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FIRST RECORDS OF LOHMANNIIDAE (ACARI: ORIBATIDA) FROM THE BERMUDA ISLANDS

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ABSTRACT — Records of nine species of the family Lohmanniidae from the Bermuda Islands, belonging to six genera, are presented and discussed (*Haplacarus foliatus* Wallwork, 1962, *Lohmannia banksi* Norton, Metz et Sharma, 1978, *L. jornoti* Mahunka, 1985, *L. similis* Balogh, 1962, *Meristacarus porcula* Grandjean, 1934, *Nesiacarus granulatus* Hammer, 1972, *Papillacarus incompletus* (Mahunka, 1985), *P. spinosus* Bischoff de Alzuet, 1972, *Torpacarus omittens omittens* Grandjean, 1950). Morphological characteristics, ecology and zoogeographical relationships are analysed. Most Lohmanniidae species were found in terrestrial habitats, a few species colonize the salt-spray area of the supralittoral zone or even the upper eulittoral zone, mainly in mangrove leaf litter. Almost all Lohmanniidae species found on Bermuda occur also in Central or South America. Dispersal by hydrochory can be assumed for most species.

KEYWORDS — Acari; Oribatida; Lohmanniidae; Bermuda; ecology; zoogeography

INTRODUCTION

The knowledge of the oribatid mite fauna from the Bermuda Islands is still very poor. Prior to this study 23 species have been recorded. Sellnick (1952) published the first three species collected on Bermuda. *Oripoda longiseta* Woolley, 1966 was discovered in the slide series from the U.S. National Museum, which was originally found on plant material ("unknown cuttings") at Boston, introduced from Bermuda without detailed site records (Woolley 1966, Balogh and Balogh 1990). Niedbala (2002) recorded 18 "Ptyctimous" oribatid species from Bermuda. Among them, three species (*Atropacarus paraclavatus* Niedbala, 2002, *Mesoplophora paragaveae* Niedbala, 2002, *Phauloppia gracilis* Sellnick, 1952) were found exclusively on Bermuda up to now. Recently a new species of the family Fortuyniidae, *Fortuynia atlantica* Krisper et Schuster, 2008 was described which is hitherto only known from the Bermuda Islands, occurring in many localities along the rocky coastlines (Krisper and Schuster 2008). An additional study, also about littoral oribatid mites, was published by Pfingstl and Schuster (2012). In the course of two collecting trips made by the second author to the Bermudas in the summers of 1977 and 1981, numerous Lohmanniidae species were collected. These taxa are presented in the present paper.

ENVIRONMENTAL SETTING

The Bermuda Archipelago, located near the western edge of the Sargasso Sea in the Atlantic Ocean,

consists of about 150 islands with a total terrestrial surface of 55 km^2, the largest island of which, called "Main island" or "Bermuda" covers about 40 km^2. Most of the other islands are very small and devoid of dense terrestrial vegetation. The islands are of oceanic origin, a land bridge to the American continent has never existed. The nearest distance to Cape Hatteras, North America, is about 960 km. Originally formed by a volcanic seamount the subaereal part is covered by coralline limestone, partially broken down into sand and fused to aeolian sandstone. The islands are largely flat, the highest point is Town Hill on Main island with an altitude of less than 100 m. There is no mountainous region. On the other hand, the islands have more than 100 km of coastline, surrounded by coral reefs. Ecologically the shoreline can be divided into three different parts: sandy beaches, rocks, and remains of a typical mangrove vegetation on some coastal sections. The inland environment is poor and characterized by sandy soils with low amounts of organic matter, small forests, bushes and grassland. Rivers or brooks are absent. Remarkable are numerous Karst caves.

The climate of the Bermudas is subtropical. It is largely influenced by the Gulf Stream which represents an important climatic factor. Additionally, this ocean current arising in the Caribbean region, is a significant factor for the colonization of the Bermuda islands by plants and animals.

The terrestrial vegetation includes different trees and shrubs, forming forests in some places. Endemic plants are rare (e.g. *Juniperus bermudiana*, "Bermuda Cedar" or *Sabal bermudana*, "Bermuda Palmetto", the only native palm). Since discovery by humans in 1503, numerous species have been introduced to the islands, deliberately or accidentally, which were responsible for the remarkable changes in the native flora and fauna of the archipelago as well as the subsequent changes in the original vegetation and landscape. A characteristic introduction is the Australian *Casuarina*-tree.

Details about the natural history of the Bermudas are given in Thomas (2004).

MATERIAL AND METHODS

List of Localities:

BE-26: Campus of the Biological Station; fully terrestrial location, sandy soil with some litter under a group of bushes; 20.7.1977

BE-30: Forest near Tom Moore's Tavern; in the neighbourhood of a small salty pool; muddy soil; 31.7.1977

BE-59: Burt Island in the Great Sound; flat supralittoral; sandy soil with a lot of gravel; 7.8.1977

BE-117: Forest near Tom Moore's Tavern; bushes near Walshingham cave; moist soil with litter, on the edge of a salty pool; 19.7.1981

BE-119: Neighborhood of Tom Moore's Tavern, at the edge of the Harbour's Pool; forest of brushes; moist soil with litter, at the rim of a small brackish pool; 19.7.1981

BE-124: Campus of the Biological Station; dry sandy soil with litter under *Casuarina*-trees; 20.7.1981

BE-126: Campus of the Biological Station; similar to BE-124, but at a distance of 12 m; 20.7.1981

BE-184: Small island W of Trunk Island in the Harrington Sound; thin soil layer with some litter; 10.8.1981

BE-225: Somerset Island, near Scaur Fort; open area; poor soil, mixed with sand; 29.8.1981

BE-230: St. George's, Lovers Lake, upper edge of the mangroves; sandy-muddy soil with threads of green algae on the surface; 31.8.1981

BE-282: Somerset Island, Mangrove Bay; transition zone between supralittoral and terrestrial area; moist sandy soil; 14.9.1981

BE-285: West shore, ca. 200 m S of Whitney Bay; sandy beach, just above the supralittoral; terrestrial sandy slope; 17.9.1981

BE-287: Parish Southampton, hill of Gibbs Lighthouse; forest on the northern slope; dry sand covered with a layer of dry litter; 20.9.1981

BE-288: Parish Warwick; forest east of the Warwick pond; dry coarse-grained soil, with dry litter on the surface; 21.9.1981

BE-299: Coast of Penthurst Park; beach, coarse-grained soil in the transition between supralittoral and terrestrial zone; 24.9.1981

BE 301: Devonshire Bay (part Rocky Bay); little sandy beach between rocks; soil below jetsam in the transition zone between supralittoral and terrestrial area; 24.9.1981

BE-303: Parish Smith's, southcoast, John Smith's Bay; upper part of the beach, transition zone up to the terrestrial area; 25.9.1981

BE-308: Walsingham Nature Reserve; forest near a small pool; moist soil, covered by a thin layer of litter; 26.9.1981

BE-310: Spittal Pond Nature Reserve; mixed forest with different trees and shrubs; reddish-grey soil with litter, mixed with sand; 26.9.1981

The mites were collected by using Berlese-Tullgren-funnels at the Biological Station of the Bermudas. All collections were carried out by the second author. The lohmanniid specimens investigated in this work are deposited in the collection of the first author. A total of 127 specimens were encountered, 55 adults and 72 juvenile instars.

RESULTS

Haplacarus foliatus Wallwork, 1962

Wallwork 1962: 466, figs. 6-11; Balogh and Balogh 1987: 343, pl. 29A; 2002a: 71; 2002b: pl. 126:1.

Dimensions: deutonymph (n=3) 518 (480 – 540) x 280 μm, tritonymph (n=2) 660 x 290 – 330 μm. Sensillus with 7-8 branches in both instars. Measurements of setae: deutonymph: *c1* 65 – 70, *d1* 60 – 70, *e1* 70, *f1* 59 – 60, distance *c1-d1* 70 – 80, *d1-e1* 70; tritonymph: *c1* 80 – 85, *d1* 80, *e1* 80 – 85, *f1* 60 – 70, distance *c1-d1* 90, *e1-f1* 85 – 90 μm. Transverse band *s7* incomplete in all studied specimens.

Remarks: The specimens from Bermuda correspond to the original description (Wallwork 1962) and are considered conspecific. The description by Wallwork (1962) is based on one adult and one tritonymph. *Haplacarus foliatus* is very similar to *H. javensis* Hammer, 1979. Main differences between the two species are: The notogastral setae are thicker in adults of *H. foliatus*, but more slender in *H. javensis* (this character could not be observed in the studied juvenile instars); notogastral setae *e1* are longer than *f1* in *H. foliatus*; transverse band *s7* is incomplete in *H. foliatus*, but complete in *H. javensis*. A comparison with adults and tritonymphs of *H. javensis* from Belize and Cocos Island, Costa Rica (Schatz 1994b), was possible. *Haplacarus foliatus* is also morphologically similar to *H. bengalensis* Bhattacharya, Bhaduri et Raychaudhuri, 1974, but the latter species has shorter notogastral setae.

Records from Bermuda: BE 230: 2 deutonymphs. BE 301: 1 deutonymph, 2 tritonymphs.

General distribution: West Africa: Ghana, Pagalu Island (Annobón); India, Philippines, Thailand; first record for Bermuda.

Lohmannia banksi Norton, Metz et Sharma, 1978

Norton et al. 1978: 18, figs. 2-3; Balogh and Balogh 1987: 334, pl. 7 A-B.

Dimensions: adult (n=13) 846 (770 – 915) x 388 (365 – 405), larva (n=7) 413 (375 – 435) x 211 (190 – 225), protonymph (n=14) 511 (460 – 565) x 264 (250 – 280), deutonymph (n=4) 615 (600 – 640) x 312 (300 – 320), tritonymph (n=5) 744 (685 – 820) x 372 (340 – 400) μm.

Prodorsum very weakly three-lobed. Sensillus with 10-12 branches in adult, trito- and deutonymph, 10 branches in protonymph, 8-9 branches in larva. Posterior exobothridial setae except in larva almost circular, measurements 50 – 60 x 40 – 55 in adult, 48 – 50 x 40 – 48 in tritonymph, 35 – 38 x 32 – 35 in deutonymph, 25 x 20 – 25 in protonymph, 20 x 7 μm in larva. Notogastral setae phylliform with serrated margins and with an obtuse, blunt tip, but at least distally with a weakly developed midrib in adult. Juvenile instars generally with smaller setae, dorsomedian setae in larva very weakly dilated with serrated margins, other notogastral setae gradually dilated to phylliform with a midrib in other instars. Posterior medial genital setae slightly widened in adult.

Remarks: A comparison with the paratype of this species was possible. The adult and juvenile specimens found on Bermuda correspond to this

type (adult) and the original description (Norton et al. 1978) and are considered conspecific. Leaf-like notogastral setae of different shape are found in several species of the genus. In their key of the genus *Lohmannia*, Balogh and Balogh (1987) state the notogastral setae of this species "without midrib" but apparently they misinterpreted the drawing of Norton et al. (1978), where the midribs of the notogastral setae are barely indicated and not specially mentioned in the text. The body size of all instars from the population in Bermuda are in the range of the population from North Carolina.

Records from Bermuda: BE 26: 2 larvae. BE 30: 2 adults, 1 tritonymph, 1 deutonymph, 2 protonymphs, 2 larvae. BE 119: 2 adults, 2 tritonymphs, 2 deutonymphs, 4 protonymphs, 1 larva. BE 124: 1 adult, 1 tritonymph, 1 protonymph, 1 larva. BE 126: 5 adults, 1 protonymph, 2 larvae. BE 282: 2 adults, 2 protonymphs. BE 285: 1 tritonymph, 1 deutonymph. BE 287: 1 adult, 2 protonymphs. BE 288: 2 protonymphs. BE 303: 1 adult. BE 310: 1 adult.

General distribution: USA, North Carolina: pine-forest floor in Durham County (Norton et al. 1978) Texas (McDaniel et al. 1979); Mexico, Quintana Roo: Sian Ka'an, lowland inundation forest, in leaf litter and soil (Vazquez 1999); first record for Bermuda.

Lohmannia jornoti Mahunka, 1985

Mahunka 1985a: 124, f. 11-15; Balogh and Balogh 1987: 334, pl. 8 A; 1988: 53, pl. 33 F; 2002a: 65; 2002b: pl. 116:12; Schatz 1993: 70, figs. 1-6.

Dimensions: adult 800 – 840 x 380 – 460 μm, deutonymph 540 x 335 μm.

Sensillus with 12 branches in adult, 10 branches in deutonymph, posterior exobothridial setae wide, size 45 x 30 μm in adult, 35 x 15 μm in deutonymph. Medial notogastral setae phylliform with serrated margins, narrow. Posterior medial genital setae setiform and ciliate.

Remarks: A direct comparison with specimens from Galapagos was possible. The specimens from Bermuda correspond to those and the original description (Mahunka 1985a) in most respects and are considered conspecific. The body size of the specimens from Bermuda is in the range of the population from Guadeloupe (length 794 – 826 μm) but considerably smaller than the population from the Galapagos Islands (930 – 1020 μm, Schatz 1993). Also the deutonymph is smaller than in specimens from Galapagos (680 – 725 x 355 – 380 μm, Schatz 1993). The species is very similar to *L. banksi* Norton et al., 1978. It differs mainly in having smaller posterior exobothridial setae, smaller and differently shaped notogastral setae, and setiform posterior medial genital setae.

Records from Bermuda: BE 124: 1 adult. BE 310: 1 adult, 1 deutonymph.

General distribution: Antilles, Guadeloupe: under shrubs near the sea (Mahunka 1985a); Ecuador, Galapagos Islands: under *Sesuvium* shrubs in the littoral zone on Santa Cruz Island, in leaf litter of a dense elfin-forest on Volcán Alcedo (Isabela Island), in fern litter and moss near a fumarole on Fernandina Island (Schatz 1993); Central America: Belize Light House Reef: Half Moon Cay, in leaf litter (Schatz 1994b: 276; Schatz 2006); Cuba Ciudad de La Habana, Santiago de las Vegas, sugar cane (*Saccharum* spp.), leaf litter and soil (Prieto and Calderón 1992); first record for Bermuda.

Lohmannia similis Balogh, 1962

Balogh 1962: 59, f. 2; Balogh and Balogh 1987: 333, pl. 4 C; 1988: 54, pl. 33 G; 2002a: 64; 2002b: pl. 116:2; Schatz 1993: 80, figs. 25-30.

Dimensions: adult (n=17) 756 (680 – 860) x 354 (325 – 380), larva (n=7) 357 (330 – 380) x 192 (170 – 210), protonymph (n=4) 456 (425 – 470) x 226 (210 – 240), deutonymph (n=11) 533 (510 – 570) x 263 (230 – 280), tritonymph (n=3) 697 (630 – 740) x 350 (340 – 360) μm.

Sensillus with 10 branches in adult and tritonymph, 8-10 branches in deutonymph, 6-8 branches in larva and protonymph. Measurement of setae: adult 42 – 60 x 18 – 25, tritonymph 40 x 21 – 22, deutonymph 30 – 40 x 15 – 20, protonymph 27 – 30 x 14 – 16, larva 10 – 22 x 5 μm. All notogastral setae slightly phylliform with serrated margins, measurements: *c1* 55 – 65, *d1* 55 – 60, *e1* 60 – 67,

f1 65 – 75 μm. Setae of ventral region as in population from the Galapagos Islands (Schatz 1993). Variation: Some adults bear 9 genital setae on one side.

Remarks: A direct comparison with specimens from Galapagos was possible. The specimens from Bermuda correspond to those and the description given in Schatz (1993) in most respects and are considered conspecific. Differences are the smaller body size in most of the population from Bermuda (Peru 830 μm, Galapagos 800-930 μm), and slightly shorter notogastral setae. The two specimens from sample BE 301 have a larger body length of 830-860 μm. Differences between *Lohmannia similis* Balogh, 1962 and the similar species *L. lanceolata* Grandjean, 1950 resp. *L. bifoliata* Willmann, 1936 are given in Schatz (1993).

Records from Bermuda: BE 59: 12 adults, 1 tritonymph, 11 deutonymphs, 3 protonymphs, 7 larvae. BE 230: 3 adults. BE 301: 2 adults, 2 tritonymphs, 1 protonymph.

General distribution: Peru: low rain forest plain in the Amazon valley near Iquitos, litter from dense forest and secondary forest (Balogh 1962); Ecuador, Galapagos Islands: numerously in the littoral zone, among algae and mangrove litter, also in litter of *Miconia* near Santa Rosa on Santa Cruz Island (Schatz 1993); first record for Bermuda.

Meristacarus porcula Grandjean, 1934

Grandjean 1934: 35, f. 7-10; Balogh and Balogh 1987: 340, pl. 22D; 1988: 56, pl. 37C; 2002a: 69; 2002b: pl. 122:9; Schatz 1994b: 278.

Dimensions: adult (n=1) 930 x 580 μm.

Surface finely punctate. Sensillus with 16-18 short branches. Transverse bands on notogaster hardly visible, but corresponding to the species-specific pattern (Grandjean 1934). Notogastral setae long, *c1* 205 μm, not reaching the lateral margin of notogaster, *c3*, *ps1* 240 μm.

Remarks: The single specimen found in Bermuda corresponds to the original description (Grandjean 1934) and to the specimens found in Galapagos and Central America (Schatz 1994b) in most respects and are considered conspecific. The body size of the Bermuda specimen is slightly smaller than the population from the Galapagos Islands (length 1020 – 1070 μm) and from Cocos Island (990 – 1065 μm). Grandjean (1934) reports a length of 950 – 1030 μm; Balogh and Balogh (1987) of 940 – 1090 μm.

Record from Bermuda: BE 310: 1 adult.

General distribution: Numerous reports from Central and South America: Panama, Guatemala, Martinique, Costa Rica: Cocos Island, Ecuador: Galapagos Islands (Schatz 1994b), Eastern Peru (Grandjean 1934, Balogh 1962); Africa: Ghana (Wallwork 1962); Philippines (Corpuz-Raros 1979). A widely distributed cirumtropical species, primarily litter inhabiting, in grasslands, plantations and secondary forests (Corpuz-Raros 1979), also in the littoral zone (Schatz 1994b); first record for Bermuda.

Nesiacarus granulatus Hammer, 1972

Hammer 1972: 14, f. 13; Balogh and Balogh 1987: 339, pl. 18 C-D; 1988: 339, pl. 19 A; 2002a: 68; 2002b: pl. 120:6; Schatz 1994b: 279.

Dimensions: adult (n=8) 501 (480 – 525) x 229 (220 – 230) μm.

Surface densely granulate. Anterior border of rostrum with a very slight incurvation. Sensillus with 10-12 branches. Notogaster with 21 pairs of notogastral setae, neotrichal setae *f′* distally to *f1* short, about same length as *f1*, other neotrichal setae in posteromarginal position long. All prodorsal and notogastral setae ciliate. Measurements of setae: *c1* 15 – 22, *c2* 15 – 25, *c3* 65 – 70, *d1* 15 – 22, *d2* 25 – 45, *d3* 75, *e1* 15 – 25, *f1* 30 – 35, *f′* 30 – 35, *h1* 45 – 50, posterior marginal setae 50 – 80 μm. Epimeral setae short and ciliate.

Juvenile instars: Larva and tritonymph encountered correspond to the adults in their species-specific characters. Dimensions: larva (n=2) 260-270 x 125-130, tritonymph (n=1) 430 x 220 μm. Colour light yellow. Surface densely granulate. Sensillus with 10 branches in larva, 12 branches in tritonymph. Cuticle of sejugal articulation wide and striated in both instars. Larva with 13 pairs of notogastral setae, anterior median setae short (10 –

20 μm) and smooth, marginal and posterior setae long (30 – 50 μm) and ciliate; tritonymph with 21 pairs of notogastral setae as in adult. Transverse bands well developed in both instars. Ventral region: Subcapitulum with 3 pairs of setae in larva, 4 pairs in tritonymph. Epimeral setal formula 3-1-2 in larva, 3-1-3-4 in tritonymph. Larva with Claparede organ between coxae I and II. Larval pseudanal plate with 3 pairs of short and smooth setae, tritonymph with 8 pairs of genital setae, 2 pairs of anal and 4 pairs of adanal setae, genital and anal setae as in adult.

Remarks: The specimens found in Bermuda correspond to the original description (Hammer 1972) and to the specimens found in Central America (Schatz 1994b) in most respects and are considered conspecific. The body size of the population from Bermuda is slightly smaller, but in the range of the populations from Tahiti and Central America.

Records from Bermuda: BE 26: 1 adult, 1 tritonymph. BE 117: 1 adult. BE 119: 4 adults, 2 larvae. BE 299: 2 adults.

General distribution: Tahiti, along the coast in *Cyperus* vegetation beneath a hedge (Hammer 1972); Japan, leaf litter from an evergreen broad-leaved forest on a seaside hill near the southern end of Kasado-jima Island (Wada 1987), Ryukyu Islands (Aoki 2009); Central America: Belize and Guatemala: in moist, decayed leaf litter under dense tree and bush vegetation as well as in hardwood tropical rain forest (Schatz 1994b, 2006); first record for Bermuda.

Papillacarus incompletus (Mahunka, 1985)

Vepracarus incompletus: Mahunka 1985b: 126, figs. 6-11; Balogh and Balogh 1987; 336, pl. 13 A; 1988, 54: pl. 34 A-D; 2002a: 66; 2002b: pl. 118:5.

Dimensions: adult (n=2) 365 – 370 x 160 μm. Colour light brown.

The specimens found in Bermuda were identified by comparison with the type specimens of this species. The populations of this species from St. Lucia, Antilles, and Bermuda are conspecific. The suture between the anal and adanal plates is undoubtedly complete, but weakly developed in the posterior part.

Papillacarus incompletus is similar to *P. hirsutus* (Aoki, 1961), which also has a spiculate secretion, setae with long cilia and strong neotrichy on the posterior part of the notogaster. The main differences between species are in the number of branches on sensilli (*P. incompletus*: 15 – 20, *P. hirsutus*: 13 – 14), the length of the notogastral setae, (*P. incompletus*: notogastral setae of different lengths, posterior marginal setae longer, *P. hirsutus*: all notogastral setae short), the epimeral setal formula (*P. incompletus*: 9-4-3-4, *P. hirsutus*: 7-4-3-4), and length of adanal setae (*P. incompletus*: long, *P. hirsutus*: short).

A synonymy of *Vepracarus* with *Papillacarus* is supposed by Lee (1985) which is accepted by Colloff and Halliday (1998) and Subías (2004). Balogh and Balogh (1987) separate the two taxa by number and shape of the posterior notogastral setae: *Papillacarus* species have less (8-17) neotrichal setae, setiform and ciliate, *Vepracarus* species bear more (20-50) neotrichal setae on the pygidium, with penicillate or arboriform shape.

Record from Bermuda: BE 184: 2 adults.

General distribution: St. Lucia, Lesser Antilles, at Castries, Vigie Point, in litter of a rocky forest, and in litter accumulated in rock crevices (Mahunka 1985b); Mexico, Quintana Roo: Sian Ka'an, lowland inundation forest, in leaf litter, moss and epiphytes (Vazquez 1999); Cuba, Prov. Habana, Nina Boñita, in soils of livestock farming (Palacios-Vargas and Socarras 1993, Socarras and Palacios-Vargas 1999); first record for Bermuda.

Papillacarus spinosus Bischoff de Alzuet, 1972

Bischoff de Alzuet 1972: 188, figs. 1-9; Balogh and Balogh 1987: 335, pl. 10 D; 1988: 54, pl. 34. *Pillacarus spinosus* (lapsus linguae): Balogh and Balogh 2002a: 65; 2002b: pl. 117:7-8.

Dimensions: adult (n=3) 535 (525-550) x 255 (250-260), deutonymph (n=2) 370-390 x 180-195 μm.

Colour light to medium brown in adult, yellowish white in deutonymph. Cuticula with a barely visible polygonale pattern, covered with small spines in both instars. Sensillus with 14-16 branches in adult, 14 branches in deutonymph.

Transverse bands hardly visible but present. Posterior concavity on notogaster weakly developed. Notogastral setae ciliate, measurements: *c1* 25 – 28, *c2* 35 – 40, *c3* 68 – 72 μm in adult, *c1* 20, *c2* 20, *c3* 36 μm in deutonymph. Eight pairs of neotrichal setae in adult and deutonymph. Posterior marginal setae of deutonymph curved with comparatively long cilia. Subcapitulum with 6 pairs of setae in adult, 5 pairs in deutonymph. Epimeral setal formula 8-4-3-4 in adult, 5-2-3-3 in deutonymph. Row *a* and the lateral setae of epimere I smooth, others ciliate.

Remarks: The specimens found in Bermuda correspond to the original description (Bischoff de Alzuet 1972) in most respects and are considered conspecific. A difference is the smaller body size of the adult specimens in Bermuda (614 x 305 μm in the specimen from Argentina).

Records from Bermuda: BE 26: 2 adults, 1 deutonymph. BE 119: 1 adult, 1 deutonymph.

General distribution: Argentina, Entre Rios (Bischoff de Alzuet 1972), ecological conditions not mentioned; Mexico, Quintana Roo: Sian Ka'an, lowland inundation forest, in leaf litter and soil (Vazquez 1999); first record for Bermuda.

Torpacarus omittens omittens Grandjean, 1950

Torpacarus omittens Grandjean 1950: 126, f. 4-5; Balogh 1961: 30, f. 37-38; Wallwork 1962: 486; Bischoff de Alzuet 1971: 101. *T. omittens omittens*: Balogh and Mahunka 1981: 56; Balogh and Balogh 1987: 343, pl. 26 C-D; 1988: 58, pl. 39 A-B; 2002a: 71; 2002b: pl. 124: 10-11; Schatz 1994a: 171.

Dimensions (values for each specimen given in table 1): adult (n=7) 601 (560 – 660) x 278 (255 – 310), deutonymph (n=2) 420 – 425 x 200 – 205, tritonymph (n=3) 515 (490 – 550) x 253 (230 – 280) μm.

Sensillus with 10-14 branches in adult, 10 branches in deuto- and tritonymph. Transverse lines *mt*, *nt*, *pt* on notogaster in most specimens present although very weakly developed, but in some specimens absent. Measurements of notogastral setae in adult: *c1*, *d1*, *e1* 10 – 17 μm, *c2* 44 – 90 μm, *d2* 70 – 80 μm, *f1* thickened, 65 – 100 μm, lateral and posteromarginal setae 90 – 120 μm. Setae *c1* and *d1* smooth, *p1* bilaterally ciliate, other dorsal setae unilaterally ciliate. Length ratio of notogastral setae in deuto- and tritonymph as in adult. Juvenile instars with some transverse rows of foveolae on notogaster. Inner epimeral setae smooth, shorter than the outer rows. Solenidion ω_1 on tarsus I with a distinct dilation distally and frequently with one weaker dilation basally.

Remarks: The specimens found on Bermuda correspond to the original description (Grandjean 1950) in most respects and are considered conspecific. Balogh and Mahunka (1981) have described a subspecies from Paraguay, *T. omittens paraguayensis* (length 570-595 μm), Schatz (1994a) described another subspecies from the Galapagos Islands, *T. omittens galapagensis* (length 620-660 μm). The separation of both subspecies is based on different combinations of morphological characters (see Schatz 1994a). Some characters show a wide variability among the population on Bermuda (table 1):

1. Body size: Most specimens in Bermuda differ from the original description in having smaller body size (560 – 580 μm) which correspond with a specimen from Ghana, West Africa (570 μm, Wallwork 1962). Grandjean (1950) gives a body length of 600 – 650 μm for the type population from Venezuela. Schatz (1994a) recorded a single individual from an island off the Belizean coast with a length of 680 μm. The specimens of sample BE 308 are distinctly larger (length of adult 650 – 660 μm, tritonymph 550 μm) than the rest of the Bermudan population, and the adults correspond in that respect with the type population.

2. Sensillus: The number of branches on sensillus is variable: 9 in specimens from Venezuela, 10-14 in specimens from Bermuda; 15-16 in other described subspecies.

3. Transverse lines on notogaster: Among the described subspecies this character is present only in *T. omittens omittens*. In most specimens from Bermuda the transverse lines are present but very weakly developed; in some specimens the lines are invisible.

TABLE 1: Morphological features of *Torpacarus omittens* specimens from the Bermuda Islands. Measurements in μm.

Sample number	BE 184	BE 184	BE 184	BE 184	BE 225	BE 225
Instar	Adult	Tritonymph	Deutonymph	Deutonymph	Adult	Adult
Body size	580 x 265	505 x 230	425 x 205	420 x 200	580 x 275	580 x 265
Sensillus branches	10-12	10	10	10	12	14
Transverse lines	present	present, very weak	present, very weak	present	absent	present
Length c1/d1/e1	14/12/14	14/12/12	9-12/10/9	11/11/11	15/14/11	13/12/10
Length c2 / c3	50/110	40/70	30/61	25/55	50-55/90	55/95
Size ratio c2/c3	1/2	<1/2	1/2	1/2	1/2	1/2
Length f1	65	65	50	45	75	75
Inner epimeral setae 1a-4a	long, smooth	long, smooth	long, smooth	long, smooth	long, smooth	long, smooth
Dilations on solenidion w_1 Tarsus I	1 distinct dilation	1 distinct, 1 very weak dilation	1 distinct dilation	1 distinct, 1 very weak dilation	1 distinct dilation	1 distinct dilation

Sample number	BE 225	BE 288	BE 288	BE 308	BE 308	BE 308
Instar	Tritonymph	Adult	Adult	Adult	Adult	Tritonymph
Body size	490 x 250	600 x 290	560 x 255	660 x 285	650 x 310	550 x 280
Sensillus branches	10	12	10-12	12	12	10
Transverse lines	present, weak	present	absent	present, very weak	present, very weak	present, very weak
Length c1/d1/e1	15/13/13	15/15/12	14/15/12	12/12/15	16/16/17	17/13/15
Length c2 / c3	44/75-83	45-65/85	45/87	90/110	85/95	80-90/100
Ratio c2/c3	1/2	<1/2	1/2	almost 1/1	almost 1/1	almost 1/1
Length f1	75	75	77	95	100	90
Inner epimeral setae 1a-4a	long, smooth	long, smooth	long, 1a ciliate, 2-4 smooth	long, smooth	long, smooth	long, smooth
Dilations on solenidion w_1 Tarsus I	1 distinct dilation	1 distinct, 1 weak dilation	1 distinct dilation	1 weak dilation	1 very weak dilation	1 weak, 1 very weak dilation

4. Length of notogastral setae: The size ratio of *c2* : *c3* is about 1 : 2 in most Bermudan specimens, as is usual in *T. omittens omittens*, but in specimens of sample BE 308 the setae *c2* are very long, causing a ratio of almost 1 : 1 (in adult and tritonymph). In the other described subspecies the setae *c2* are maximally half as long as setae *c3*. The setae *f1* are long in all Bermudan specimens as is usual in *T. omittens omittens* and *T. omittens paraguayensis*.

5. Shape of inner epimeral setae: The epimeral setae of the median row (*1a, 2a, 3a, 4a*) are long and smooth in most Bermudan specimens as is usual in *T. omittens omittens*, but in one adult of sample BE 288 setae *1a* are long and ciliate. In the other described subspecies these epimeral setae are long and ciliate in *T. omittens paraguayensis* resp. short and smooth in *T. omittens galapagensis*.

6. The solenidion *ω1* on tarsus I has a distinct dilation distally in all populations of *T. omittens omittens* investigated in this respect, but one additional weaker basal dilation in most specimens in the population on Bermuda. The other described subspecies have 2 weaker dilations each.

These differences do not justify the separation of the population or part of the population of *T. omittens omittens* on Bermuda as a separate taxon. However, the variability of characters in different populations of this widespread species might be explained by isolation and the parthenogenetic reproduction mode of the Lohmanniidae (Norton and Palmer 1991).

Records from Bermuda: BE 184: 1 adult, 1 tritonymph, 2 deutonymphs. BE 225: 2 adults, 1 tritonymph. BE 288: 2 adults. BE 308: 2 adults, 1 tritonymph.

General distribution: In several places around the Caribbean Sea (Mexico, Belize, Panama, Cuba, Guadeloupe, St. Lucia, Venezuela) as well as in West Africa (detailed records listed in Grandjean 1950, Wallwork 1962, Mahunka 1985a, 1985b, Schatz 1994a, 2006, Starý 1998, Prieto and Schatz 2004, Subías *et al.* 2004); first record for Bermuda. Balogh (1962) and Bischoff de Alzuet (1971) recorded *T. omittens* also from Peru and Argentine. It is uncertain whether these individuals belong to *T. omittens paraguayensis* Balogh et Mahunka, 1981 or to *T. omittens omittens* Grandjean, 1950 (Schatz 1994a).

Ecological Notes

The Bermuda Islands are predominantly low without much ecological diversity. Most Lohmanniidae species occur in different rather terrestrial habitats, in sandy soils and leaf litter (*Lohmannia jornoti*, *Meristacarus porcula*, *Nesiacarus granulatus*, *Papillacarus incompletus*, *P. spinosus*, *Torpacarus omittens omittens*). *Lohmannia banksi* was the most frequent species on the islands (11 samples, 15 adults and 31 juvenile instars) in a wide range of habitats, from terrestrial locations in the interior with leaf litter and sandy soils to the edges of brackish and salty pools and the salt-drenched supralittoral zone. *Haplacarus foliatus* (2 samples, 5 juvenile instars) and *Lohmannia similis* (3 samples, 17 adults and 25 juvenile instars) were mainly found in sandy or muddy samples from the supralittoral zone.

Some Lohmannidae species (adults and juveniles) colonize the salt-spray area of the supralittoral zone and were even found in lower regions of the littoral zone, mainly in leaf litter near *Avicennia* mangroves (*Haplacarus foliatus*, *Lohmannia similis*). On the Galapagos Islands a total of 13 Lohmanniidae species was found (Schatz 1998, Schatz unpublished data), among them six species prevailing in the littoral zone, mainly in leaf litter under mangroves (including *Lohmannia similis* and *Meristacarus porcula*). Some of those species were even collected from the sea surface between the islands, washed from the shore (Peck 1994). But despite those findings in the border area between land and sea Lohmanniidae cannnot be considered to be exclusively thalassobiotic. Several members of the family seem to have a certain tolerance towards saline conditions, but as yet no species was found spending its whole life cycle in periodically inundated littoral zones. Furthermore Lohmanniidae

species seem to avoid the littoral zone of rocky coasts. It is possible that their occurrence in saline conditions within the littoral zone is linked to the leaf litter of mangroves (Schuster, unpublished data of studies in Central and South America).

Zoogeographical Remarks

Previous to this study no single Lohmanniid species was recorded from the Bermuda Islands. All species except *Haplacarus foliatus* were previously known from North, Central or South America: (North America, North Carolina: *Lohmannia banksi*. Central America: *L. banksi*, *L. jornoti*, *Meristacarus porcula*, *Nesiacarus granulatus*, *Papillacarus incompletus*, *P. spinosus*, T*orpacarus omittens omittens*. South America: *Lohmannia similis*, *Meristacarus porcula*, *Papillacarus spinosus*). Since the Bermuda Islands are situated in the Gulf Stream a hydrochorous dispersal from Central America can be assumed for most species, but also a zoochorous (by migrating birds and their nesting material) and anthropochorous dispersal with plant material seems possible.

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