Gastrotrichs in bromeliads – newly recorded *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (Chaetonotida) from the Łódź Palm House

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ABSTRACT
Chaetonotus (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 was found during a study of fauna in water micro-reservoirs with bromeliads exhibited at the Łódź Palm House (Poland). This freshwater gastrotrich species was previously known only from the *locus typicus* in central Amazonia (Brazil). This observation constitutes the first finding of gastrotrichs in water microreservoirs formed in the axils of Bromeliaceae in artificial habitats such as greenhouses. It also raises the number of freshwater gastrotrichs found in palm houses to 19, and the number of nominal species known from Poland to 100. Newly recorded species correspond to the original descriptions but differ in some characters. Taxonomic, morphometric and biogeographic remarks are provided for the species together with microphotographs and drawing figures.

KEY WORDS
Bromeliaceae,
Chaetonotidae,
Gastrotricha,
greenhouse,
new record.

RÉSUMÉ
Des gastrotriches dans des broméliacées – nouvelle signalisation de Chaetonotus *(*Hystricochaetonotus*)* furcatus *Kisielewski, 1991 (Chaetonotida) dans les serres de Łódź.*
L'espèce *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 a été découverte au cours de recherches sur la faune vivant dans les microréservoirs d'eau de broméliacées exposées dans la serre tropicale de Łódź (Pologne). Cette espèce d'eau douce n'était connue jusqu'à présent que de la localité type, en Amazonie centrale (Brésil). Il s'agit de la première mention d'un gastrotriche dans les microréservoirs d'eau formés à l'aisselle des feuilles de Bromeliaceae dans un environnement artificiel, comme une serre tropicale. Cette découverte porte à 19 le nombre d'espèces d'eau douce de gastrotriches vivant dans des serres, et à 100 le nombre d'espèces nominales connues de Pologne. Les espèces nouvellement trouvées correspondant aux descriptions originales, mais en diffèrent par quelques caractères. Des remarques taxonomiques, morphométriques et biogéographiques sont proposées pour les espèces, ainsi que des microphotographies et des schémas.

MOTS CLÉS
Broméliacées,
Chaetonotidae,
gastrotriche,
serre,
signalisation nouvelle.

INTRODUCTION

Gastrotrichs are small, free-living invertebrates which varies from 50 to 3500 µm (Kisielewski 1997). They inhabit all types of aquatic (fresh, brackish and marine waters) and semi-terrestrial ecosystems (e.g., peat bogs, sedge swamps, alder forests) around the world (Kisielewski 1981, 1997; Balsamo *et al.* 2008, 2014; Kieneke & Schmidt-Rhaesa 2015). Gastrotricha constitute a significant component of benthic, psammic and epiphytic communities (e.g., Nesteruk 1996, 2004; Balsamo & Todaro 2002; Balsamo *et al.* 2008, 2014). Currently, there are approximately 820 known species of Gastrotricha belonging to two orders: Chaetonotida Remane, 1925 [Rao & Clausen, 1970] and Macrodasyida Remane, 1925 [Rao & Clausen, 1970] (Balsamo *et al.* 2009; Hummon & Todaro 2010; Todaro 2014; Kieneke & Schmidt-Rhaesa 2015).

The Bromeliaceae is a family of monocotyledon flowering plants naturally occurring primarily in the Neotropical region and comprising more than 2500 species (Frank *et al.* 2004). Many species of bromeliads have a complex structure of leaves that are spirally arranged in the shape of rosettes which form cavities retaining water and detritus. Such water micro-reservoirs, including those formed in the axils of Bromeliaceae, were termed "phytotelmata" by Varga (1928). Through rainwater retention, phytotelmata form small lentic and often ephemeral habitats for many groups of organisms. They provide a suitable environment for numerous protozoans, invertebrates and even vertebrates (Janetzky *et al.* 1996; Lopez *et al.* 1999; Mogi 2004; Frank *et al.* 2004; Palacios-Vargas *et al.* 2012; Wilches-Álvares *et al.* 2013; Durán-Ramírez *et al.* 2015). Despite the relatively large number of studies on Bromeliaceae fauna in natural habitats, knowledge about them is still very limited. In addition, in bromeliad microreservoirs gastrotrichs were found only once so far.

Palm houses and greenhouses are common in many European cities. They are usually grand, historical buildings with expositions of many exotic plant species which were often imported from their natural habitats. Along with the plants, seeds, soil, litter and other elements of the exhibition, numerous invertebrate taxa, both native European and alien species, are introduced to these palm houses in a random and uncontrolled manner. Thanks to the relatively high temperature and humidity that are maintained at a constant level, the greenhouses are a convenient place for the formation of stable populations of numerous invertebrate species that live for many years. Because of this, palm houses are often considered to be "tropical islands" in a temperate climate (Zawierucha *et al.* 2013). Gastrotricha fauna have only been studied in two greenhouses so far, i.e. at the Poznań Palm House (Poland) and at the Copenhagen Palm House (Denmark) (Kolicka *et al.* 2013; Kolicka 2014). In addition to this poor state of knowledge on Gastrotricha in palm houses in general and the lack of gastrotrich findings in phytotelmata from artificial habitats, another reason for conducting a study at the Palm House of the Botanical Garden in Łódź was the scarcity of data on fauna in this building. So far only a single study on oribatid mites has been carried out in this greenhouse (Niedbała 2014).

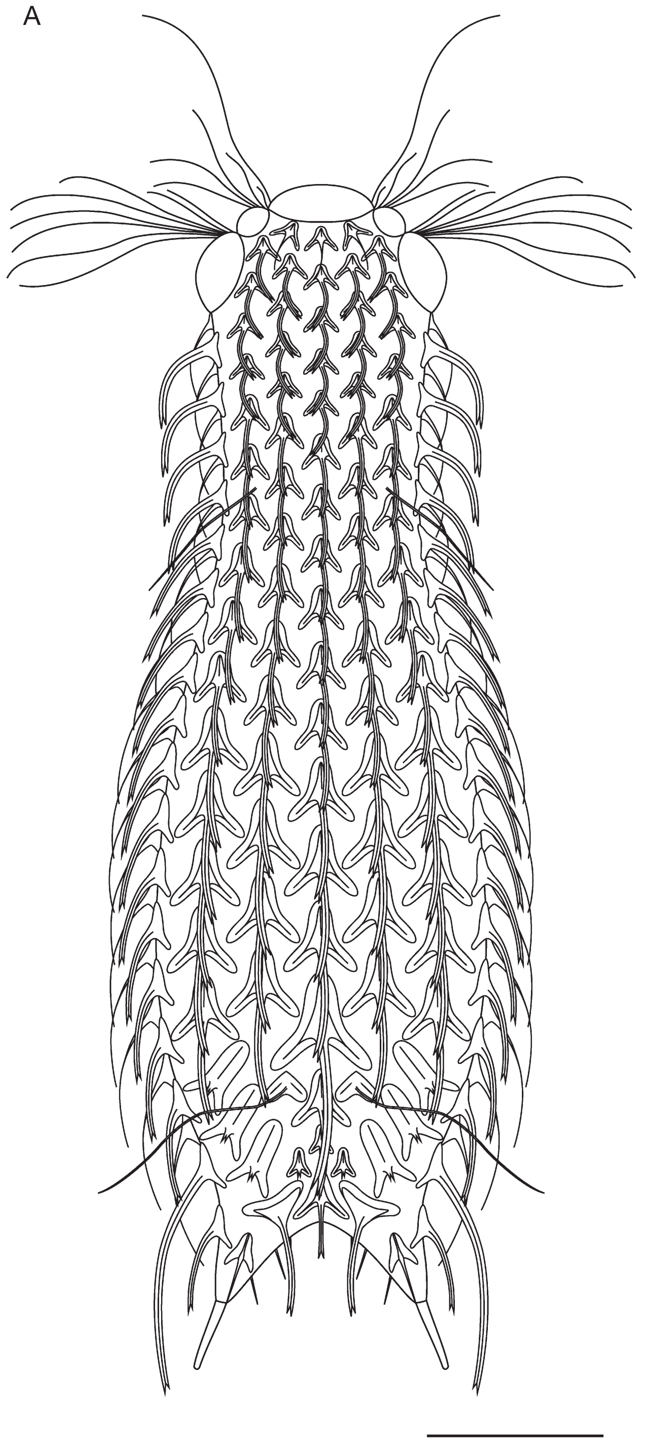

Fig. 1A. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (schematic drawings): dorsal view. Scale bar: 20 µm.

MATERIAL AND METHODS

Study site

The sampling took place at the Palm House of the Botanical Garden in Łódź (51°45'37"N, 19°28'48"E). The present building of the Łódź Palm House was opened in 2003, however, its history dates back to 1925, when it was the

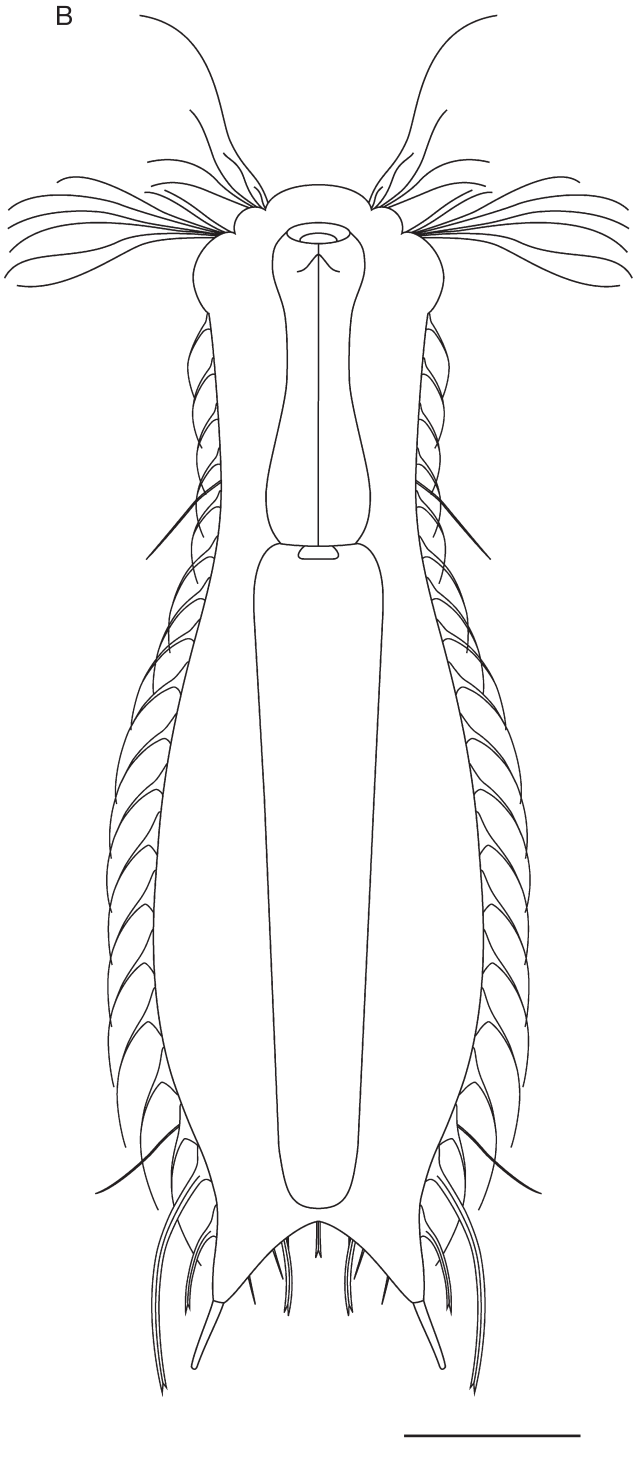

FIG. 1B. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (schematic drawings): view of internal morphology. Scale bar: 20 μm.

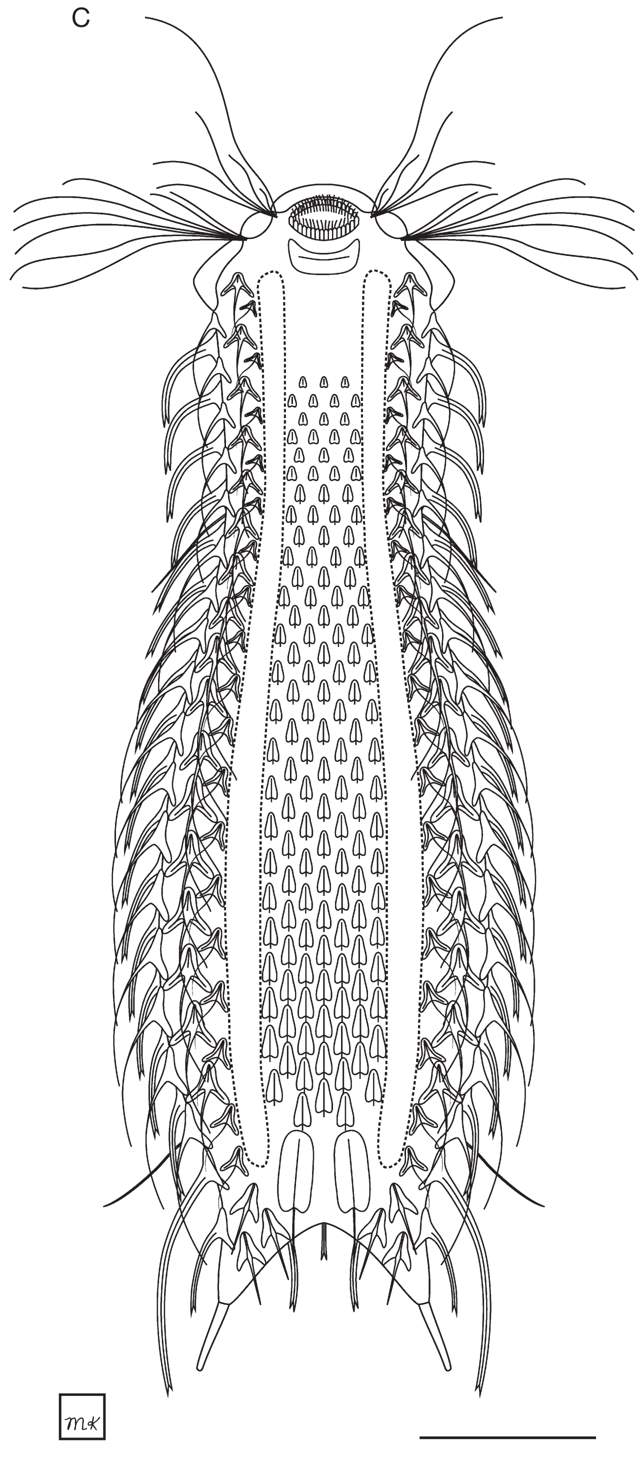

FIG. 1C. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (schematic drawings): ventral view. Scale bar: 20 μm.

first building to house a collection of ornamental plants. Over the years the palm house underwent numerous extensive modernisation and reconstruction works. Currently it has a surface of 1100 m^2 and consists of three pavilions and a plant raising room. The pavilions are dedicated to plants with different growing requirements: Pavilion 1: Mediterranean forests, woodlands and scrubs; Pavilion 2: Equatorial climate vegetation; and Pavilion 3: Desert and semi-desert vegetation. Many of the plants exhibited in the collection today came to Łódź probably in the second half of the 19th century as the decoration of orangeries that were in the possession of tsarist officials and factory owners. Due to a series of political and economic changes connected with the First and Second World Wars, many private collections of tropical plants were closed and transferred to city greenhouses. It is very difficult to investigate the place of origin and date in which particular plants were brought, thus one can only conclude that some of them probably came from natural habitats. Currently, the Łódź Palm House collection is continuously enriched with plant specimens from floral wholesalers, exchanges between palm houses and greenhouses in Poland and other parts of Europe as well as with their own cultivation.

Methods

Samples of water and sediments were taken three times (15.XII.2012, 30.IV.2013, 12.VI.2013) from water micro-reservoirs formed in the axils of Bromeliaceae at the Łódź Palm House (Pavilion 2 and the plant raising room). Due to the very small amount of water and sediment or their lack in individual whorls of individual plants, the material was combined with that from all plants in one position. A position included plants within a circle about 0.5-1.0 metres in diameter. A total of 29 samples were gathered during the sampling sessions. The material was collected using Pasteur pipettes and then transported to the laboratory and analysed intravitally for Gastrotricha within *c.* 72 hours.

The material was poured into petri dishes and scanned for gastrotrichs with an Olympus SZ51 stereo microscope. All gastrotrichs were extracted with a micropipette and studied alive. All specimens were viewed with an Olympus BX41 microscope equipped with phase contrast optics. During the observation the animals were photographed with an Array Artcam 300 MI digital camera and then measured with QuickPhoto Camera software.

Detailed measurements were provided for documented specimens. Morphological characters were measured only if their orientations were suitable. The measurements are given in micrometres (μm) and expressed in ranges and the indices are expressed in percentages.

The description of the recorded species follows the convention of Hummon *et al.* (1992), in which positions of certain morphological characters are given in percentage units (U) of the total body length measured from the anterior to the posterior end (the distal end of the furca). The identification of gastrotrichs, morphological study and naming of characters, formulae and indices as used in the present study follow Kisielewski (1991, 1997).

RESULTS

Gastrotrichs were only found from the first sampling in one position from Pavilion 2 at the Łódź Palm House. In the recorded material, 14 specimens belonging to *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 were found. The observed individuals of this species had a very delicate body that deformed and burst easily. The spines were also extremely prone to breaks and deformations, despite their apparent thickness and massiveness.

TAXONOMIC ACCOUNT

Phylum GASTROTRICHA Mečnikow, 1865
Order CHAETONOTIDA Remane, 1925
[Rao & Clausen, 1970]
Suborder PAUCITUBULATINA d'Hondt, 1971
Family Chaetonotidae Gosse, 1864
(*sensu* Leasi & Todaro 2008)
Subfamily Chaetonotinae Gosse, 1864
(*sensu* Kisielewski 1991)

Genus *Chaetonotus* Ehrenberg, 1830

Typus generis. — *Chaetonotus* (*Chaetonotus*) *larus* (Müller, 1773).

Terra typica. — Denmark.

Subgenus *Hystricochaetonotus* Schwank, 1990

Type species. — *Chaetonotus* (*Hystricochaetonotus*) *hystrix* Mečnikow, 1865.

Terra typica. — Russia.

Remarks

A polyphyletic subgenus in terms of molecular data (e.g., Kånneby *et al.* 2013); it encompasses 28 nominal freshwater species and 10 marine species (Balsamo *et al.* 2009; Todaro 2015). Present in benthic and periphytic habitats (Kisielewski 1997).

Chaetonotus* (*Hystricochaetonotus*) *furcatus
Kisielewski, 1991
(Figs 1-11; Table 1)

Chaetonotus (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991: 32-35; figs 35-39; table 11.

Locus typicus. — Juréia Reserve, Amazonia. Water micro-reservoirs of Bromeliaceae.

Location of the examined material. — Łódź Palm House (51°45'37"N, 19°28'48"E), Pavilion 2.

Material examined. — 14 specimens (12 adults and 2 juveniles), 13 photographed. The micro-photographs are available at Muséum national d'Histoire naturelle in Paris and the Natural History Collections at Adam Mickiewicz University in Poznań under accession number NHC-GCHF-12-1-20 and in the author's collection.

Diagnosis. — Body length from 123.9 to 138.0 μm. Stocky body. Relatively short adhesive tubes, becoming slightly thinner towards the end. Clearly five-lobed head. The cephalion and pleuria visible in the head outline. Ocellar granules absent. Hypostomium small and kidney-shaped. A weak cuticular reinforcement inside the pharynx anterior dilatation (two thin, unconnected bars). All scales on dorsal, dorsolateral, lateral, ventrolateral and ventral body sides clearly three-lobed with a very strong, heavily vaulted, high keel. The scales form 15-17 single longitudinal rows of 18-19 scales each. Six types of spines arise out from the scales: 1) slightly curved, thick spines that taper towards a hair-like end (head spines arising from the first scales in each dorsal longitudinal row); 2) long, heavily curved spines

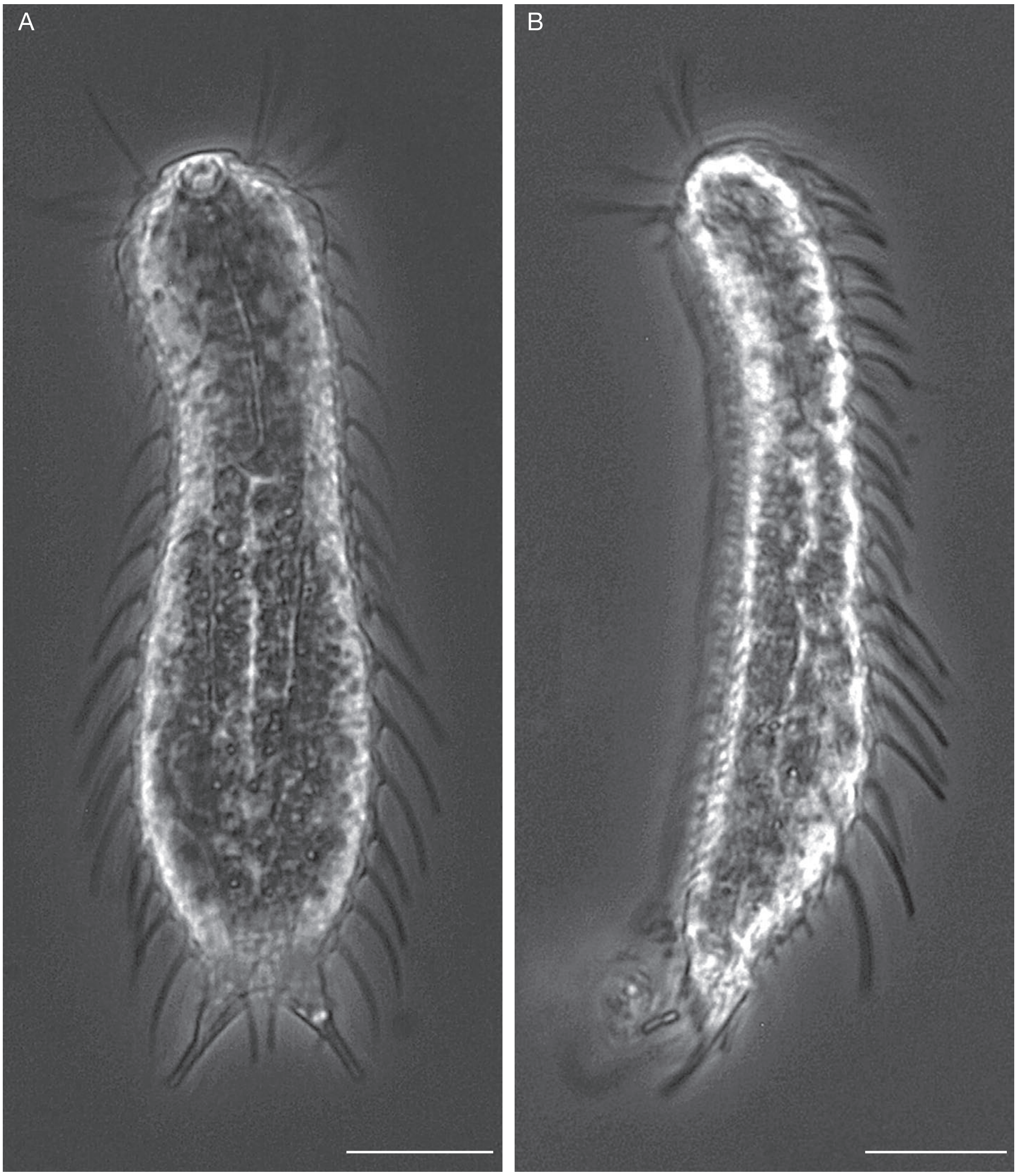

FIG. 2. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (phase contrast microphotographs): **A**, habitus; **B**, lateral view. Scale bars: 20 μm.

with a bifurcated end (head spines arising from scales on the dorsal and dorsolateral body region); 3) long, slightly curved spines with a bifurcated end (neck and trunk spines arising from scales on the dorsal and dorsolateral body region (except for the posterior part of the trunk); 4) short spines with a bifurcated end that extend over the posterior end of the scales (posterior trunk region spines arising from dorsal scales); 5) short spines with a bifurcated end that do not extend over the posterior edge of the scale (posterior trunk region spines arising from dorsal scales); and 6) thin, non-bifurcated, hair-like spines (head, neck and trunk spines arising from lateral, ventrolateral and ventral scales). Ventral interciliary field covered with scales from about the end of the anterior pharynx dilatation (*c.* U13). Ventral interciliary field terminal scales large, oval, with a shallow indentation at the posterior end and with thin spines.

EMENDED DESCRIPTION

Body stocky. Head five-lobed, the cephalion and pleuria visible in the body outline. Cephalion narrow (see Table 1) with a free posterior edge. Epipleuria located at U5-U8 and *c.* two times smaller than the hypopleuria located at U8-U16. Both pairs of pleuria asymmetrical-dorsal parts of epipleuria and hypopleuria with heavily convex, rounded edges and extending visibly beyond the head outline; ventral part of the pleuria extending slightly beyond head outline and straight with angular, sharp edges (Figs 1, 3). Indentations between pleuria present, thus giving the head a five-lobed appearance. Two pairs of cephalic ciliary tufts located between the cephalion and the epipleuria at U5 as well as

Table 1. — Morphometric parameters for *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991. Abbreviations: **N**, number of specimens; **SD**, standard deviation; **M**, mean value.

Character	N	Ranges on adult specimens	SD	M	N	Ranges on juvenile specimens	SD	M
Body length	7	123.9-138.0	4.85	130.86	2	110.0-114.6	3.25	112.3
Pharynx length	7	34.9-38.9	1.37	37.70	2	37.4-39.5	0.78	38.45
Width of anterior pharynx thickening (a)	5	9.7-11.9	0.84	11.00	2	10.0-11.1	0.78	10.55
Width of pharynx narrowing that follows anterior thickening (n)	5	8.7-10.3	0.67	9.50	2	7.9-10.1	1.56	9.00
Width of pharynx at its middle length (m)	5	6.7-8.6	0.78	7.84	2	6.5-8.0	1.06	7.25
Width of posterior pharynx thickening (p)	5	11.4-13.5	0.79	12.48	2	12.3-13.5	0.85	12.90
Length of cephalic cilia in anterior tuft	7	(3.8-5.6)-(24.2-30.4)	0.56; 2.19	4.81; 26.37	2	(3.4-4.8)-(25.5-26.3)	0.99; 0.57	4.10; 25.90
Length of cephalic cilia in posterior tuft	7	(10.8-13.6)-(20.3-25.2)	1.00; 0.86	12.57; 21.19	2	(8.5-12.8)-(19.8-20.8)	3.04; 0.71	10.65; 20.30
Hypostomium length	7	3.1-3.6	0.16	3.40	2	2.9-3.6	0.49	3.25
Hypostomium width	7	8.1-9.9	0.59	9.00	2	7.9-8.3	0.28	8.10
Cephalion length	8	3.8-4.4	0.25	4.10	2	3.5-3.7	0.14	3.60
Cephalion width	7	12.4-13.7	0.43	13.13	2	12.9-13.1	0.14	13.00
Diameter of mouth ring	8	6.9-7.4	0.22	7.11	2	7.0-7.5	0.35	7.25
Furca length	9	18.4-21.1	0.88	19.29	2	19.3-19.5	0.14	19.40
Length of adhesive tube	9	7.2-8.6	0.41	7.93	2	8.4-8.6	0.14	8.50
Neck spine length	8	(7.9-11.4)-(10.5-13.8)	1.08; 1.04	10.10; 12.54	2	(10.2-10.3)-(12.7-13.1)	0.07; 0.28	10.25; 12.90
Lateral neck spine length	7	(9.7-12.0)-(16.0-17.9)	0.73; 0.61	11.20; 17.07	2	(10.9-11.4)-(16.7-17.4)	0.35; 0.49	11.15; 17.05
Dorsal trunk spine length – the normal length spine	8	(8.1-10.6)-(18.9-22.6)	0.81; 1.12	9.46; 20.28	2	(8.6-9.9)-(17.2-18.9)	0.92; 1.20	9.25; 18.05
Lateral trunk spine length	7	(13.4-14.9)-(18.7-22.8)	0.52; 1.52	14.04; 19.90	2	(13.2-13.5)-(17.6-18.8)	0.21; 0.85	13.35; 18.20
Dorsal trunk spine length – the first alternating row with shortened spine	8	3.4-4.4	0.29	3.99	2	3.7-4.1	0.28	3.90
Dorsal trunk spine length – the consecutive alternating row with shortened spine	7	(1.7-2.3)-(3.0-4.8)	0.22; 0.57	2.10; 3.63	2	(2.0-2.1)-(3.2-3.3)	0.07	2.05; 3.25
Dorsal trunk spine length – the central pair	7	10.5-11.9	0.47	11.40	2	11.2	0.00	11.20
Dorsal trunk spine length – the central odd	7	3.8-4.7	0.30	4.26	2	3.9-4.3	0.28	4.10
Parafurcal spines length	7	8.7-9.6	0.42	9.01	2	8.2-9.3	0.07	8.75
Spine scale of interciliary field length	5	(0.2-0.5)-(1.8-3.0)	0.12; 0.45	0.37; 0.37	1	0.3-2.3	–	0.30; 2.30
Spine terminal scale of interciliary field length – the central pair	7	5.2-7.1	0.65	5.90	2	5.2-5.3	0.07	5.25
Neck scales length	7	(4.3-5.3)-(5.4-7.0)	0.34; 0.59	4.84; 6.59	2	(4.3-4.7)-(61-6.8)	0.28; 0.49	4.50; 6.45
Neck scales width	7	(4.6-5.5)-(5.2-6.8)	0.38; 0.53	5.10; 6.11	2	(4.6-5.0)-(6.1-6.8)	0.28; 0.42	4.80; 6.10
Trunk scales length	7	(6.0-7.5)-(8.6-10.1)	0.57; 0.46	7.07; 9.27	2	(6.1-7.1)-(8.5-9.1)	0.71; 0.42	6.60; 8.80
Trunk scales width	7	(5.3-6.9)-(8.1-9.8)	0.49; 0.51	6.21; 8.81	2	(5.2-6.2)-(7.7-8.5)	0.71; 0.57	5.70; 8.10
Dorsal trunk scale length – the first alternating row with shortened spine	7	7.2-8.2	0.40	7.671428571	2	6.8-7.6	0.57	7.20
Dorsal trunk scale width – the first alternating row with shortened spine	7	6.0-6.8	0.33	6.40	2	5.2-6.6	0.99	5.90
Dorsal trunk spine length – the first alternating row with shortened spine	5	(2.2-2.9)-(4.4-4.8)	0.31; 0.17	2.58; 4.66	2	(2.1-2.3)-(3.5-4.5)	0.14; 0.71	2.20; 4.00
Dorsal trunk spine length – the consecutive alternating row with shortened spine	5	(2.0-2.4)-(3.1-4.2)	0.20; 0.40	2.30; 3.68	2	(1.9-2.1)-(2.7-3.7)	0.08; 0.71	2.00; 3.20
Length of posterior trunk dorsal scales	7	(6.6-7.8)-(6.9-8.3)	0.41; 0.48	2.30; 3.68	2	(6.2-7.0)-(6.4-7.2)	0.57	2.00; 3.20
Width of posterior trunk dorsal scales	6	(3.8-4.6)-(4.0-5.2)	0.29; 0.41	4.03; 4.40	2	(3.2-3.8)-(3.4-4.2)	0.42-0.57	3.50; 3.80
Dorsal trunk scale on furca base length – the central pair	7	5.4-6.9	0.51	6.33	2	5.4-6.5	0.78	5.95
Dorsal trunk scale on the furca base width – the central pair	6	5.3-7.0	0.64	6.13	2	5.6-6.7	0.78	6.15

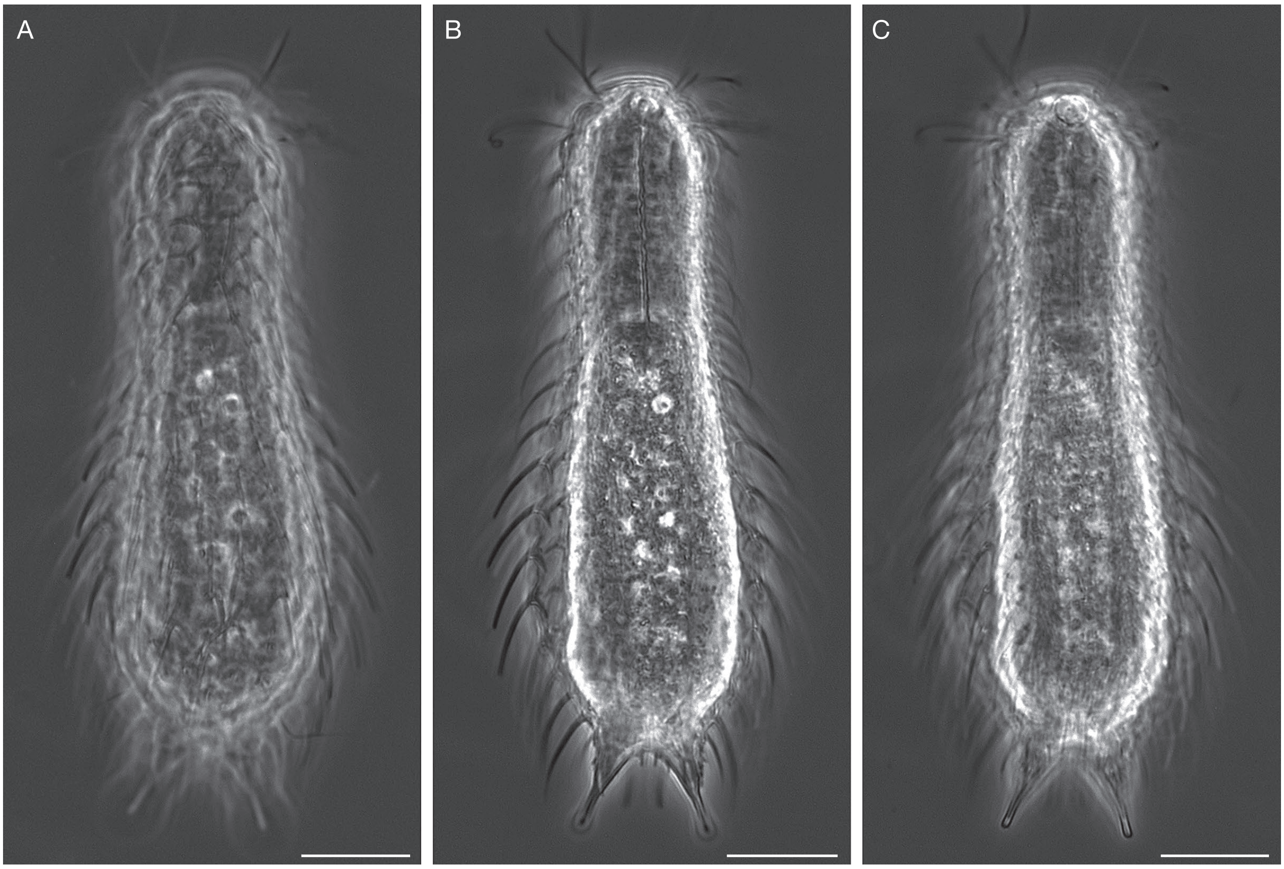

Fig. 3. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (phase contrast microphotographs); adult specimen: **A**, dorsal view; **B**, view of internal morphology; **C**, ventral view. Scale bars: 20 µm.

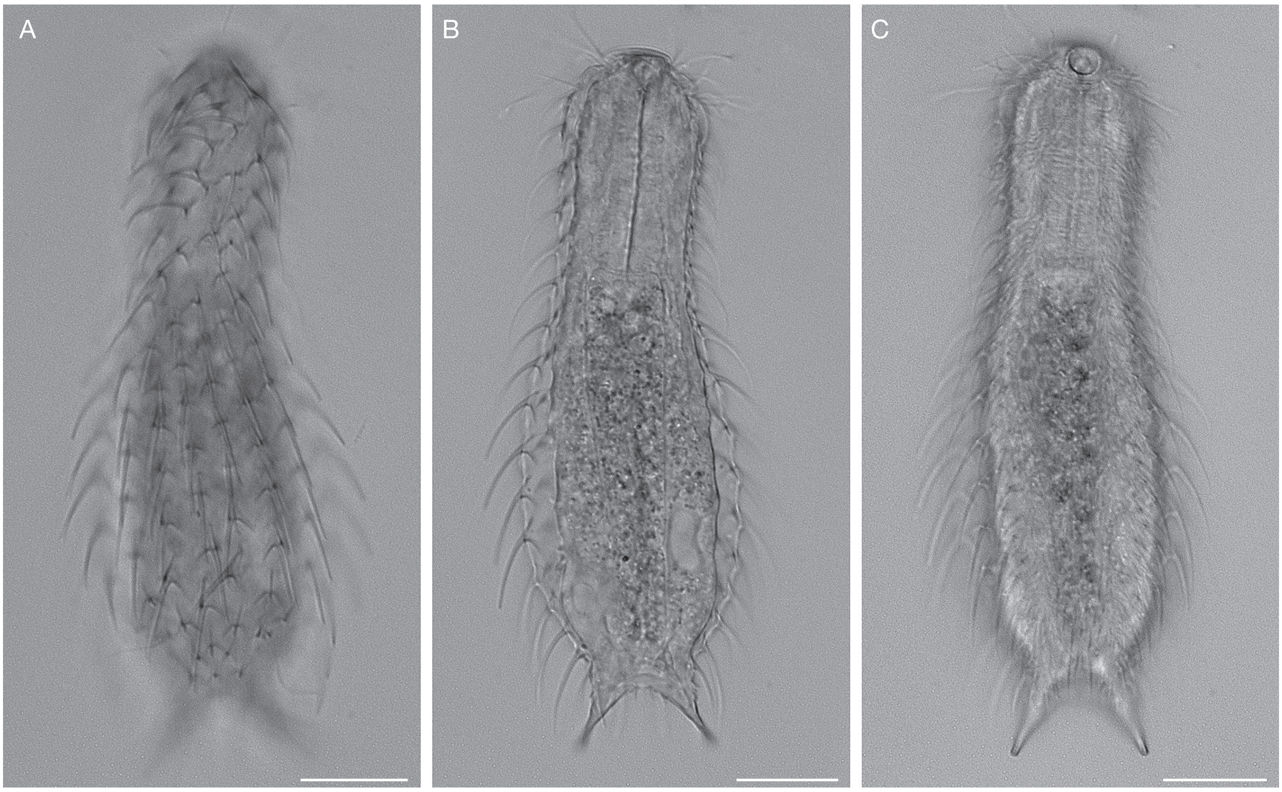

Fig. 4. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (bright field microphotographs); adult specimen: **A**, dorsal view; **B**, view of internal morphology; **C**, ventral view. Scale bars: 20 µm.

Fig. 5. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (phase contrast microphotograph): specimen with mature egg-habitus. Scale bar: 20 µm.

between the epipleuria and hypopleuria at U8 (six cilia in the anterior tuft and eight cilia in the posterior tuft). Cephalic cilia arise on the ventrolateral side of the body. Cilia of the two distinct pairs of tufts significantly different in length. First cephalic cilium in the anterior pair considerably longer than the other cilia, the second cilium always very short (Table 1). Ocular granules not present. Mouth ring located subterminally at U3-U6 and with granular cuticular reinforcements. In addition, the mouth ring with short, thin cuticular hairs. Hypostomium narrow, kidney-shaped and with small protuberances near the anterior edges. Pharynx with two dilatations; the posterior wider than the anterior one (11.4-13.5 µm vs 9.7-11.9 µm). A weak reinforcement present inside the anterior pharynx dilatation, composed of thin, short, unconnected cuticular bars located at U11-U12 (Fig. 1). Pharynx connected to a straight intestine (which runs from U35 to U85) through the pharyngeal-intestinal junction (U34) without a clearly marked anterior section different in term of morphology (Figs 1B, 3B, 4B). Neck slightly narrower than the head and gradually expanding into the trunk. Trunk widest at *c.* U69 (Figs 1-4). Furca base clearly marked; furcal branches outwardly directed. Adhesive tubes straight, relatively short (7.2-8.6 µm) and taper slightly towards the ends.

Except the ventral interciliary field, the entire body covered with three-lobed scales with a large, heavily domed keel. Scales that cover the body significantly different in their morphology and not overlapping or touching one another's edges (see Table 1; Fig. 1); located in 15-17 longitudinal alternating columns of 18-19 scales each. Head scales with long, narrow posterolateral lobes and a short, weakly marked anterior lobe. Head scales adjacent to the cephalion and epipleuria tilted medially towards midline scale (Figs 1A, 9A, 10A). Subsequent scales following the contours of the body in such a manner that the longitudinal rows extend almost parallel. Anterior lobes of neck scales and dorsal trunk scales gradually lengthening toward the rear of the body up to the widest trunk region (U69) (see Table 1). One dorsal scale, located in the widest trunk region in the central longitudinal row at *c.* U67-75, larger than the other scales. Scales with very short spines located on the dorsal and dorsolateral body surfaces (U76-U85), posteriorly to the largest scale. Four of these scales located in the central part of the dorsal posterior trunk region; the anteriormost of these scales the largest (at U76) and the next three scales situated behind it considerably smaller. The three pairs of remaining scales with very short spines located dorsolaterally on the posterior trunk region and on the furca base (U81-U85); these scales elongated, with posterolateral lobes that extend only slightly outward (Figs 1A, 9D). At the dorsal side of each furcal appendage, three scales present at U86-U90: the central scale orientated parallel to the body axis, the two lateral to it scales orientated diagonally to the body axis (Figs 1A, 9D). Three-lobed scales of the same type as the trunk scales present on the furcal appendages (on the dorsal, dorsolateral and lateral sides). Scales in the ventral longitudinal row of scales located closest to the ciliary band smaller than the surrounding scales (Figs 1C, 11); these scales having the same shape as the scales on the central part of the trunk and located next to the normal-sized scales; rotated by *c.* 30° towards the bands of locomotor cilia, facing the bands with the anterior lobe.

Longitudinal locomotor bands on the ventral side begin at U9 and end at U86. Ventral interciliary field covered with small scales that begin beyond the anterior pharynx dilatation (U13) (see Table 1). Scales on the ventral interciliary field oval and with a shallow indentation on the posterior edge, a weakly marked keel and straight spines (Figs 1C, 11). Size and density of the scales and length of the spines increasing from the anterior to the posterior part of the body (see Table 1). These scales distributed in 7-9 longitudinal rows of 17-19 scales each. Ventral interciliary field terminal scales oval and distinctly larger than the other ventral scales (see Table 1);

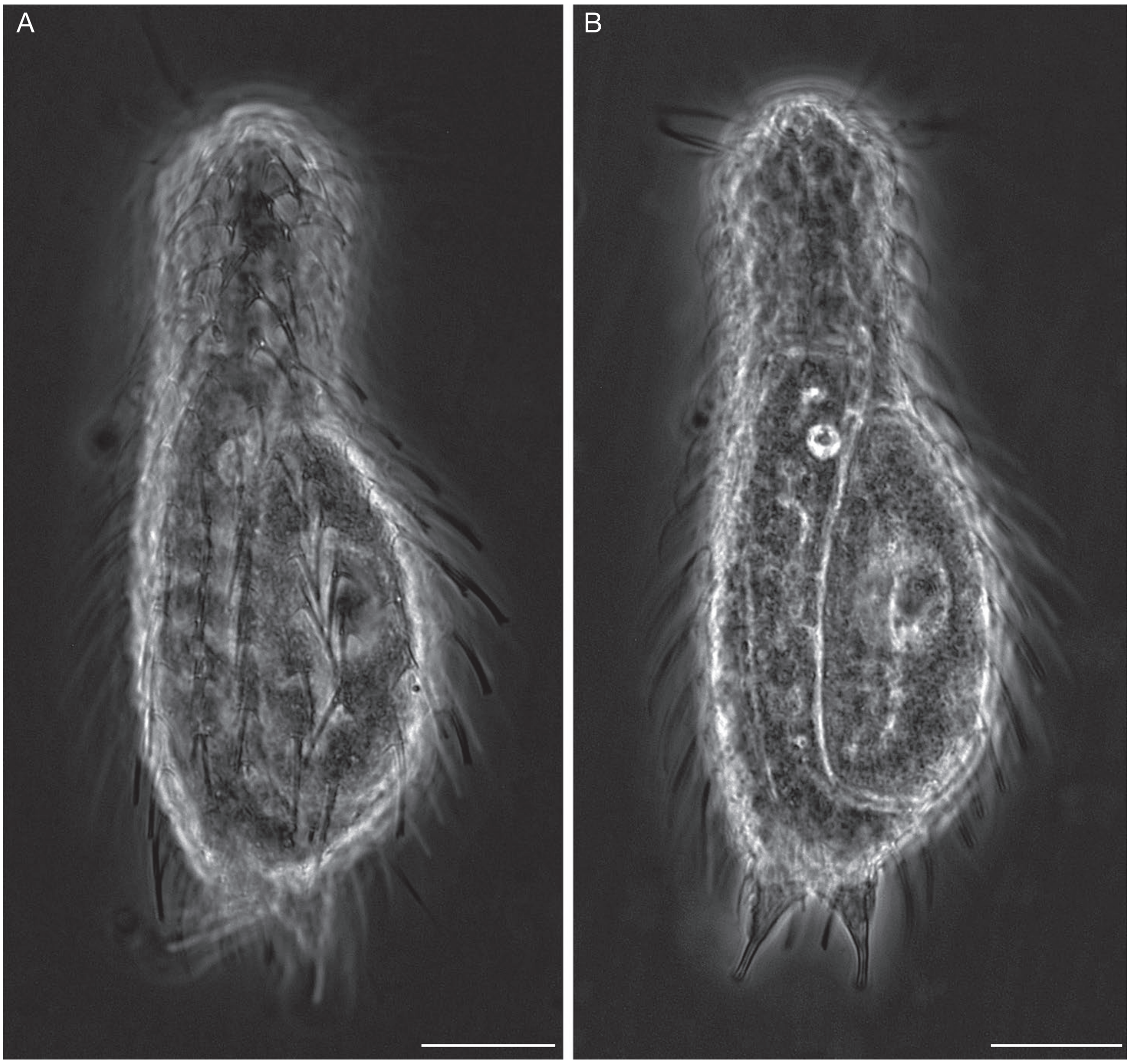

Fig. 6. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (phase contrast microphotographs): specimen with mature egg: **A**, dorsal view; **B**, view of internal morphology. Scale bars: 20 µm.

with a straight keel and straight spines that extend over the indentation in the furca. Posterior edge of the terminal scales slightly indented (Fig. 11C).

Six types of spines arising from the three-lobed scales on the dorsal, dorsolateral, lateral, ventrolateral and ventral scales (see Table 1). Head spines arising from the first scales in each dorsal longitudinal row basally thick and slightly curved; in the remaining part heavily curved and tapered towards the hair-like end. These spines shorter than the other spines and not bifurcated at the end (Fig. 9A; Table 1). Spines of the subsequent scales on dorsal and dorsolateral part of the head as well as of the neck and trunk (except for the terminal part of the trunk) asymmetrically bifurcated at the end. Spines in dorsal view narrow, but wide and a deeply furrowed in lateral plane (Figs 1, 11); this furrow running from the keel to the bifurcated end of the spines. Spines of head scales (except anterior scales) long and heavily curved. Spines arising from the dorsal part of the neck and trunk only slightly curved. Spines of the dorsal scales on the posterior part of the trunk short and of varying length. Spines in the first alternating row extending over the posterior end of the scale, but spines in the subsequent alternating rows not extending over it. Spines of scales located on the internal side of the furca base of normal length. Spines of the lateral and ventrolateral scales having a short, thick base and tapered towards the end; heavily curved and with no distal bifurcation; also longer than the dorsal and dorsolateral spines. Lateral spines of the last pair on the trunk larger, more heavily curved, tapered towards the end in the lateral plane, distally bifurcated and extending almost to the ends of the adhesive tubes (U98). Parafurcal scales with the same structure as the last pair of lateral trunk spines and extending to about the base of the adhesive tubes (U92) (Figs 1-4). Spines of scales located on the ventral body side closest to the ciliary bands (normal-sized scales and small scales) clearly thinner and finer, hair-like on entire length (Figs 1, 11).

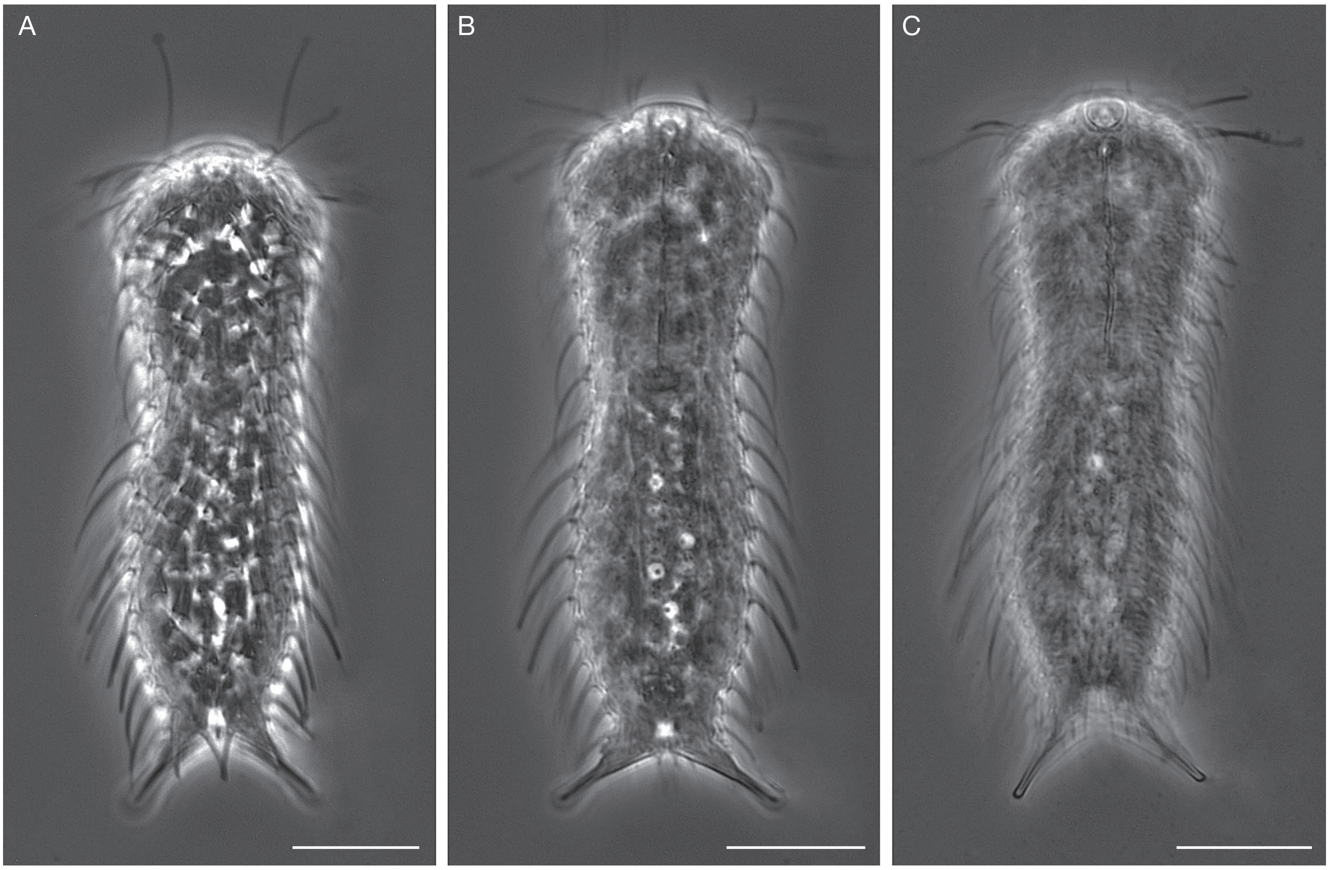

Fig. 7. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (phase contrast microphotographs); juvenile specimen: **A**, dorsal view; **B**, view of internal morphology; **C**, ventral view. Scale bars: 20 µm.

Two pairs of dorsal sensory bristles. Anterior pair of the sensory bristles arising out of small, spherical papillae located in the transition part between the neck and trunk and (U36). Posterior pair of sensory bristles located in the first alternating row of dorsal scales with short spines (U79). These bristles arise from double-keeled scales shaped like an upside-down heart (Fig. 9D).

Remarks

Specimens found at the Łódź Palm House were slightly smaller than specimens observed in their *locus typicus* (110.0-138.0 µm vs 134-148 µm). Furthermore, some taxonomic traits viz hair-like spines present on the sides of the trunk and the length of the parafurcal spines, scales with spines instead of just spines on the dorsal posterior trunk region, furca base and furcal appendages of the observed specimens differ from those described by Kisielewski (1991) for this species. A comparison of the observed specimens with paratypes (two preserved paratypes remained in relatively good condition and showed traits that were not described in detail in the original description and image mainly with regard to the presence of hair-like spines along the entire body and the length of the last pair of lateral spines) allowed for the conclusion that the observed specimens and paratypes came from the same species. The trait differences between the original description and the actual appearance of these specimens were most likely caused by the short period of availability of live specimens and difficulties with field research in Amazonia.

Chaetonotus (*Hystricochaetonotus*) *furcatus* has hitherto been identified only based on morphological traits without the possibility of a direct, live comparison of specimens from different populations. It is likely that future morphological and molecular research will show what the true taxonomic position of this species is, i.e. whether it is not a single species but rather a set of species very similar in term of morphology, a complex of cryptic species or a single taxon that was introduced to various parts of the world through the import of Bromeliaceae.

Additionally, six elongated oval formations, likely parasites, were observed inside the body integument in the trunk area of one specimen (Fig. 8). Similar formations in Chaetonotidae were found earlier inside integuments in *Chaetonotus* (*Hystricochaetonotus*) *persetosus* Zelinka, 1889 (Remane 1936) and in *Chaetonotus* (*H.*) *spinulosus* Stokes, 1887 (Roszczak 1969). In both cases these formations were interpreted as a kind of eggs. Due to the mode of reproduction and that freshwater gastrotrichs have ability to produce one egg at once (e.g., Balsamo *et al.* 2014) and internal structure of these formations, it is more likely that these formations are symptoms of infection by a parasite. Nowadays, putative parasites in Chaetonotida are live euglenoids which been noted inside the intestine (Kisielewska *et al.* 2015).

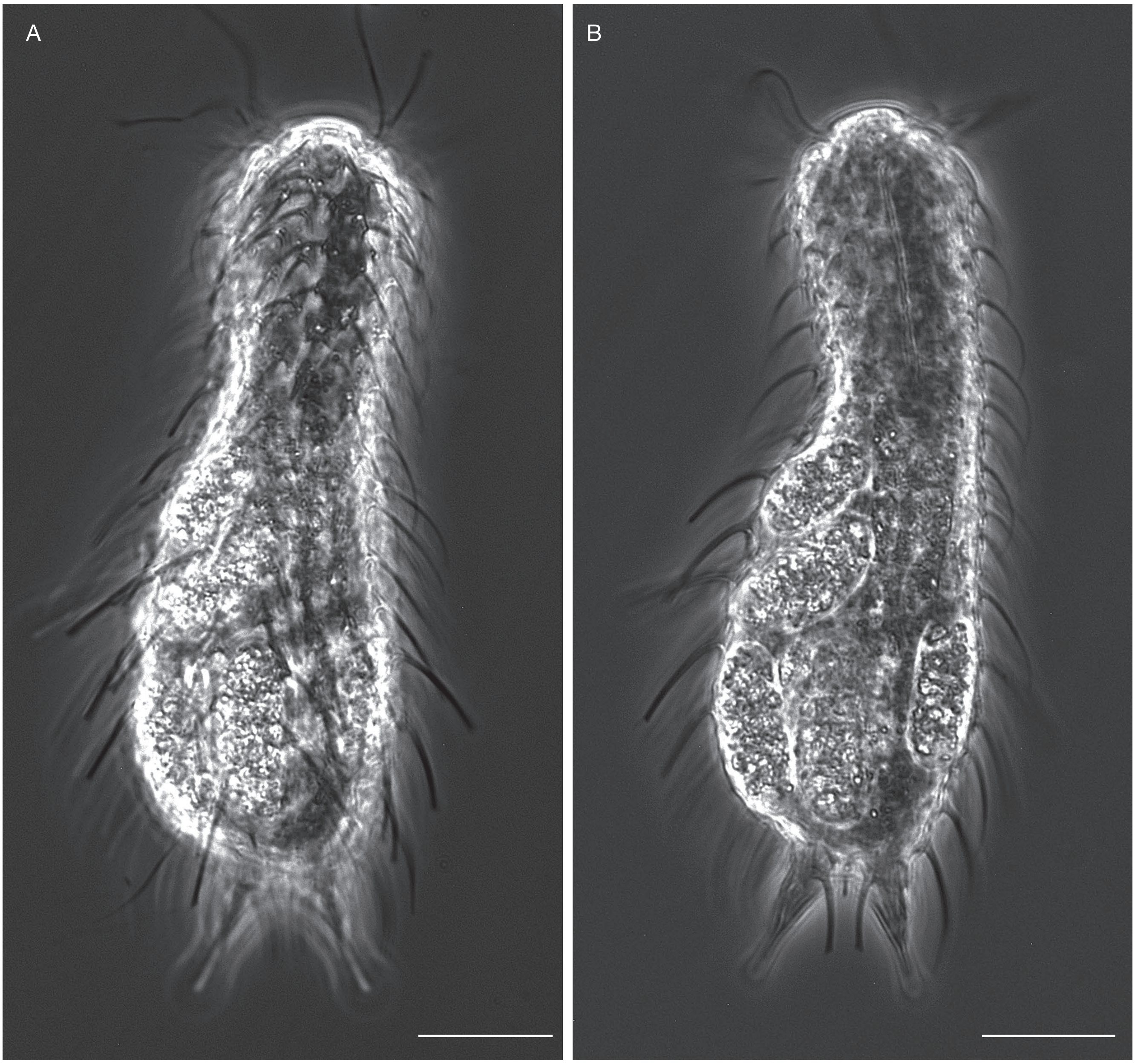

Fig. 8. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (phase contrast microphotographs): specimen with elongated oval formations inside the trunk; **A**, dorsal view; **B**, view of internal morphology. Scale bars: 20 µm.

DISCUSSION

Water micro-reservoirs that formed in the foliage axils of Bromeliaceae in the Łódź Palm House collection created favourable conditions for *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991. This species was the first gastrotrich described from the phytotelmata of bromeliads and had so far not been found outside their *locus typicus* in central Amazonia. Observation of this species in an artificial habitat, i.e. a greenhouse located in a different climate zone and on a different continent but in the same microhabitat, may indicate strong adaptation of *C.* (*H.*) *furcatus* to Bromeliaceae. Many invertebrates are only known from phytotelmata and have not been found elsewhere, but there is no detailed information regarding any animal-bromelid relationship (Lopez *et al.* 1999). However, many organisms that inhabit phytotelmata seem to be endemic with respect to these microhabitats. It can be assumed that these organisms have anatomic features or a life cycle and life trait histories that allow them to occupy and live in these ephemeral habitats (Richardson 1999). This gastrotrich may be another example of a species specialised to live in bromeliad micro-reservoirs. However, the water micro-reservoirs that form in the axils of Bromeliaceae contain not only specialists but also species known for their wide tolerance of habitats. It must be taken into account the possibility that individuals found in various locations into bromeliads do not belong to one species and are

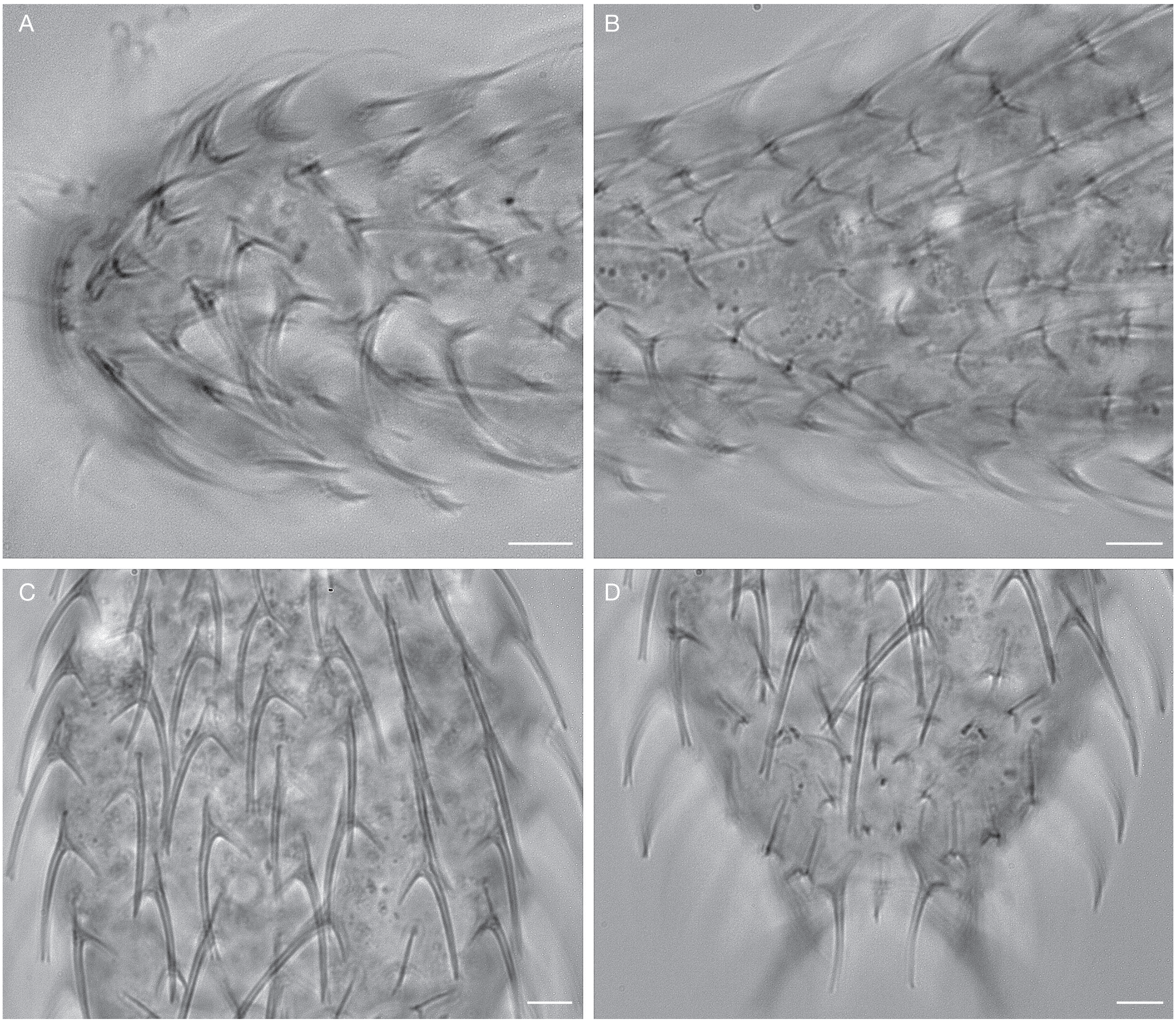

Fig. 9. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (Bright field microphotographs): **A**, dorsal view of scales in head region; **B**, dorsal view of scales in neck region; **C**, dorsal view of scales in trunk region; **D**, dorsal view of scales in posterior trunk region and in furcal base. Scale bars: 5 µm.

in fact a set of species very similar in term of morphology or a set complex of cryptic species. Considerations on the issue if we are dealing with one or with several separate species require further detailed morphological and molecular analyses. This is also the case of the other species of Gastrotricha that have been identified so far in bromeliads, namely: *Chaetonotus* (*Chaetonotus*) *oculifer* Kisielewski, 1981, *C.* (*Primochaetus*) *acanthodes* Stokes, 1887, *Heterolepidoderma ocellatum* (Mečnikow, 1865) *sensu* Kisielewski, 1981, and *Lepidodermella squamata* (Dujardin, 1841). These taxa are considered to be common in different types of habitats (e.g., Schwank 1990; Kisielewski 1997). However, at least for the species *L. squamata* there is evidence that this taxon is not a single species with high morphological variability but rather a complex of various species (*inter alia* Kånneby *et al.* 2012, 2013). Kisielewski (1991) draws attention to the morphological features that differentiate specimens found in Bromeliaceae and the members of theoretically the same species inhabiting different habitats. It is possible that the taxa found in bromeliads are highly specialised, separate species that are evolutionarily adapted to these hard-to-reach, shortly-existing habitats and are only morphologically similar to already known and widespread species. The second possible explanation for the presence of these species is their tolerance to a wide range of environmental conditions and few developmental requirements; their morphological differences prove a wide range of phenotypic plasticity depending on the habitats they occupy. Unfortunately, it is difficult to verify the validity of both assumptions due to insufficient data, thus further detailed morphological and molecular studies are necessary. The presence of *C.* (*H.*) *furcatus* at the Łódź Palm House in such a distinct habitat as water micro-reservoirs in the foliage axils of Bromeliaceae shows how little is known about Gastrotricha:

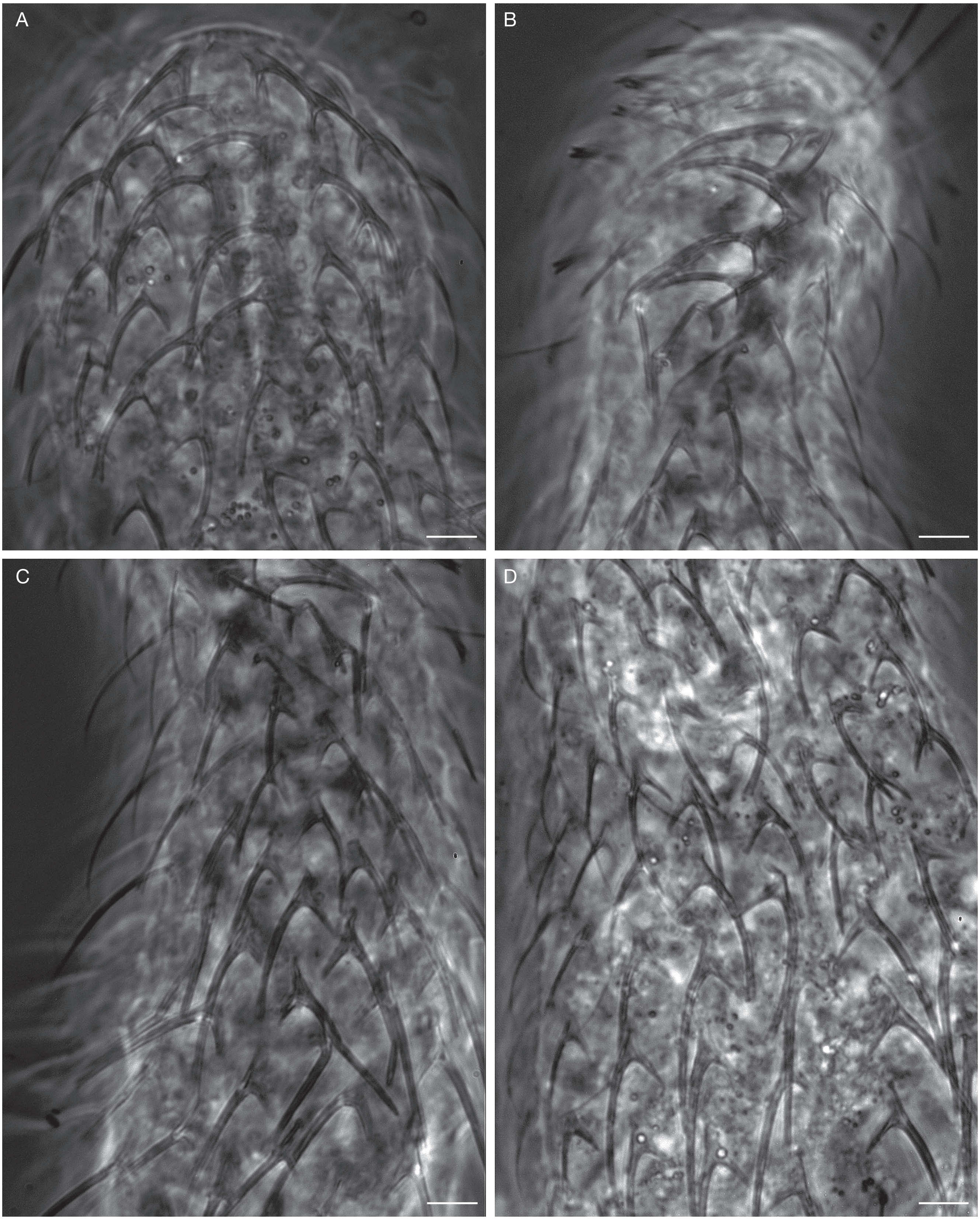

Fig. 10. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (phase contrast microphotographs): **A**, dorsal view of spines in head region; **B**, lateral view of spines in head region; **C**, lateral view of spines in neck and trunk region; **D**, dorsal view of spines in neck and trunk region. Scale bars: 5 µm.

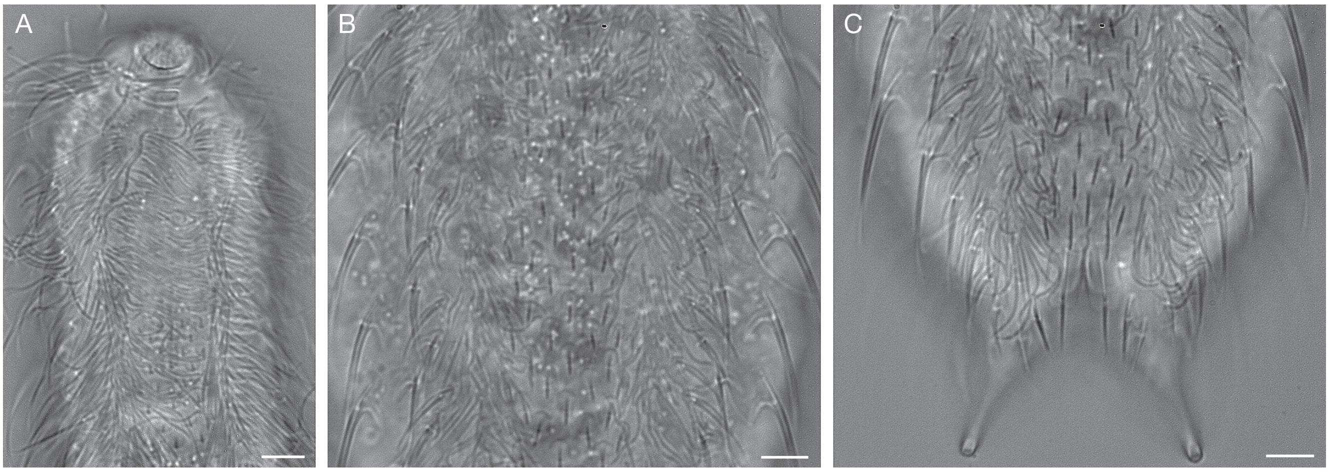

Fig. 11. — *Chaetonotus* (*Hystricochaetonotus*) *furcatus* Kisielewski, 1991 (bright field microphotographs): **A**, ventral view of head and neck region; **B**, ventral view of trunk region; **C**, ventral view of posterior trunk region. Scale bars: 5 μm.

their colonisation capability, dispersal ability and tolerances. This uncertainty also highlights how deficient existing knowledge is about aquatic communities formed in bromeliads or in artificial habitats in palm houses. The finding of a subsequent, i.e. 19th, species of gastrotrichs in the third palm house also indicates that palm houses and greenhouses create favourable conditions for the development and occurrence of these invertebrates which were introduced to them in various ways, in addition to indicating that Gastrotricha are an important constant and abundant component of the fauna of these "urban islands of diversity" (Kolicka *et al.* 2013, 2015; Kolicka 2014).

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