



A checklist of Pontarachnidae (Acari: Hydrachnidia) and notes on distributional patterns of the species

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Abstract

A worldwide checklist of the pontarachnid mites is provided based on published reports and original data. A total of 53 valid species of pontarachnid mites have been compiled, of which the genus *Pontarachna* includes 30 species, while 23 species belong to the genus *Litarachna*. The highest number of species (n=16) is reported from the marine province Tropical West of the Pacific Ocean. A deutonymph of *Litarachna triangularis* is reported here from Dongsha Atoll, Taiwan. Patterns of endemism and seemingly incomplete species distributional records are the result of a lack of intensive faunistic surveys in different parts of the world. The taxonomy of Pontarachnid mites will be improved by the use of mite-specific sampling methods and the application of molecular phylogenetics.

Key words: pontarachnid mites, marine Arthropoda, *Litarachna*, *Pontarachna*, distribution

Introduction

The water mite family Pontarachnidae Koenike, 1910, belongs to the superfamily Hygrobatoidae (Viets, 1987, Smit & Alberti 2010) and is recognized as the only family of the true water mites (Hydrachnidia) occurring in the marine environment. Tuzovskij (1983, 1987) placed the Pontarachnidae in the superfamily Pontarachnoidea. The family has peculiar morphological structures, most and foremost the so-called wheel-like acetabula, which most probably have osmoregulatory function (Smit & Alberti 2010). Later on, this type of wheel-like structure was found in the aturid genus *Haloaxonopsis* Pešić, Smit & Saboori, 2012 also, which inhabits saline streams along the Persian Gulf, Iran (Pešić *et al.* 2012).

The family consists of two genera, *Pontarachna* Philippi, 1840 and *Litarachna* Walter, 1925. The genus *Litarachna* was split into two subgenera by Cook (1958) but the division was later withdrawn (Cook 1986). There is a lack of data on the ecology and life history of pontarachnid mites. The larva (free-living or parasitic) and its host (if any) are unknown (Cook 1996), and it is possible that the larval stage is bypassed (Pešić *et al.* 2011).

There is no published worldwide catalogue of pontarachnid mites and literature sources on this group of marine arthropods remain dispersed. The first paper summarizing the state of knowledge of the family Pontarachnidae was published by Walter (1925). Smit & Alberti (2010) provided an updated report on this family, including the ultrastructural details of diagnostic morphological structures. The most recent checklist of pontarachnid mites was published by Pešić *et al.* (2012a), listing 43 species worldwide. They mentioned that data on pontarachnid records are geographically unevenly distributed and that most species are known from the tropical Central Indo-Pacific Ocean. Since then a plethora of publications on pontarachnid mites has been released, rendering the 2012 checklist outdated. In addition, the 2012 checklist includes only species names, without any additional information on pontarachnid taxa and habitats, therefore, an updated list of pontarachnids with additional notes on species distribution was necessary. This new catalogue is aimed to stimulate further studies on this widely distributed but obviously neglected group of marine fauna.

Methods

The present checklist is prepared based on records published by the end of 2018 and original data. Specimens examined in the study were collected by the second author. All measurements are given in μm . The following abbreviations are used: Cxgl-4 = coxoglandulare 4, dL = dorsal length, H = height, L = length, Lgl-3 = lateroglandulare 3, P-1 to P-5 = palp segments 1 to 5, V3 = gland *sensu* Wiles et al. (2002); W = width.

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.

Systematic catalogue

Family Pontarachnidae Koenike, 1910

Genus *Litarachna* Walter, 1925

Type species: *Litarachna communis* Walter, 1925

Litarachna amnicola Cook, 1986

Locality and Habitats: *Tasmania*—Interstitial deposits of George River in northwest Tasmania (Cook 1986), less than 15 miles from the sea (Cook 1996); Tamar Valley, Tamar River, North of Launceston, marsh around lagoon, muddy bottom (Pešić & Smit 2009).

Distribution: Australian region (fresh water)—Tasmania and PSW—estuarine habitats of Tasmanian region.

Remarks: Smit (2016) indicated that the specimens reported by Pešić & Smit (2009) collected from an estuarine habitat.

Litarachna antalyaensis Pešić, Durucan & Chatterjee, 2018

Locality and Habitats: *Turkey*—Antalya, Hamit Bey Plaji, Gulf of Antalya, Mediterranean Sea, 7 m depth (Durucan *et al.* 2018).

Distribution: MDB—Mediterranean Sea—Turkey.

Litarachna bartschae Smit, 2003

Locality and Habitats: *Australia*—Watering Cove, Burrup Peninsula, Western Australia (Smit 2003); *Brunei Darussalam*—Brunei Bay, Pulau Bedukang (Pešić *et al.* 2013b); *Singapore*—Bartsch (2015).

Distribution: ITE, PTW—Western Australia, Brunei Darussalam, Singapore.

Litarachna brasiliensis Smit, 2007

Locality and Habitats: *Brazil*—Tramandaí River, Imbé, Rio Grande do Sul (Smit 2007).

Distribution: Neotropical region (fresh water)—Brazil; ASW—Brazil.

Remarks: Smit (2009) commented that fresh water pontarachnids are also found in estuaries or near the coast.

Litarachna bruneiensis Pešić, Chatterjee, Marshall & Pavićević, 2011

Locality and Habitats: *Brunei Darussalam*—Sungai Brunei Estuary and Bay, from a dense *Avicennia marina* pneumatophore mat (Pešić *et al.* 2011); Brunei Bay, Pulau Bedukang among epiphytal algae from pneumatophores of mangroves during low tide (Pešić *et al.* 2013b).

Distribution: PTW—Brunei Darussalam.

Litarachna caribica Pešić, Chatterjee & Schizas, 2008

Locality and Habitats: *Netherlands Antilles*—Curaçao, Nieuwpoort, among epiphytal algae from *Rhizophora* mangle (red mangrove) roots (Pešić *et al.* 2008d); *Panama*—Taboguilla Island among algae and rubbles, 3-5 m depth (Pešić *et al.* 2015).

Distribution: ATW, PTE—Netherlands Antilles (Caribbean Sea), Panama (Pacific Ocean).

Remarks: Pešić *et al.* (2015) mentioned that the populations of *Litarachna caribica* from the Pacific coast of Panama and those of Curaçao should be examined with molecular markers in order to test whether the morphologically identical trans-isthmian mite populations are genetically similar, indicating a recent dispersal process, or if they are genetically divergent, indicating an ancient separation.

Litarachna cawthorni Wiles, Chatterjee & De Troch, 2002

Locality and Habitats: *Kenya*—Gazi Bay among sea grasses (Wiles *et al.* 2002).

Distribution: ITW—Kenya.

Litarachna communis Walter, 1925

Locality and Habitats: *France*—Banyuls-sur-Mer, among algae (Walter 1925); on the algae at surf zone, the Baie du Troc, Banyuls-sur-Mer (Moto & Abé 2014); Pyrénées-Orientales (Smit & Gerecke 2010); near Ramatuelle, among algae at a depth of less than 0.5 m (Smit & Alberti 2010); *Croatia*—Rovinj among *Cystosira* algae at 1-3 m depth (Walter 1925); Rovinj, northern Adriatic Sea, among algae and *Posidonia* sea grass (Viets 1939-40, 1941); Adriatic Sea near Split (Viets 1941, Pešić & Smit 2016); from Pag Island (Zavodnik *et al.* 2006), Sveta Justina Island, stones with algae, depth 0.5 m (Pešić *et al.* 2018). *Russia*—Crimea, 7 km from Jalta (Tuzovskij 1977); *Italy*—Punta Vico (Lacco Ameno of Ischia), among *Posidonia oceanica* (Mari & Morselli 1983, 1989); Tyrrhenian Sea (Grottiniat S. Severa, Civitavecchia) (Mari & Morselli 1993); *Montenegro*—Adriatic Sea near Rt Ratac (Pešić *et al.* 2010, Pešić & Smit 2016); Valdanos near Ulcinj (Pešić *et al.* 2010); *Turkey*—Izmir Bay, Aegean Sea (Koç *et al.* 2015, Pešić *et al.* 2010); Marmara Sea, among *Zostera marina* sea grasses (Artüz & Pešić 2016).

Distribution: MDB—Mediterranean Sea (Croatia, France, Italy, Montenegro, Turkey), Black Sea (Russia).

Remarks: Moto & Abé (2014) provided a redescription of male, female and nymph of this species and designed lectotypes and paralectotypes. Furthermore, Moto & Abé (2014) commented that the specimens reported from the Black Sea by Tuzovskij (1978a, b) should be considered as another species.

Mari & Morselli (1983) found this species occurring up to a depth of 25 m, although most specimens were found between 3 and 5 m. Mari & Morselli (1983) also reported a biased sex ratio in *L. communis* (more than 80% males) in their collection.

Artüz & Pešić (2016) reported intersexuality in *Litarachna communis* from the western coast of the Sea of Marmara among *Zostera marina* sea grass.

Litarachna curtivalpis Smit, 2003

Locality and Habitats: *Australia*—tidal flat with coarse sediment and also among *Sargassum*, 40 Mile Beach, Dampier, Western Australia (Smit 2003); *Singapore*—Lazarus Island, tidal surface sediment rich in debris (Smit 2009).

Distribution: ITE, PTW—Western Australia, Singapore.

Litarachna degiustii Cook, 1958

Locality and Habitats: *Bahamas*—Bimini, recovered from the digestive tract of gobbid fish *Bathygobius* sp.; in a shallow water over a bottom composed of a mixture of sand and mud (Cook 1958), near Lee Stocking Island, Norman's pond Cay (Pešić *et al.* 2008d); *Netherlands Antilles*—Curaçao, Nieuwpoort, among epiphytal algae from *Rhizophora mangle* (red mangrove) roots (Pešić *et al.* 2008d).

Distribution: ATW—Caribbean Sea, Bahamas, Curaçao.

Litarachna denhami (Lohmann, 1909)

Locality and Habitats: *Australia*—Western Australia, Sharks Bay, sandy and muddy bottom with plants (Lohmann 1909, Walter 1925); *Sargassum*, low water, 40 Mile Beach, Dampier Area, Western Australia (Smit 2003, Pešić & Smit 2016); *Egypt*—Red Sea near Hurdaga (Viets 1959); *Republic of South Africa*—Park Rynie (Wiles *et al.* 2002); *India*—Malvan, west coast of India, Maharashtra, Arabian Sea, among subtidal macroalgae (Pešić *et al.* 2008c). *New Guinea*—Marine littoral, Base G beach, Jayapura (Smit 2011).

Distribution: ITE, ITW, PTW—Western Australia, South Africa, India, Egypt, New Guinea.

Remarks: The taxonomic position of specimens assigned to *L. denhami* from distant places such as Western Australia (Smit 2003), India (Pešić *et al.* 2008c, 2009), South Africa (Wiles *et al.* 2002) warrant further studies, ideally using a molecular approach, in order to clarify the taxonomy (Pešić & Smit 2015).

Litarachna duboscqi Walter, 1925

= *Pontarachna rhodia* Fischetti, 1928

= *Litarachna rhodia* (Fischetti, 1928)

Locality and Habitats: *France*—Mediterranean Sea, Banyuls-sur-Mer, 1-3 m depth; Baie du Troc (Walter 1925); *Croatia*—Adriatic Sea near Rovinj (Rovigno) (Walter 1925), Adriatic Sea (Viets 1939), Adriatic Sea near Split (Viets 1941, Kapiris *et al.* 2014); *Greece*—Eastern Mediterranean Sea (Fischetti 1928 as *Pontarachna rhodia*); *Russia*—Crimea, Black Sea 7 km from Jalta (Tuzovskij 1977); *Spain*—Canary Islands, San Andrés, Playa de Las Teresit, island of Tenerife (Zawal & Pešić 2015); *Turkey*—Izmir Bay in the Aegean Sea (Koç *et al.* 2015), Antalya, Hamit Bey Plaji (Durucan *et al.* 2018).

Distribution: MDB—Mediterranean Sea (Adriatic Sea and Aegean Sea), Black Sea.

Remarks: Pešić reported in Kapiris *et al.* (2014) the phenomenon of intersexuality in *Litarachna duboscqi* collected from the Adriatic Sea.

Litarachna enigmatica Pešić, Durucan & Chatterjee, 2018

Locality and Habitats: *Turkey*—Antalya, Hamit Bey Plaji, Mediterranean Sea, 7 m depth (Durucan *et al.* 2018).

Distribution: MDB—Turkey.

Remarks: This species is unique within the genus *Litarachna* in the postgenital sclerite having a pair of wheel-like acetabula (Durucan *et al.* 2018), a character found only in the females of *Pontarachna*.

***Litarachna gracilis* Pešić, 2013**

Locality and Habitats: *South Korea*—East Sea, Gangneung beach, Sokcho beach, interstitial (Pešić 2013b).

Distribution: PNW—South Korea.

***Litarachna haleioides* Smit, 2016**

Locality and Habitats: *Australia*—Queensland, Cape York Peninsula, Seisia, marine littoral at low tide in small pools (Smit 2016).

Distribution: PTW—Eastern Australia.

***Litarachna halei* (Womersley, 1937)**

Localities and habitats: *Australia*—Sellick's Beach, in *Sargassum*, South Australia, (Womersley 1937; Smit 2003); on *Amphibolis*, Bickley Point, Rottnest Island (Smit 2003).

Distribution: ISE—Western and southern Australia.

Remarks: Smit & Alberti (2010) reported that *Litarachna halei* from South Australia lives both in benthic habitats as well as in association with scyphozoan jelly fishes.

***Litarachna hongkongensis* Smit, 2002**

Locality and Habitats: *China*—Starfish Bay, associated with Serpulidae polychaetes, Hong Kong (Smit 2002).

Distribution: PTW—South China Sea, China.

***Litarachna indica* Pešić, Chatterjee & Ingole, 2012**

Locality and Habitats: *India*—West coast of India, Goa (North Goa), Virnoda Pernem, among algae from mangrove (*Rhizophora*) pneumatophores (Pešić *et al.* 2012).

Distribution: ITE—Arabian Sea, India.

***Litarachna kamui* Uchida, 1935**

Locality and Habitats: *Japan*—Bay of Usu, Hokkaido, found as plankton and also attached to seaweeds (Uchida 1935, Abé 2005).

Distribution: PNW—Bay of Usu, Japan.

***Litarachna lopezae* Pešić, Chatterjee, Alfaro & Schizas, 2014**

Locality and Habitats: *Puerto Rico*—Bajo de Sico, depth 69.5 m (a mesophotic reef formation located in Mona Passage off Puerto Rico) (Pešić *et al.* 2014).

Distribution: ATW—Caribbean Sea, Puerto Rico.

***Litarachna lukai* Pešić, 2013**

Locality and Habitats: *South Korea*—Yellow Sea, Wido Island, interstitial (Pešić 2013b).

Distribution: PNW—South Korea.

***Litarachna madagascariensis* Pešić, 2013**

Locality and Habitats: *Madagascar*—Fort Dauphin (Tulear), Mandena, coastal lake at mouth of river Amendano (Pešić 2013a).

Distribution: PTW—Madagascar.

***Litarachna marshalli* Wiles, Chatterjee & De Troch, 2002**

Locality and Habitats: *Republic of South Africa*—Sardinia Bay, Durban; Park Rynie, Durban; Mtakatye Estuary, Durban (Wiles *et al.* 2002).

Distribution: ITW—South Africa.

***Litarachna minuta* Pešić, Chatterjee & Marshall, 2013**

Locality and Habitats: *Brunei Darussalam*—Brunei Bay, Pulau Bedukang among epiphytal algae from pneumatophores of mangroves during low tide (Pešić *et al.* 2013b).

Distribution: PTW—Brunei Darussalam.

***Litarachna muelleri* Smit, 2008**

Locality and Habitats: *Malaysia*—Pulau Babi Besar, medium part of reef flat, in and under dead corals, intertidal—1 m depth, Tioman Archipelago, Gulf of Thailand (Smit 2008a).

Distribution: PTW—Malaysia.

***Litarachna sabangensis* Viets, 1984**

Locality and Habitats: *Philippines*—Sabang Island, east of Cebu, Intertidal, among silty coral sand in front of *Avicennia* mangroves, Camotes Sea (Viets 1984)

Distribution: PTW—Philippines.

***Litarachna sagamiensis* Moto & Abé, 2013**

Locality and Habitats: *Japan*—Sagami Bay, Zushi City, Yokosuka City, coast of Kanagawa, central Japan, among *Sargassum* in the intertidal zone less than 0.5m depth (Moto & Abé 2013).

Distribution: PNW—Japan.

***Litarachna smiti* Pešić, Chatterjee & Ahmed Abada, 2008**

Locality and Habitats: *Saudi Arabia*—Red Sea: Southwestern coast of Saudi Arabia, Al Birk, Al-Horydah among macroalgae (Pešić *et al.* 2008 a, b).

Distribution: ITW—Red Sea, Saudi Arabia.

***Litarachna thetis* Pešić & Smit, 2016**

=*Litarachna divergens*—Uchida 1935: p. 187, Figs. 4–6;
=*Litarachna divergens*—Viets 1957 (part): p. 154.
=*Litarachna denhami*—Pešić *et al.* 2008: p. 71, Figs. 6–10

Locality and Habitats: *South Korea*—Masan-ri, inner bay of Pohang, Youngil Bay among coralline algae and submerged macroalgae on shallow sublittoral rocks, depth <1 m (Pešić *et al.* 2008a under the name *Litarachna denhami*; Pešić & Smit 2016); *Korea*, Gupyeong-ri, marine littoral (Pešić & Smit 2016). *Japan*—Oshoro, Hokkaido, Misaki Japan (Uchida 1935 under the name *Litarachna divergens*; Pešić & Smit 2016).

Distribution: PNW—South Korea, Japan.

***Litarachna triangularis* Smit, 2009**

(Fig. 1)

Locality and Habitats: *Singapore*—Lazarus Island, tidal surface sediment rich in detritus; West Coast Park, sediment associated with *Avicennia* mangroves (Smit 2009).

New Finds: Taiwan, Dongsha Atoll (20.684618 N, 116.769521 E), collected (May 2016) from 4 m depth among sediment and coral fragments, two deutonymphs (Collected by Nikolaos V. Schizas), one of them dissected and slide mounted (Fig. 1).

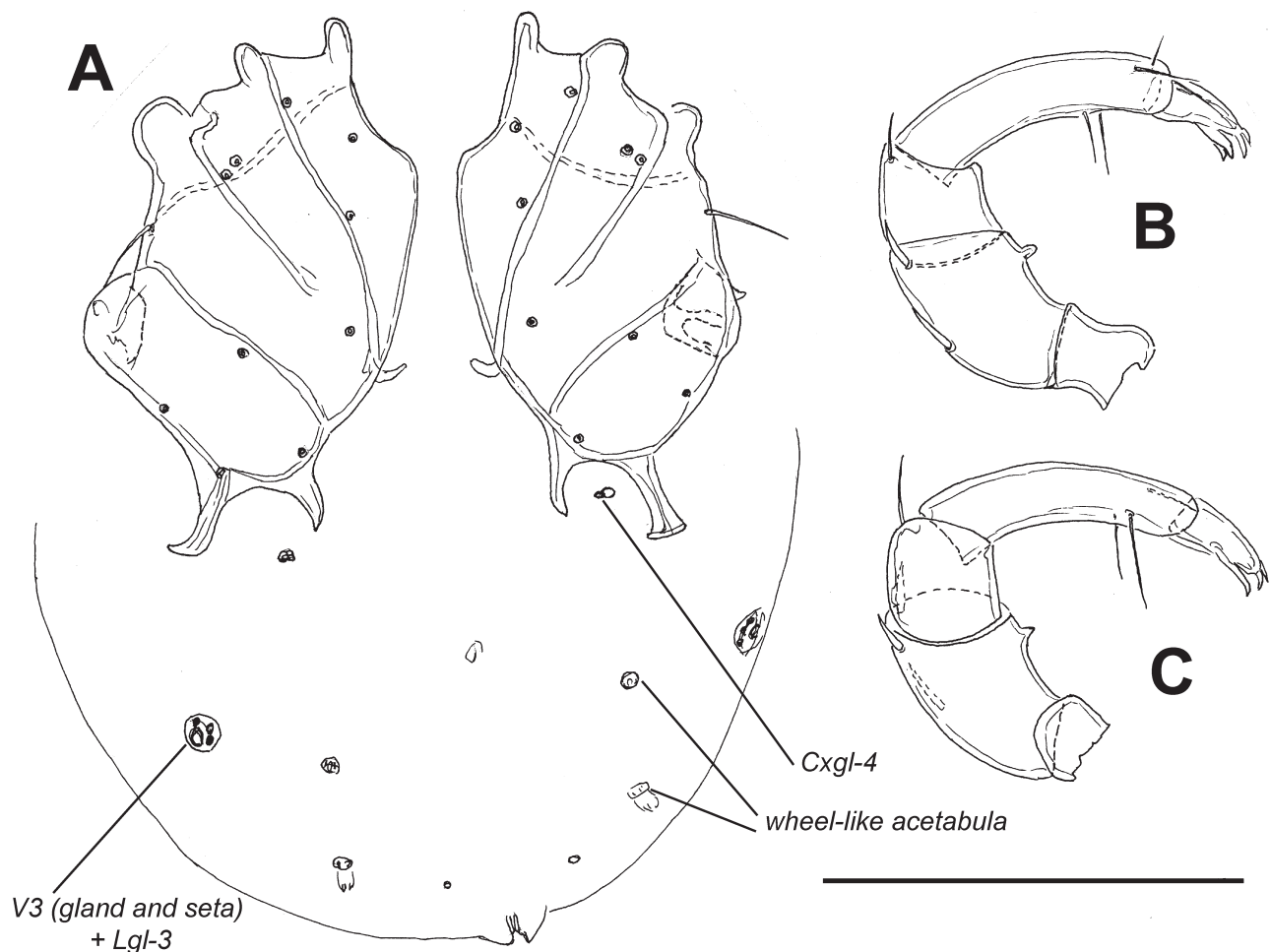


FIGURE 1. *Litarachna triangularis* Smit, 2009, deutonymph. A= idiosoma, ventral view; B-C = palp. Scale bars = 100 μ m.

Remarks: The deutonymph specimens from Taiwan fit well in the description of *Litarachna triangularis* a species described from Singapore on the basis of a female and deutonymph. Smit (2009) did not provide any figures and measurements of his deutonymph except the idiosoma size. We give here some additional figures and measurements of the deutonymph from Dongsha Atoll tentatively assigned to *L. triangularis*. Deutonymph—Idiosoma L 223, W 183; coxal field L 109; palp total 190, dL/H, dL/H ratio: P-1, 14/17, 0.83; P-2, 52/28, 1.84; P-3, 30/26, 1.13; P-4, 67/17, 3.9; P-5, 27/11, 2.4; P-2/P-4 ratio 0.77.

Distribution: PTW—Singapore; Dongsha Atoll (South China Sea)

Litarachna sp.

Locality and Habitats: *Puerto Rico*—Rio Grande, from marine littoral, associated with tubes of the polychaete *Sabellastarte magnifica* (Pešić *et al.* 2014).

Genus *Pontarachna* Philippi 1840

Type species: *Pontarachna punctulum* Philippi, 1840.

Pontarachna adriatica Morselli, 1980

Locality and Habitats: *Italy*—Northern Adriatic brackish waters, Ferrara and Ravenna provinces (Morselli 1980). *Slovenia*—gut content analysis of the Golden grey mullet *Lisa aurata* from Piran Bay at 12 m depth (Siokou *et al.* 2013). *Turkey*—Southern Black Sea, Sinop Bay, 10 m depth (Pešić *et al.* 2013a).

Distribution: MDB—Central and east Mediterranean Sea, Adriatic Sea, Black Sea.

Pontarachna aenariensis Mari & Morselli, 1983

Locality and Habitats: *Italy*—Punta Vico—Lacco Ameno of Ischia, among *Posidonia oceanica* sea grass (Mari & Morselli 1983, 1989).

Distribution: MDB

Remarks: This species was most numerous between 3 and 5 m depth, and was not found below 6 m (Mari & Morselli 1983).

Pontarachna africana Smit 2002

Locality and Habitats: *Republic of South Africa*—Gansbaai, 100 km southeast of Cape Town (Smit 2002).

Distribution: ISW—Republic of South Africa.

Pontarachna anellata Sokolow, 1936

= *Pontarachna hinumaensis* Imamura, 1958

Locality and Habitats: *Russia*—Sea of Ochotsk, Russian Pacific coast (Sokolow 1936, 1940); Japan Sea (Sokolow 1940). *Japan*—Brackish water marsh, Hinuma marsh (Imamura 1958).

Remarks. Smit (2002) synonymized *Pontarachna hinumaensis* Imamura, 1958, a species only known from male specimens, with *P. anellata* Sokolow, 1936, a species described on the basis of only female specimens.

Distribution: PNW—Russia, Japan.

***Pontarachna arabica* Pešić, Chatterjee & Ahmed Abada, 2008**

Locality and Habitats: *Saudi Arabia*—Red Sea: South Western Coast of Saudi Arabia, Al Birk among macroalgae (Pešić *et al.* 2008b).

Distribution: ITW—Saudi Arabia.

***Pontarachna australis* Smit, 2003**

Locality and Habitats: *Australia*—Watering Cove, Burrup Peninsula, Western Australia (Smit, 2003); *Taiwan*—He-Ping-Dao, NE Taiwan, intertidal, among coralline algae (Pešić *et al.* 2008a); *Philippines*—Mindanao Island, about 157 km E-SW of Davao city, north-eastern coast of Pujada Bay (close to a small community called Guang-guang) among the sea grass *Thalassia hemprichii* (Pešić *et al.* 2009). *India*—Andaman Islands, South Andaman, Mahatma Gandhi National Park (Marine Park), Wandoor, Port Blair among sediments of macroalgae *Padina* sp. (Pešić *et al.* 2009).

Distribution: PTW, ITE—Australia, Philippines, Taiwan, India.

***Pontarachna capensis* Lohmann, 1909**

Locality and Habitats: *Republic of South Africa*—Simonstown, Cape Province (Lohmann 1909, Walter 1925).

Distribution: ISW—Republic of South Africa.

***Pontarachna curvipalpis* Smit, 2016**

Locality and Habitats: *Australia*—Queensland, Orpheus Island, Pioneer Bay, between algae and coral rubble (Smit 2016).

Distribution: PTW—Australia.

***Pontarachna cruciata* Hall, 1912**

Locality and Habitats: *USA*—Beach pools, Laguna Beach, California (Hall 1912, Walter 1925).

Distribution: PNE—western USA.

***Pontarachna dampierensis* Smit, 2003**

Locality and Habitats: *Australia*—40 Mile Beach, Dampier Area, Western Australia among *Sargassum* at low water level (Smit 2003).

Distribution: ITE—Western Australia.

***Pontarachna episce* Smit, 2008**

Locality and Habitats: *Turkey*—Yumurtalık, littoral at a depth between 0 and 15 m, found in the gill of a fish Shi Drum or Bearded Umbrine *Umbrina cirrosa* Linnaeus, 1758 (Smit 2008b).

Distribution: MDB—Turkey.

***Pontarachna erythraea* Viets, 1966**

Locality and Habitats: *Egypt*—Red Sea near Hurdaga (Viets 1966).

Distribution: ITW—Red Sea.

***Pontarachna formosae* Lohmann, 1909**

Locality and Habitats: *Taiwan*—Japan Sea near Takao, west coast of Taiwan (old = Formosa) (Lohmann 1909, Walter 1925).

Distribution: PTW—Taiwan.

***Pontarachna hoffmannae* Cook, 1996**

Locality and Habitats: *Republic of South Africa*—Groot River in Natures Valley, near western edge of Tsitsikama National Park, eastern cape province, freshwater habitats, less than 5 miles from the sea (Cook 1996).

Distribution: Afrotropical region (fresh water)—Republic of South Africa and ISW—Republic of South Africa.

Remarks: Vites KO (1964) reported *P. punctulum* from Keurbooms River estuary, Eastern Cape. However, Smit & Alberti (2010) commented that Viets (1964) identified these specimens erroneously as *P. punctulum*, and indicated that the specimens belong to *P. hoffmannae*.

***Pontarachna ivonae* Pešić, 2013**

Locality and Habitats: *South Korea*—Yellow Sea, Wido Island, Seokgeum beach, interstitial; East Sea, Gangneung beach, littoral (Pešić 2013b).

Distribution: PNW—South Korea.

***Pontarachna longipes* Smit, 2008**

Locality and Habitats: *Malaysia*—Pulau Babi Besar, medium part of reef flat in and under corals, intertidal—1 m, Tioman Archipelago, Gulf of Thailand (Smit 2008a).

Distribution: PTW—Malaysia.

***Pontarachna minuta* Smit, 2003**

Locality and Habitats: *Australia*—tidal flat with coarse sediment, 40 Mile Beach, Dampier, (Smit 2003).

Distribution: ITE—Western Australia.

***Pontarachna nemethi* Pešić, Chatterjee & Schizas, 2012**

Locality and Habitats: *Puerto Rico*—El Seco, east of Vieques Island, from 52–67 m depth (Pešić *et al.* 2012).

Distribution: ATW—Caribbean Sea, Puerto Rico.

***Pontarachna otto* Harvey, 1998**

Locality and Habitats: *Australia*—Magnetic Island, Queensland, coral sand, Eastern Australia (Harvey 1998).

Distribution: PTW—Eastern Australia.

***Pontarachna pacifica* Uchida, 1935**

= *Pontarachna pacificum*—Imamura, 1965

Locality and Habitats: *Japan*—Oshora, plankton also attached to seaweeds (Uchida 1935). *Russia*: Japan Sea, Island Beljzov, littoral, in Amphizoa community; Island Petrow, littoral, communities with *Rhodomella larix* (Sokolow 1936)

Distribution: PNW—Japan, Russia.

Remarks: Sokolow (1936) described a new subspecies, *Pontarachna anellata pilosa*.

***Pontarachna pontica* Viets, 1928**

Locality and Habitats: *Russia*—Black Sea near Sevastopol (Viets 1928).

Distribution: MDB—Black Sea.

***Pontarachna punctulum* Phillippi, 1840**

= *Pontarachna lacazei* Moniez, 1888

= *Pontarachna tergestina* Von Schaub, 1889

Locality and Habitats: *Italy*—Gulf of Naples (Phillippi 1840, Walter 1925); Adriatic Sea near Trieste (Von Schaub 1889, Walter 1925 as *Pontarachna tergestina* Von Schaub, 1889); Adriatic Sea (Carriglio 2010); coast of Tuscany among sea grass meadows of *Posidonia oceanica*, colonized a rocky bottom at 8 m to 25 m depth (Bedini *et al.* 2011); Punta Vico—Lacco Ameno of Ischia, among *Posidonia oceanica* sea grass (Mari & Morselli 1983). *France*—Banyuls-Sur-Mer (Moniez 1890 as *Pontarachna lacazei*); Banyuls-sur-Mer, Baie du Troc (Walter 1925); Var—Baie de Cavalière, Cap Rossignol, Pointe du Pramousquier (Motaş 1928); Hérault (Etang de Thou between Montpellier and Béziers (Lundblad 1956); Alpes-Maritimes, Hérault, Pyrénées-Orientales (Smit & Gerecke 2010). *Croatia*—Rovinj near Punta Muccia, Czstosira, 1-3 m depths (Walter 1925); *Egypt*—Red Sea near Hurdaga (Viets 1959). *Russia*—Crimea: Black Sea near Sevastopol, *Ulva* community (Walter 1925 as *Pontarachna tergestina* Von Schaub, 1889); Black Sea near Sevastopol (Viets 1928); Black Sea 7 km from Jalta (Tuzovskij 1977). *USA & Canada*—Thayer (1984) listed *Pontarachna punctulum* in the epiphytic fauna of sea grass *Zostera marina* from North Carolina to Nova Scotia. *Turkey*—Aegean Sea, Ýzmir Bay: Çepmealty from algae, sponges and sediment (Koç *et al.* 2015).

Distribution: MDB—Mediterranean Sea (Adriatic Sea, Italy, France, Croatia, Turkey), Black Sea (Russia); ANW—USA, Canada; ITW—Red Sea (Egypt).

Remarks: The record of this species from Red Sea (Egypt), USA and Canada calls for a better comparison of the geographic populations; future comparisons should include molecular data.

***Pontarachna valkanovi* Petrova, 1978**

Locality and Habitats: *Bulgaria*—Interstitial zone of the marine littoral (0.6–1.2 m depth) of the Bulgarian Black Sea coast (Petrova 1978). *Turkey*—Turkish Black Sea coast, Sinop Bay, littoral, 3 m depth (Pešić *et al.* 2013a).

Distribution: MDB—Black Sea, Bulgaria, Turkey.

Species incerta

Litarachna divergens Walter, 1925

Locality and Habitats: Walter (1925) introduced *Litarachna divergens* specimens collected in Trieste, Italy, Adriatic Sea by Von Schaub (1889) as *Pontarachna punctulum*. Walter (1925) also assigned a specimen from the Black Sea recorded by Sernow (1913) to *L. divergens*. Soar (1927) recorded this species from Suez Canal.

Remarks: This species considered as *species incerta* by Pešić & Smit (2016). Pešić & Smit (2016) also stated that the record from Turkey published by Thessalou-Legaki *et al.* (2012) under the name of *L. divergens* probably refers to *L. communis* Walter, 1925. The population from Hokkaido, Japan published by Uchida (1935) as *Litarachna divergens* recently was assigned to *L. thetis* Pešić & Smit (Pešić & Smit 2016).

Discussion

A total of 53 valid species of pontarachnid mites have been described, allocated to the genus *Pontarachna* (n=30 species) and the genus *Litarachna* (n=23 species).

Table 1 provides species names of mites reported from different provinces of the world. Most species (15 species) are known from the Tropical West Pacific Ocean followed by nine species in Mediterranean and associated areas, seven species in Tropical East Indian Ocean, and six species in Tropical West Indian Ocean. The number of species present in each marine province is shown in Fig. 2. The richness of pontarachnid mites per particular area is most likely related to the intensity of faunistic surveys with the appropriate collecting methods for mites. For example, the absence of pontarachnids from various provinces such as South East and South West Pacific Ocean is certainly due to lack of intensive surveys. This view is also supported by the fact that the biodiversity of pontarachnid mites in Tropical East Pacific Ocean consists of only one species while Tropical West Pacific Ocean consists of 15 species, clearly indicating that much more work on pontarachnid mites has been carried out in Tropical West Pacific Ocean than Tropical East Pacific Ocean.

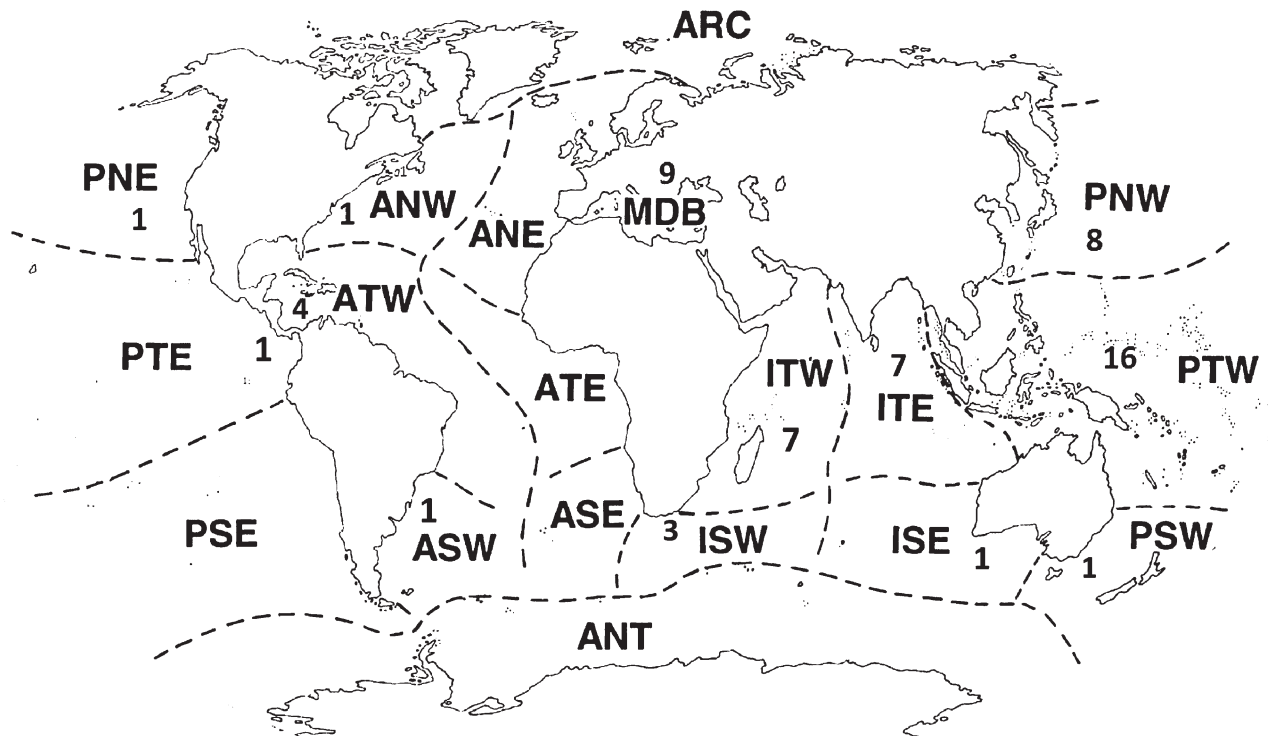


FIGURE 2. Number of pontarachnid species present in each marine province.

Three species (*Litarachna amnicola*, *L. brasiliensis*, and *Pontarachna hoffmannae*) have been described from freshwaters. However, Smit (2009) commented that these species occurred in estuaries or locations near the sea, where the salinity varies throughout the day according to the tidal regime. Occasionally, pontarachnid mites have been recorded from marine interstitial spaces, usually as single specimens and as representatives of surface dwelling species (e.g., *Litarachna amnicola*, *Pontarachna valkanovi*, and *Pontarachna ivonae*—see Pešić 2013 for discussion). Two species, *Litarachna lukai* and *L. gracilis*, exhibited reduced eye pigmentation indicating that they can be the first representatives of true interstitial pontarachnid mites (Pešić 2013).

TABLE 1. Species names of pontarachnid mites reported from different marine provinces of the world.

Area	Species
ANE, Atlantic Ocean, North-East	-
ANT, Antarctica and sub-Antarctic	-
ANW, Atlantic Ocean, North-West	<i>Pontarachna punctulum</i>
ARC, Arctic region	-
ASE, Atlantic Ocean, South-East	-
ASW, Atlantic Ocean, South-West	<i>Litarachna brasiliensis</i>
ATE, Atlantic Ocean, Tropical East	-
ATW, Atlantic Ocean, Tropical West	<i>Litarachna caribica</i> <i>Litarachna degiustii</i> <i>Litarachna lopezae</i> <i>Pontarachna nemethi</i>
ISE, Indian Ocean, South-East	<i>Litarachna halei</i>
ISW, Indian Ocean, South-West	<i>Pontarachna africana</i> <i>Pontarachna capensis</i> <i>Pontarachna hoffmannae</i>
ITE, Indian Ocean, Tropical East	<i>Litarachna bartschae</i> <i>Litarachna curtialpis</i> <i>Litarachna denhami</i> <i>Litarachna indica</i> <i>Pontarachna australis</i> <i>Pontarachna dampierensis</i> <i>Pontarachna minuta</i>
ITW, Indian Ocean, Tropical West	<i>Litarachna cawthorni</i> <i>Litarachna denhami</i> <i>Litarachna marshalli</i> <i>Litarachna smiti</i> <i>Pontarachna arabica</i> <i>Pontarachna erythraea</i> <i>Pontarachna punctulum</i>
MDB, Mediterranean Sea, Black Sea, Caspian Sea and Aral Sea	<i>Litarachna antalyaensis</i> <i>Litarachna communis</i> <i>Litarachna duboscqi</i> <i>Litarachna enigmatica</i> <i>Pontarachna adriatica</i> <i>Pontarachna aenariensis</i> <i>Pontarachna episce</i> <i>Pontarachna pontica</i> <i>Pontarachna punctulum</i>
PNE, Pacific Ocean, North-East	<i>Pontarachna cruciata</i>

.....continued on the next page

TABLE 1. (Continued)

Area	Species
PNW, Pacific Ocean, North-West	<i>Litarachna gracilis</i>
	<i>Litarachna kamui</i>
	<i>Litarachna lukai</i>
	<i>Litarachna sagamiensis</i>
	<i>Litarachna thetis</i>
	<i>Pontarachna anellata</i>
	<i>Pontarachna ivonae</i>
	<i>Pontarachna pacifica</i>
PSE, Pacific Ocean, South-East	-
PSW, Pacific Ocean, South-West	<i>Litarachna amnicola</i>
PTE, Pacific Ocean, Tropical East	<i>Litarachna caribica</i>
PTW, Pacific Ocean, Tropical West	<i>Litarachna bartschae</i>
	<i>Litarachna bruneiensis</i>
	<i>Litarachna curtivalpis</i>
	<i>Litarachna denhami</i>
	<i>Litarachna haleioides</i>
	<i>Litarachna hongkongensis</i>
	<i>Litarachna madagascariensis</i>
	<i>Litarachna minuta</i>
	<i>Litarachna muelleri</i>
	<i>Litarachna sabangensis</i>
	<i>Litarachna triangularis</i>
	<i>Pontarachna australis</i>
	<i>Pontarachna curvipalpis</i>
	<i>Pontarachna formosae</i>
	<i>Pontarachna longipes</i>
	<i>Pontarachna otto</i>
Fresh Water	<i>Litarachna amnicola</i>
	<i>Litarachna brasiliensis</i>
	<i>Pontarachna hoffmannae</i>

Most of the pontarachnid species are found near the shore. However, there are some species recorded from relatively greater depths. Mari & Morselli (1983) found *Litarachna communis* occurring to a depth of 25 m while a *P. punctulum* specimen was reported from a depth upto 25 m in the coast of Tuscany (Bedini *et al.* 2011). *Pontarachna nemethi* was collected from a mesophotic coral reef ecosystem (MCE) near Vieques Island of Puerto Rico at 52–67 m depth (Caribbean Sea) and *Litarachna lopezae* was collected from another MCE at 69.5 m depth from Bajo de Sico of Puerto Rico (Caribbean Sea) (Pešić *et al.* 2012a, 2014).

There are some reports of pontarachnids associated with mangroves as discussed in the checklist of mites associated with mangroves (Chatterjee *et al.* 2018). At least eight species, i.e., *Litarachna bartschae*, *L. bruneiensis*, *L. caribica*, *L. degiustii*, *L. minuta*, *L. indica*, *L. sabangensis* and *L. triangularis* were reported in close association with mangroves, mostly as members of the epiphytial community. Smit & Alberti (2010) reported that *Litarachna halei* from South Australia lives both in benthic habitats as well as in association with Scyphozoans.

Most of the pontarachnids have been reported from algae, sea grass, sand, etc. but there are species (e.g., *Pontarachna pacifica*), which have been reported as plankton; however, even in this particular case, the mites were associated with *Sargassum* floats.

Some species have been reported among seagrasses. *Litarachna cawthorni* has been found among seagrasses in Kenya (Wiles *et al.* 2002). *Pontarachna australis* was reported among the seagrass *Thalassia hemprichii* from Philippines (Pešić *et al.* 2009). *L. communis* and *Pontarachna aenariensis* were reported among *Posidonia oceanica* meadows from Italy (Mari & Morselli 1983, 1989); Artüz & Pešić (2016) also reported this species from the Sea of Marmara among *Zostera marina*. *Pontarachna punctulum* was reported among *Posidonia oceanica* from north-western Mediterranean Sea (Bedini *et al.* 2011). Smit (2016) reported that in the Mediterranean Sea, pontarachnids are easily collected between sea grass.

Occasionally pontarachnid mites have been found in the gill filaments or in the gut of marine fishes. *Ponta-*

rachna episce was collected from a gill filament of the Shi Drum or Bearded Umbrine (*Umbrina cirrosa*), collected in the Mediterranean coast of Turkey (Smit 2008b). *Pontarachna adriatica* was found among the gut contents of the Golden grey mullet *Lisa aurata* from Slovenia, Piran Bay at the depth of 12 m (Siokou *et al.* 2013).

Few species have been reported to be associated with polychaetes. Smit (2002) reported *L. hongkongensis* from Starfish Bay, Hong Kong, from Serpulidae worms. Pešić *et al.* (2014) reported a *Litarachna* collected from Rio Grande, Puerto Rico associated with tubes of the polychaete *Sabellastarte magnifica*.

The diverse locations and habitats reported in this review suggest that different sampling methods would be necessary to survey effectively for pontarachnid mites. The presence of a few specialized taxonomists, the sampling bias during environmental or biodiversity assessments and the absence of molecular studies have hampered the progress in pontarachnid taxonomy. This checklist is a step towards the improvement of pontarachnid taxonomy.

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