different marine province is most likely related to the intensity of faunistic surveys with the appropriate collecting methods for mites. For example, the absence of halacarid mites from more than 1000 m depth in some oceanic region such as South-East, South West and Tropical East Indian Ocean is certainly due to lack of intensive surveys.

Among 48 determined species known from more than 1000 m depth, only 13 species viz. *Agaue abyssorum*, *A. obscura, A. parva, A. verrucosa, Atelopsalis tricuspis*, *Bradyagaue drygalskii*, *Copidognathus atlanticus, C. posticus, C. uniareolatus*, *Halacarus peregrines*, *Lohmarmella fukushimai, Pelacarus aculeatus, Werthella plumifera* were reported from more than 1000 m depth as well as less than 1000 m depth (Table 2). Among 9 undetermined species *Copidognathus* sp. (in

Bartsch, 2011 as *Copidognathus* sp. B) was found from more than 1000 m depth as well as less than 1000 m detpth (Table 2). *Agaue obscura*, *A. parva*, *Bradyagaue drygalskii*, *Lohmannella fukushimai* and *Pelacarus aculeatus* are known from shallow water to more than 1000 m depth (Table 2). *Agaue verrucosa* was also reported from 201–2707 m depth.

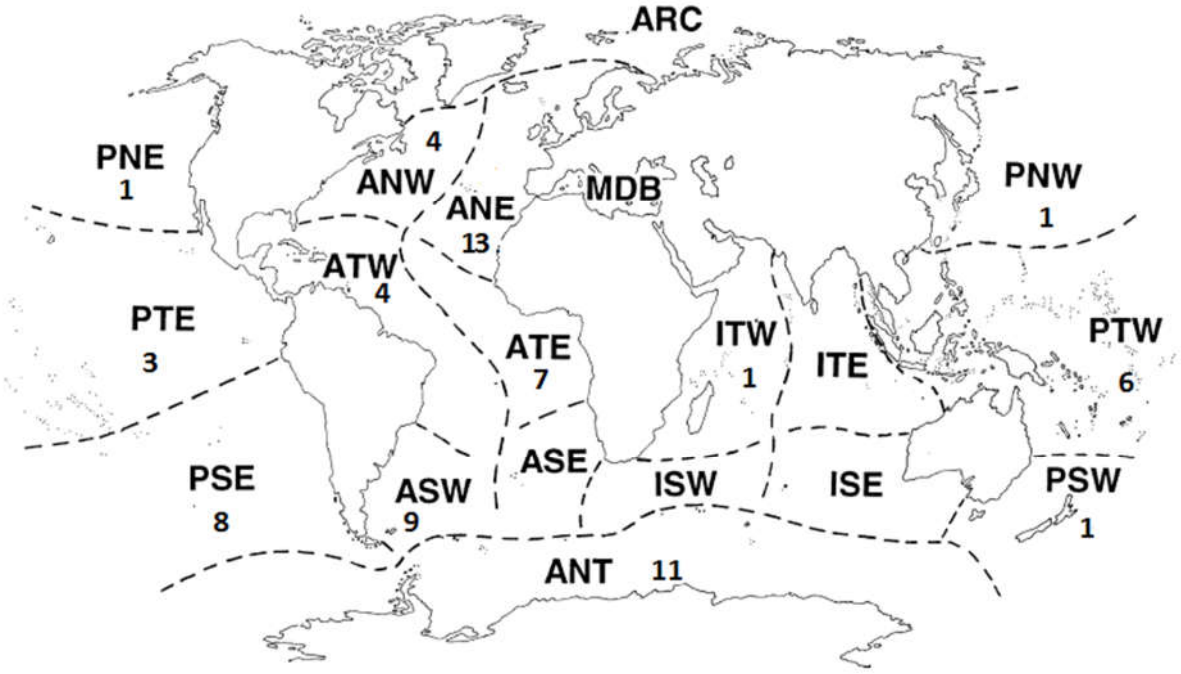

Figure 1. Number of halacarid species reported from more than 1000 m depths in each marine provinces of the world.

Table 1. Halacarid mites reported from more than 1000 m depth in different marine provinces of the world.

Area	Species
ANE, Atlantic Ocean, North-East	*Agaue abyssorum*
	Agaue corollata
	Agauides cryosi
	Atelopsalis tricuspis
	Bathyhalacarus sp. (in Bartsch, 1994)
	Bradyagaue stocki
	Colobocerasides koehleri
	Copidognathus alvinus
	Halacarus longior
	Halacarellus auzendei
	Pelacarus aculeatus
	Thalassarachna alvina
	Thalassarachna caecoides
ANT, Antarctica and sub-Antarctic region	*Agaue obscura*
	Agaue verrucosa
	Agaue sp. (in Bartsch, 2005)
	Bathyhalacarus anomalus
	Bradyagaue aspidionis
	Bradyagaue drygalskii
	Halacarus longior
	Halacarus profundus
	Lohmannella abyssalis

Table 1. Continued.

Area	Species
ANT, Antarctica and sub-Antarctic region	*Lohmarmella fukushimai*
	Werthella sp. (in Bartsch, 2005
ANW, Atlantic Ocean, North-West	*Agaue corollata*
	Bathyhalacarus abyssiculus
	Bathyhalacarus atlanticus
	Halacarus longior
ARC, Arctic region	-
ASE, Atlantic Ocean, South-East	-
ASW, Atlantic Ocean, South-West	*Agaue verrucosa*
	Bathyhalacarus aculifer
	Bathyhalacarus acutus
	Copidognathus abyssiculus
	Copidognathus abyssorum
ASW, Atlantic Ocean, South-West	*Agaue verrucosa*
	Bathyhalacarus aculifer
	Bathyhalacarus acutus
	Copidognathus abyssiculus
	Copidognathus abyssorum
	Copidognathus atlanticus
	Halacarus longior
	Halacarus peregrinus
	Werthella atlantica
	Werthella atlantica
	Werthella sp. (in Bartsch, 1986)
ITW, Indian Ocean, Tropical West	*Werthelloides bathyalis*
MDB, Mediterranean Sea,Black Sea, Caspian Sea and Aral Sea	-
PNE, Pacific Ocean, North-East	*Copidognathus papillatus*
PNW, Pacific Ocean, North-West	*Bathyhalacarus quadricornis*
PSE, Pacific Ocean, South-East	*Bathyhalacarus humboldti*
	Copidognathus anops
	Copidognathus bruuni
	Copidognathus inusitatus
	Copidognathus posticus
	Copidognathus uniareolatus
	Halacarellus bandyi
	Werthella plumifera
PSW, Pacific Ocean, South-West	*Agaue parva*
PTE, Pacific Ocean, Tropical East	*Copidognathus papillatus*
	Copidognathus tritoni
	Lohmannella sp. (in Bartsch, 2013 as *Lohmannella* sp. 2)
PTW, Pacific Ocean, Tropical West	*Agauopsis bathyalis*
	Bathyhalacarus dictyotus
	Bathyhalacarus sordidus
	Copidognathus papillatus
	Copidognathus sp. (in Bartsch, 1989 as *Copidognathus* sp. B)
	Lohmannella sp. (in Bartsch, 2013 as *Lohmannella* sp. 1)

Four species viz. *Bathyhalacarus aculifer*, *B. quadricornis*, *Copidognathus abyssiculus* and *C. abyssorum* are known from more than 5000 m depth. The deepest record is of the halacarid mite *Bathyhalacarus quadricornis*, which was found from the Western Pacific in 6850 m depth (Jankovskaja 1978).

Halacarids from deep-sea gas seeps in the Gulf of Mexico were studied by Bartsch (2011) and commented that these species were not bound to deep-sea communities. The halacarids found in

seep habitats likely tolerate short term hypersalinity, anoxia and exposure to methane, hydrogen sulphide and other toxic seep fluids (Bartsch 2011).

Hydrothermal vents are the result of seawater percolating up through fissures in the ocean crust in the vicinity of spreading centres and back-arc basins (Zeppilli *et al*. 2018). Some species viz. *Copidognathus alvinus*, *C. nautilei*, *C. papillatus*, *C. triton*, *Halacarellus auzendei*, *Halacarus prolongatus*, *Lohmannella* spp. and *Thalassarachna alvina* are known from deep-sea more than 1000 m depth hydrothermal vent area. Though most of these species were reported only from hydrothermal vent area, this may be due to lack of collection of halacarid mites from other areas. These halacarids are not bound to a habitat with vent fluids and raised temperature; possibly they are not vent endemics (Bartsch 2013).

Several deep-sea halacarids are characterised by lack of cornea, presence of long legs, epimeral and anal protuberances, dense coating with cuticular filaments. But these characters are not strictly a response to living in greater depths deep-sea areas (Bartsch 1988). Absence of cornea and eye pigments is also found in species from aphotic habitats and tidal ground water. Presence of very long legs, epimeral protuberances, dense coating with cuticular filaments also sometime occur in shallow water halacarids and are supposed to be due to life in very soft sediments (Bartsch 1988).

Our current knowledge of the diversity of deep-sea halacarid mites from more than 1000 m depth is far from complete. Future investigations of the deep-sea halacarid mites are expected to reveal many more species.

Table 2. Halacarid species reported from more than 1000 m depth and presence or absence of those species from less than 1000 m depth and shallow waters (tidal to 200 m depth).

Name of the Species	More than 1000 m depth	Less than 1000 m depth	Shallow waters (tidal to 200 m depth)	Remarks
Agaue abyssorum	+	+	-	
Agaue corollata	+	-	-	
Agaue obscura	+	+	+	
Agaue parva	+	+	+	
Agaue verrucosa	+	+	-	201–2707 m depth
***Agaue* sp. (in Bartsch, 2005)**	+	-	-	
Agauides cryosi	+	-	-	
Agauopsis bathyalis	+	-	-	
Atelopsalis tricuspis	+	+	-	
Bathyhalacarus abyssiculus	+	-	-	
Bathyhalacarus acanthophorus	+	-	-	
Bathyhalacarus aculifer	+	-	-	5208–5223 m depth
Bathyhalacarus acutus	+	-	-	
Bathyhalacarus anomalus	+	-	-	
Bathyhalacarus atlanticus	+	-	-	
Bathyhalacarus dictyotus	+	-	-	
Bathyhalacarus humboldti	+	-	-	
Bathyhalacarus quadricornis	+	-	-	5090–6850 m depth
Bathyhalacarus sordidus	+	-	-	
***Bathyhalacarus* sp. (in Bartsch, 1994)**	+	-	-	
Bradyagaue aspidionis	+	-	-	
Bradyagaue drygalskii	+	+	+	
Bradyagaue stocki	+	-	-	
Colobocerasides koehleri	+	-	-	
Copidognathus abyssiculus	+	-	-	5208–5223 m depth
Copidognathus abyssorum	+	-	-	5208–5223 m depth
Copidognathus alvinus	+	-	-	

Table 2. Continued.

Name of the Species	More than 1000 m depth	Less than 1000 m depth	Shallow waters (tidal to 200 m depth)	Remarks
Copidognathus anops	+	-	-	
Copidognathus atlanticus	+	+	-	993–1011 m depth
Copidognathus bruuni	+	-	-	
Copidognathus flabellifents	+	-	-	
Copidognathus inusitatus	+	-	-	
Copidognathus nautilei	+	-	-	
Copidognathus papillatus	+	-	-	
Copidognathus posticus	+	+	-	
Copidognathus tritoni	+	-	-	
Copidognathus uniareolatus	+	+	-	
***Copidognathus* sp. (in Bartsch, 1989 as *Copidognathus* sp. B)**	+	-	-	
***Copidognathus* sp. (in Bartsch, 2011 as *Copidognathus* sp. A)**	+	-	-	
***Copidognathus* sp. (in Bartsch, 2011 as *Copidognathus* sp. B)**	+	+	-	
Thalassarachna caecoides	+	-	-	
Werthella atlantica	+	-	-	
Werthella plumifera	+	+	-	
***Werthella* sp. (in Bartsch, 1986)**	+	-	-	
***Werthella* sp. (in Bartsch, 2005)**	+	-	-	
Werthelloides bathyalis	+	-	-	

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فهرست کنه‌های دریای عمیق (Acari, Halacaridae) یافت شده از عمق بیش از ۱۰۰۰ متر

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چکیده

مجموعه‌ای از گونه‌های کنه‌های هالاکارید در اعماق دریا که از عمق بیش از ۱۰۰۰ متر پیدا شده است، بر اساس گزارش‌های منتشر شده تهیه شد. در مجموع ۵۷ گونه متعلق به جنس *Agaue* (۶ گونه)، *Agauides* (۱ گونه)، *Atelopsalis* (۱ گونه)، *Bathyhalacarus* (۱۱ گونه)، *Bradyagaue* (۳ گونه)، *Colobocerasides* (۱ گونه)، *Copidognathus* (۱۶ گونه)، *Halacarellus* (۲ گونه)، *Halacarus* (۳ گونه)، *Lohmannella* (۵ گونه)، *Pelacarus* (۱ گونه)، *Thalassarachna* (۲ گونه)، *Werthella* (۱ گونه) و *Werthelloides* (۱ گونه) از اعماق دریا با عمق بیش از ۱۰۰۰ متر فهرست شده‌اند. چهل و هشت گونه تا سطح گونه شناسایی شدند در حالی‌که ۹ گونه فقط تا سطح جنس تعیین شدند. غنای کنه‌های هالاکارید از عمق بیش از ۱۰۰۰ متر در استان های مختلف دریایی به احتمال زیاد با میزان بررسی‌های فونستیک مرتبط است.

واژگان کلیدی: عمق ۱۰۰۰ متر یا بیشتر؛ اعماق دریا؛ دریایی؛ کنه‌های هالاکارید؛ Prostigmata.

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