This article was downloaded by: [University of Bath]

On: 13 February 2014, At: 10:30

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK

Journal of Natural History

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/tnah20>

Systematic status of *Hydrozetes octosetosus* Willmann, 1932 (Acari: Oribatida: Hydrozetidae) in the light of ontogenetic and ecological studies

Stanisław Seniczak^a, Torstein Solhøy^b & Anna Seniczak^a

^a Department of Ecology, University of Technology and Life Sciences, Bydgoszcz, Poland

^b Department of Biology, University of Bergen, Bergen, Norway

Published online: 02 Dec 2010.

To cite this article: Stanisław Seniczak, Torstein Solhøy & Anna Seniczak (2007) Systematic status of *Hydrozetes octosetosus* Willmann, 1932 (Acari: Oribatida: Hydrozetidae) in the light of ontogenetic and ecological studies, *Journal of Natural History*, 41:33-36, 2081-2098, DOI: [10.1080/00222930701535353](http://dx.doi.org/10.1080/00222930701535353)

To link to this article: <http://dx.doi.org/10.1080/00222930701535353>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms &

Systematic status of *Hydrozetes octosetosus* Willmann, 1932 (Acari: Oribatida: Hydrozetidae) in the light of ontogenetic and ecological studies

STANISŁAW SENICZAK¹, TORSTEIN SOLHØY² & ANNA SENICZAK¹

¹Department of Ecology, University of Technology and Life Sciences, Bydgoszcz, Poland, and

²Department of Biology, University of Bergen, Bergen, Norway

(Accepted 6 June 2007)

Abstract

The systematic status of *Hydrozetes octosetosus* was investigated by comparing this species to *H. lacustris*, which is the type species for the genus *Hydrozetes* Berlese, 1902. These species are similar, but probably not synonyms as recently proposed. They differ mainly by the position of notogastral seta *lm* in the adult and position and length of this seta and total number of long setae in the posterior part of nymphs. In the adult of *H. octosetosus*, this seta inserts behind the opisthosomal gland opening (*gla*), but in front of it in *H. lacustris*. In the nymphs of *H. octosetosus* seta *lm* inserts behind *gla* opening, but medially to it in *H. lacustris*. In *H. octosetosus* this seta is very long and the total number of long setae in nymphs is four pairs, while in *H. lacustris* seta *lm* is short and the total number of long setae in nymphs is three pairs.

Keywords: *Acari*, *aquatic mites*, *Hydrozetes octosetosus*, *juvenile stages*, *ontogeny*, *oribatid mites*, *setation*

Introduction

Most oribatid mites live in terrestrial ecosystems, where they transform organic matter and release mineral elements for plant growth. But overall, this group of mites inhabits various ecosystems, from extremely dry to wet and flooded. Some species, like those of the genus *Hydrozetes*, live in freshwater habitats, such as lakes, ponds, and rivers (Krantz and Baker 1982). They occur mainly on plants, but also burrow inside stalks and in damaged and decaying leaves (Krantz 1978; Norton 1994).

Species of *Hydrozetes* are well adapted to fresh water, both by their physiology and morphology, and can live submersed in water indefinitely. The adults have microtubercles near the respiratory stigmata, which hold a thin layer of air (Krantz and Baker 1982); this plastron allows the mites to exchange respiratory gases with water. Some morphological adaptations, such as the boat shape of nymphs, long setae on the posterior part of the body, and thick and stiff setae on distal parts of the legs also seem important.

Correspondence: Stanisław Seniczak, Department of Ecology, University of Technology and Life Sciences, Kordeckiego 20, Pl 85-225 Bydgoszcz, Poland. Email: stseni@utp.edu.pl

ISSN 0022-2933 print/ISSN 1464-5262 online © 2007 Taylor & Francis

DOI: 10.1080/00222930701535353

Adults of *Hydrozetes* can disperse through water in a special way. They form a gas bubble in the midgut, which decreases the density of their body and allows them to rise in the water rather quickly. This phenomenon, named levitation, was investigated in detail by Newell (1945). He found that the gas bubble is formed from smaller bubbles, which are pumped successively to the midgut by the pharynx. The mites can resorb the gas bubble to sink in the water column.

The genus *Hydrozetes* is common in lakes and rivers, but is not rich in species. Subías (2004) listed 25 species, of which six occur in Europe: *H. confervae* (Schränk, 1781), *H. lacustris* (Michael, 1882), *H. lemnae* (Coggi, 1897), *H. octosetosus* Willmann, 1932, *H. parisiensis* Grandjean, 1948, and *H. thienemanni* Strenzke, 1943. They have been described and illustrated as adults, and in some species the nymphs have also been illustrated and partly described. *Hydrozetes confervae* and *H. thienemanni* are dioecious, while the other species are parthenogenetic and reproduce by thelytoky (Grandjean 1948), including *H. octosetosus*.

The adults of European species of *Hydrozetes* are about 500 µm long, oval in shape, with rather long legs and a well-sclerotized cuticle of brown coloration. At first glance these species look similar to each other and this creates problems with their determination, especially for species such *H. confervae*, *H. lacustris*, and *H. lemnae*, which were described in the 18th and 19th centuries. The original descriptions are short and drawings are generalized, which makes the determination of species very confusing. This problem was well summarized by Newell (1945), who prepared a more detailed description of the genus *Hydrozetes* and a key to five taxa, including *H. confervae*, *H. lacustris*, and *H. lacustris octosetosus*.

According to descriptions and keys (Coggi 1897; Michael 1898; Willmann 1931, 1932; Strenzke 1943; Newell 1945; Grandjean 1948; Ghilarov and Krivoluckij 1975; Weigmann 2006), the adults of European species of *Hydrozetes* differ in the shape of the bothridium, the presence and shape of the sensillus, the number and shape of some notogastral setae, the shape of tectopodia I, the shape of some setae on tarsus I, the number of setae on femur IV, the number of claws on leg IV, and the dimension of the body. Because of the brown coloration, the adults need clearing at least in lactic acid, which makes ecological investigations very time consuming. In contrast, the juvenile stages of these species have a weakly sclerotized cuticle and flesh-coloration, and therefore their morphological characters are well visible without clearing. The most important morphological character of nymphs is the number of long setae in the posterior part of the body. For example, *H. octosetosus* has four pairs of long setae, while *H. lacustris* has three pairs. Deichsel (2004) recently studied the variation in number of these setae in *H. lacustris*, and considered *H. octosetosus* Willmann, 1932 and *H. parisiensis* Grandjean, 1948 as junior synonyms of *H. lacustris* (Michael, 1882).

Hydrozetes octosetosus was described by Willmann (1932) as a subspecies of *H. lacustris*. The description of the adult was rather short and generalized, and concerned mainly the anterior part of the body, which was also illustrated. The author did not investigate the pattern of notogastral setae in detail, so the description was, at several points, convergent with the diagnosis of *H. lacustris*. Fortunately, he also gave a short description and drawing of a nymph with four pairs of long setae in the posterior part of the body, which distinctly separated this taxon from *H. lacustris*. Nevertheless, many authors overlooked *H. octosetosus* in ecological investigations, and since Willmann (1932) no other author has recorded it in Europe. It was mentioned as a separate taxon by Newell (1945), Grandjean (1948), Fernández and Travé (1984), and Subías (2004), but only in the latter two papers was it

considered as a separate species. According to Subías (2004) *H. octosetosus* is recorded in central Europe, while *H. lacustris* is a boreal species.

The aim of this paper is to revise the systematic status of *H. octosetosus* Willmann, 1932, which, contrary to Deichsel (2004), we consider to be a separate species. We compare the morphological characters of juvenile and adult stages of *H. octosetosus* with those of *H. lacustris* (Michael, 1882), which is the type species for the genus *Hydrozetes* Berlese, 1902, and also the distribution of both species.

Material and techniques

For the morphological study on the ontogeny of *H. lacustris* and *H. octosetosus* we chose lakes where these species did not occur together. *Hydrozetes lacustris* was collected in lake U1 (Ulriken, Bergen, Norway), where it occurred alone and in high density (Table I). *Hydrozetes octosetosus* was collected in lake Martwe (Tuchola Forest, Poland), where it was distinctly more abundant than the co-occurring *Hydrozetes* sp. 1 and *H. lemnae*. The morphological description and illustrations of *H. lacustris* include the dorsal aspect of larva and tritonymph, anal region of larva and anogenital region of all nymphal stages, where new segments and setae appear during ontogeny. As the ontogeny of both species is similar, the drawings of *H. octosetosus* are limited to the dorsal aspect of larva and tritonymph, and the anal region of the larva and the anogenital region of the tritonymph. The adults of investigated species are also considered, to document the full development of setation during ontogeny. Terminology used follows that of Grandjean (see Travè and Vachon 1975 for many references).

The density of *H. octosetosus* and *H. lacustris* was investigated in *Sphagnum* mosses on the edges of some lakes in Bergen, Norway (lakes U1 and U2, Ulriken; lake Blåmansvannet and lakes F1 and F2, Fløyen; in each lake one sample of 20 cm × 20 cm × 5 cm was taken in June 2005) and in the Tuchola Forest, Poland (lakes Martwe and Wielkie Gacno; in each lake 10 samples of 10 cm × 10 cm × 5 cm were taken in September 2005).

Table I. Measurements of some morphological characters of juvenile stages of *Hydrozetes lacustris* and *H. octosetosus* (mean measurements of 5–10 specimens in µm).

Morphological characters	<i>H. lacustris</i>				<i>H. octosetosus</i>			
	L	PN	DN	TN	L	PN	DN	TN
Body length	231	303	378	498	242	314	375	480
Body width	141	171	235	290	143	178	231	280
Length of								
Seta <i>le</i>	25	16	16	16	30	30	31	33
Seta <i>in</i>	17	12	15	16	32	15	16	16
Seta <i>c</i> ₃	16	12	15	17	14	12	12	12
Seta <i>la</i>	14	13	15	17	14	14	16	17
Seta <i>lm</i>	19	13	15	17	42	About body length		
Seta <i>h</i> ₁	21	23	33	42	22	24	33	42
Genital opening	nd	28	37	53	nd	26	36	51
Anal opening	55	72	98	130	58	74	96	124

L, larva; PN, protonymph; DN, deutonymph; TN, tritonymph; nd, not developed.

Results

Morphology of juvenile stages of *Hydrozetes lacustris* (Michael, 1882)

Larva. Larva with three pairs of legs, shape oval, body flesh-coloured (Figure 1). Prodorsum triangular, porose, lateral part slightly wrinkled. Setae *ro*, *in*, and *ex* smooth, seta *le* barbed; seta *le* longest, seta *ex* shortest. Bothridium (*bo*) weakly developed, sensillus (*ss*) long, setiform.

Gastronotal region with 12 pairs of setae, including seta *h*₃ positioned near anal opening (Figure 2A). Setae of *c*-series, *da*, *dm*, and *la* shorter than other setae and smooth. Seta *lm*

Figure 1. *Hydrozetes lacustris*, larva, dorsal aspect.

Figure 2. *Hydrozetes lacustris*. (A) Anal region of larva; (B) anogenital region of protonymph.

also smooth and situated medially to opisthosomal gland opening (*gla*), setae *dp*, *lp*, *h*₁, and *h*₂ on small apophyses and barbed; seta *h*₁ thicker and shorter than *h*₂, stiff and pointed. Length of setae of *d*- and *l*-series increases from anterior to posterior part of gastronotal region. Seta *h*₂ longest, seta *h*₃ shortest. Cupule pair *ih* positioned lateral to anterior part of anal valves. Cuticle with small pits.

Nymphal stages. All nymphs with four pairs of legs, slimmer than larva, boat-shaped and flesh-coloured. Number and shape of setae on the prodorsum as in larva, but more setae (15 pairs) present in the gastronotal region.

The successive juvenile stages differ distinctly in the body size (Table I) and the number of setae in the anogenital region. Genital valves of protonymph with two pairs of setae

(Figure 2B); three pairs of pseudanal setae (p_1 – p_3) on paraproctal valves; setae p_2 and p_3 thin, seta p_1 thick and stiff; all setae smooth. Pairs of cupules ips positioned lateral to anterior part of anal valves. Genital valves of deutonymph with four pairs of setae (Figure 3A). A pair of aggenital setae (ag) between genital and anal valves; three pairs of pseudanal setae present; three pairs of adanal setae (ad_1 – ad_3) on paraproctal valves; all setae short, thin, and smooth. Anogenital region rarely with pits. Genital valves of tritonymph usually with six pairs of setae (Figure 3B), seta ag present. Setae p_2 and p_3 and

Figure 3. *Hydrozetes lacustris*, anogenital region of: (A) deutonymph; (B) tritonymph.

three pairs of adanal setae small. Anal valves with two pairs of small setae. Pairs of cupules *iad* positioned lateral to anterior part of anal valves of deuto- and tritonymph. Anogenital region of nymphs rarely with pits.

The shape of setae on dorsal and lateral part of gastronotal region is similar to those in the tritonymph (Figure 4). Setae of *c*-series, *d*-series, *la*, and *lm* short and smooth, seta *lm*

Figure 4. *Hydrozetes lacustris*, tritonymph, dorsal aspect.

situated medially to *gla*. Other setae longer and thicker and positioned on small apophyses in posterior part of body. Setae *lp*, *h*₂, and *h*₁ as long as body, thick at basal part, pointed and smooth; setae *h*₃ and *p*₁ distinctly shorter, but thicker, stiff, pointed, and smooth. Central part of gastrontotal region with small pits, frontal and lateral parts slightly wrinkled.

Morphology of juvenile stages of Hydrozetes octosetosus Willmann, 1932

The juvenile stages of *H. octosetosus* are similar to those of *H. lacustris* in the body shape and the number of setae (Figures 5–7), but differ from them in several important morphological characters, as follows:

1. The position of seta *lm* in relation to opening *gla*: in *H. octosetosus* this seta inserts posteriorly to *gla*, but medially to it in *H. lacustris*; consequently in the former species the distance between seta *lm* and *lp* is distinctly shorter than between seta *lm* and *la*, while in the latter species the distance between setae of *l*-series is similar.
2. The length of seta *lm*: in *H. octosetosus* this seta is rather long in the larva and very long in the nymphal stages, while in *H. lacustris* it is short.

Figure 5. *Hydrozetes octosetosus*, larva, dorsal aspect.

Figure 6. *Hydrozetes octosetosus*. (A) Anal region of larva; (B) anogenital region of tritonymph.

Figure 7. *Hydrozetes octosetosus*, tritonymph, dorsal aspect.

3. The length of setae *le* and *ex* in all juvenile stages: in *H. octosetosus* seta *le* is longer but seta *ex* is shorter than in *H. lacustris*.
4. The length of seta *in* in the larva: in *H. octosetosus* this seta is longer than in *H. lacustris*.
5. The number of genital setae: the nymphs of *H. octosetosus* usually have more of these setae than those of *H. lacustris*.

6. The shape of some setae on tarsus I, which is considered an important morphological character of the genus *Hydrozetes* (Willmann 1931; Grandjean 1948; Ghilarov and Krivoluckij 1975; Weigmann 2006): in the tritonymph of *H. octosetosus* seta *pv''* is thinner, while seta *s* is thicker than in *H. lacustris* (Figure 8); *H. octosetosus* has also thinner seta *pv''* on tarsus II than *H. lacustris*.

Development and variability of setation

The number of setae on the prodorsum remains similar during the ontogeny of *H. lacustris* and *H. octosetosus*, but these species differ in the length of some setae (Table I). Compared to those of *H. lacustris*, all juvenile stages of *H. octosetosus* have seta *le* nearly twice as long and seta *ex* distinctly shorter, while seta *in* is longer only in the larva. The bothridium is

Figure 8. Tritonymph, paraxial aspect of: (A) tarsus I of *Hydrozetes lacustris*; (B) tarsus I of *H. octosetosus*; (C) tarsus II of *H. lacustris*; (D) tarsus II of *H. octosetosus*.

weakly developed in all juvenile stages, with long, setiform sensillus. In the adults of these species the sensillus is short, setiform or absent, rarely clavate. From among 535 adults of *H. lacustris* from lake U1 (Ulriken, Norway) only seven specimens had a clavate sensillus on one or both sides.

The number of gastronotal setae changes similarly during the ontogeny of these species, because new segments and setae appear in the anal region. There are 12 pairs of gastronotal setae in the larva, while in the protonymph three pairs of pseudanal setae (p_1-p_3) first appear on segment PS, and the number of gastronotal setae is 15 pairs; p -series setae are present in the deutonymph, tritonymph, and adults (Figures 9, 10). In the protonymph some setae (lp , h_1 , and h_2 in *H. lacustris* and lm , lp , h_1 , and h_2 in *H. octosetosus*) grow very long in the posterior part of the body, and remain similar in the deutonymph and

Figure 9. *Hydrozetes lacustris*, adult, dorsal aspect. (A) Region of bothridium.

Figure 10. *Hydrozetes octosetosus*, adult, dorsal aspect.

tritonymph. In the deutonymph three pairs of adanal setae (ad_1-ad_3) first appear on segment AD, and are present in the tritonymph and adult. In the tritonymph two pairs of setae appear on the anal valves and are present in the adult. In both species the coxisternal setal formula is 3-1-2 (larva), 3-1-2-1 (protonymph), 3-1-2-2 (deutonymph), and 3-1-2-3 (tritonymph and adult). In the larva seta $1c$ is difficult to observe, because it is scaliform and covers Claparède's organ, which is well presented by Grandjean (1963). In the investigated populations the formula of the genital setae was 2-4-(6-7)-(6-7) (protonymph to adult) in *H. lacustris* and (2-3)-(5-6)-(7-8)-(7-8) in *H. octosetosus*. Some nymphs and adults have one genital seta more on one side than on the other.

In the juvenile stages of *H. octosetosus* the migration of seta lm is observed from medial to posterior position in relation to opening gla , compared to *H. lacustris*. In all juvenile stages of *H. lacustris* this seta is small, thin, and smooth and placed medially to gla , rarely behind it, while in the adult it is usually in front of gla . In *H. octosetosus* this seta is rather long and barbed in the larva, and is placed slightly behind gla opening, while in the protonymph,

deutonymph, and tritonymph it is placed behind *gla* and is very long. In the adult seta *lm* is similar in shape to the other notogastral setae, and is positioned behind *gla*, near seta *lp*.

In the juvenile stages of both species some variability in the gastronotal setae also occurred. In *H. octosetosus* one seta *lm* was sometimes thin and, when it was broken near the basal part, it looked like a short seta. In some individuals one seta *lm* grew closer to *gla* than the other, and some other gastronotal setae were positioned at different distances from the anterior border.

In the adults of *H. octosetosus* and *H. lacustris* the loss of some setae of the *c*-series was observed, compared to the tritonymph. Based on the position of these setae in the tritonymph, the first seta or pair of setae *c*₁ was lost, and also the next seta or pair of setae *c*₃, and only setae *c*₂ remained. Among 165 adults of *H. octosetosus* from lake Martwe (Tuchola Forest, Poland) one had all setae of the *c*-series, five adults had five setae, 61 adults had four setae, 35 adults had three setae and 63 adults had a pair of setae *c*₂. Among 57 adults of *H. lacustris* from this lake eight had five setae, 33 adults had four setae, three adults had three setae, and 13 adults had a pair of setae *c*₂. Interestingly, the Norwegian adults of *H. lacustris* had more *c*-series setae than the Polish adults. Among 535 adults of this species from lake U1 (Ulriken) nine had all setae of the *c*-series, 11 adults had five setae, and the others had four setae (pairs *c*₂ and *c*₁).

The adult of *H. octosetosus* differs from that of *H. lacustris* in several important morphological characters, as follows:

1. The position of seta *lm* relative to opening *gla*: in *H. octosetosus* this seta inserts behind this opening, while in *H. lacustris* it is in front of it; consequently in the former species seta *lm* inserts far from seta *la* and near seta *lp*, while in the latter species the distance between setae of *l*-series is similar.
2. The length of dorsal setae, mainly the *d*-series: in *H. octosetosus* these setae are longer than in *H. lacustris*.
3. The length of prodorsal setae *le* and *in*: in *H. octosetosus* these setae are longer than in *H. lacustris*.
4. The number of genital setae: *H. octosetosus* usually has more of these setae than *H. lacustris*.
5. The length of seta *ft'* and shape of seta *s* on tarsus I: in *H. octosetosus* seta *ft'* is shorter than in *H. lacustris* and seta *s* is barbed, while in the latter species is smooth (Figure 11).

Occurrence of investigated species in lakes

In Norwegian lakes *H. lacustris* and *H. octosetosus* occurred together, but in different proportions (Table II). The exception was lake U1, where *H. lacustris* lived alone and in high density. In Polish lake Martwe in the Tuchola Forest *H. octosetosus* occurred together with *Hydrozetes* sp. 1 and *H. lemnae*, while in lake Małe Gacno it occurred together with *H. lacustris* and *Hydrozetes* sp. 1.

Discussion and remarks

Juvenile stages of oribatid mites are generally poorly known, and keys to species concern mainly the adults. In the higher Oribatida (Brachypylina or Circumdehiscentiae), to which the genus *Hydrozetes* belongs, the juvenile stages differ distinctly from the adults, mainly in

Figure 11. Adult, paraxial aspect of tarsus I of: (A) *Hydrozetes lacustris*; (B) *H. octosetosus*.

the body shape, cuticular sclerotization, and the shape and numbers of setae on the dorsal part of the hysterosoma. In the case of *H. lacustris* and *H. octosetosus*, the nymphs have some long setae on the posterior part of the body and their determination seems to be easier than for the adults. Besides, the morphological characters of juveniles are very helpful in a more precise determination of species.

Our conclusions regarding *H. octosetosus* and *H. lacustris* are inconsistent with the results of Deichsel (2004), who considered *H. octosetosus* a junior synonym of *H. lacustris*, with a position intermediate between the latter and mites that would usually be identified as *H.*

Table II. Density (individuals per dm³) of *Hydrozetes lacustris*, *H. octosetosus*, and *Hydrozetes* sp. 1 in some lakes in Norway and Poland.

Lake and locality	Species	No. of adults	No. of nymphs	Total	Density (ind. dm ⁻³)
Lake U1, Ulriken, Norway, 611 m a.s.l.	<i>H. lacustris</i>	535	67	602	301
Lake U2, Ulriken, Norway, 584 m a.s.l.	<i>H. octosetosus</i>	118	6	124	62
	<i>H. lacustris</i>	64	5	69	35
Lake Blåmansvannet, Fløyen, Norway, 402 m a.s.l.	<i>H. lacustris</i>	225	198	423	212
	<i>H. octosetosus</i>	248	72	320	160
Lake F1, Fløyen, Norway, 551 m a.s.l.	<i>H. lacustris</i>	26	17	43	22
	<i>H. octosetosus</i>	6	4	10	5
Lake F2, Fløyen, Norway, 560 m a.s.l.	<i>H. lacustris</i>	226	45	271	136
	<i>H. octosetosus</i>	45	31	76	38
Lake Martwe, Tuchola Forest, Poland, 112 m a.s.l.	<i>H. octosetosus</i>	185	92	277	55
	<i>Hydrozetes</i> sp. 1	26	5	31	5
	<i>H. lemnae</i>	–	1	1	<1
Lake Małe Gacno, Tuchola Forest, Poland, 125 m a.s.l.	<i>H. octosetosus</i>	62	9	71	14
	<i>H. lacustris</i>	57	1	58	12
	<i>Hydrozetes</i> sp. 1	2	–	2	<1

parisiensis. In the adults he considered such morphological characters as the body length, distance between insertions of setal pairs *la*, *da*, and bothridia, and the number of notogastral setae in *l*- and *h*-series. In the juvenile stages he observed no morphological differences except the number of long setae on the posterior part of nymphs. Among 186 studied adults from six sites, Deichsel (2004) observed a gradual transition of the total number of *l*- and *h*-series setae between five and ten pairs. Similarly, among 56 studied nymphs the number of long setae varied between two and eight pairs. The author quantified the systematic value of these characters, using the Wards method with Euclidean distances in Statistica 6.0 (StatSoft, Tulsa, OK, USA).

Cluster analysis did not confirm the diagnostic value of the total number of *l*- and *h*-series setae in the adult. Consequently, Deichsel (2004) assumed that the morphological variability he observed was intraspecific, and considered *H. parisiensis* Grandjean, 1948 and *H. octosetosus* Willmann, 1932 to be junior synonyms of *H. lacustris* (Michael, 1882). He also proposed two morphotypes of *H. lacustris*: *H. lacustris lacustris* (forma typica), with a total number of 13 pairs of notogastral setae in the adult, and at most four pairs of long setae in the posterior part of nymphs, and *H. lacustris parisiensis*, with more than 13 pairs of notogastral setae in the adult and more than four pairs of long setae in the nymphs. These morphotypes are also considered in Weigmann's (2006) key to the adults of German species of *Hydrozetes*. In Weigmann and Deichsel (2006), the description of *H. lacustris* included an illustration of *H. lacustris* f. *parisiensis*, but in the key to the nymphs only four species are included: *H. confervae*, *H. lacustris*, *H. lemnae*, and *H. thienemanni*.

In the light of our results Deichsel's (2004) synonymies can be questioned. *Hydrozetes octosetosus* differs from *H. lacustris* in several morphological characters that he did not study: namely the position of seta *lm* relative to the opening *gla*; the length of seta *in* in the larva and setae *le* and *ex* in all juvenile stages; the number of genital setae; and the shape of some setae on tarsus I and II. While he counted the total number of setae of *l*- and *h*-series in the adults, he did not separate the series, which is made necessary by the presence of *H. parisiensis* in the population. In the latter species, neotrichy occurs in the *h*-series (Grandjean 1948), where usually more than three pairs of setae are present. As *H. lacustris* has only three pairs of *h*-series setae and the same number of *l*-series setae, which variability did Deichsel (2004) really observe: *l*-series, *h*-series, or both series? We believe he was observing variability of *h*-series setae in *H. parisiensis*. Since he did not take note of the relative positions of seta *lm* to opening *gla*, he could not recognize the adults of *H. octosetosus*; if they were present, they were included in *H. lacustris*.

Deichsel (2004) did not name the *c* setae in his drawing, so we can only conclude that German populations of *H. lacustris* had one pair of setae *c*₂, if the total number of notogastral setae was 13 pairs. However, adults of *H. lacustris* from Norway have two to three pairs of setae of *c*-series, and those from Poland have one to three pairs, so the total number of notogastral setae is higher than that reported by Deichsel. This problem applies also to adults of *H. octosetosus* from lake Martwe in the Tuchola Forest, which have one to three pairs of *c*-series setae. Taking this into consideration, it is useless to compare total numbers of notogastral setae when adults of *H. lacustris* or *H. octosetosus* are mixed with those of *H. parisiensis*, because two series of setae (*c*- and *h*-series) vary. For example, adults of *H. lacustris* and *H. octosetosus* with two pairs in the *c*-series have the same total number of notogastral setae as adults of *H. parisiensis*, which have one pair in the *c*-series and four pairs in the *h*-series.

In the nymphal stages Deichsel (2004) observed the number of long setae to vary between two and eight pairs, but as noted above the reader does not know the source of the

variability: it may be in the *l*-series, the *h*-series or both series. In the nymphal stages this problem is more complicated than in the adults, because in a population of *H. lacustris* mixed with *H. parisiensis* the number of long setae varies in both *l*-series and *h*-series. *Hydrozetes lacustris* has one long pair in the *l*-series (*lp*), while *H. parisiensis* (after Grandjean 1948) has two pairs (*lm* and *lp*), just as in *H. octosetosus*. Additionally, the number of long *h*-series setae varies in *H. parisiensis* because of neotrichy, so the total number of long setae has no systematic value. If nymphs of *H. octosetosus* were present in Deichsel's (2004) study, they would have been included in *H. parisiensis*. It would be atypical of adults of *H. lacustris* to have a total of five pairs of setae in the *l*- and *h*-series, and nymphs with a total of two pairs of long setae in the posterior part of body, which Deichsel observed. The adults of both *H. lacustris* and *H. octosetosus* have six pairs of setae in the combined *l*- and *h*-series, while *H. parisiensis* has more setae because of neotrichy. In the nymphs of *H. lacustris* three pairs of long setae (*lp*, *h*₁, *h*₂) are present, while in *H. octosetosus* there are four pairs (*lm*, *lp*, *h*₁, *h*₂) and in *H. parisiensis* more than four pairs because of neotrichy (*lm*, *lp*, and all long setae of the *h*-series).

Hydrozetes lacustris and *H. octosetosus* are interesting in that some setae of the *c*-series have been lost, relative to the tritonymph, and such patterns are thought to reflect phylogeny. During this phylogeny two pairs of setae (*c*₁, *c*₃) are subject to loss, after which only setae *c*₂ remained. However, it is still not clear which pair is lost first, *c*₃ or *c*₁; Grandjean (1951, 1968) believed it was pair *c*₃, while Shaldybina (1972) thought it was pair *c*₁. The order of loss of setae of the *c*-series in this study is *c*₁ then *c*₃, consistent with Shaldybina (1972). However, Grandjean's (1951, 1968) pattern of loss of setae of this series also appears in the higher oribatid mites, for example, in the family Ceratozetidae, where pair *c*₃ is lost before pair *c*₁ (Seniczak et al. 1990).

In studied adults of *H. octosetosus* and *H. lacustris* the sensillus was short, setiform, or was absent, rarely clavate. Willmann (1932) observed only a clavate sensillus in *H. octosetosus*, while Michael (1898) mentioned both forms of sensillus in *H. lacustris*.

In European species of *Hydrozetes* the shape of some setae on tarsus I of adults may have a diagnostic value (Grandjean 1948), but is probably relevant to the juvenile stages too and varies geographically. For example, in the Norwegian adults of *H. lacustris* seta *s* was smooth, while in those studied by Willmann (1931) it was barbed; the Norwegian adults also had thinner seta *pv*'' and thicker seta *u* compared to those studied by Grandjean (1948). Therefore the leg setation of *Hydrozetes* should be investigated on wider geographical material.

The distribution of *H. octosetosus* differs from that of *H. lacustris*. In some lakes these species occur together, but in different proportions. Moreover, *H. lacustris* occurred alone in lake U1 (Ulriken, Norway), while *H. octosetosus* occurred in lake Martwe (Tuchola Forest, Poland) without *H. lacustris*. This kind of distribution would not be expected from a single highly variable species of the type proposed by Deichsel (2004). *Hydrozetes octosetosus* is new to the fauna of Poland, based on the list published by Olszanowski et al. (1996), and to the Norwegian fauna (Mehl 1979).

Acknowledgements

We cordially thank Prof. Dr Roy A. Norton, State University of New York, Syracuse, USA, for his thorough review of this manuscript and many valuable suggestions. Cathy Jenks, Department of Biology, University of Bergen, Norway, is acknowledged for linguistic improvements of the last version of the manuscript.

References

- Coggi A. 1897. Una nuova specie di Oribatide. In: Canestrini G, editor. Prospetto dell'Acarofauna Italiana, Bologna 8:916–921.
- Deichsel R. 2004. A morphometric analysis of the parthenogenetic oribatid mites *Hydrozetes lacustris* and *Hydrozetes parisiensis*—sister species or morphotypes? *Phytophaga* 14:383–388.
- Fernández N, Travé J. 1984. La variabilité chaetotaxique et la néotrichie gastronomique des Hydrozetidae (Oribates). *Acarologia* 25:407–417.
- Ghilarov MC, Krivoluckij DA. 1975. Key for soil mites. Sarcopitiformes. Moscow: Nauka. 381 p. (Rus).
- Grandjean F. 1948. Sur les *Hydrozetes* (Acariens) de l'Europe occidentale. *Bulletin du Muséum National d'Histoire Naturelle, Paris, Série 2* 20:328–335.
- Grandjean F. 1951. Sur deux espèces du genre *Dometorina* n. g. et les mœurs de *D. plantivaga* (Berl.) (Acariens, Oribates). *Bulletin du Muséum National d'Histoire Naturelle, Paris* 75:224–242.
- Grandjean F. 1963. Sur deux espèces de Brachychtoniidae et leur développement. *Acarologia* 5:122–151.
- Grandjean F. 1968. *Schusteria littorea* n. g., n. sp. et les Selenoribatidae (Oribates). *Acarologia* 10:116–150.
- Krantz GW. 1978. A manual of acarology. Corvallis: Oregon State University Bookstores.
- Krantz GW, Baker GT. 1982. Observations on the plastron mechanism of *Hydrozetes* sp. (Acari: Oribatida: Hydrozetidae). *Acarologia* 23:273–277.
- Mehl R. 1979. Checklist of Norwegian ticks and mites (Acari). *Fauna Norvegica, B* 26:1–45.
- Michael AD. 1898. Oribatidae. In: Lohmann H, editor. *Das Tierreich. Acarina 3. Lieferung*. Verlag Frießländer R. & Sohn, Berlin. p 1–93.
- Newell IM. 1945. *Hydrozetes* Berlese (Acari, Oribatoidea): the occurrence of the genus in North America, and the phenomenon of levitation. *Transactions of the Connecticut Academy of Arts and Sciences* 36:253–275.
- Norton RA. 1994. Evolutionary aspects of oribatid mite life histories and consequences for the origin of the Astigmata. In: Houck MA, editor. *Mites: ecological and evolutionary studies of life-history patterns*. New York: Chapman & Hall. p 99–135.
- Olszanowski Z, Rajski A, Niedbala W. 1996. Catalogue of Polish fauna. Mites (Acari), moss mites (Oribatida). *Sours Poznań* 34(9):1–243. (Pol).
- Seniczak S, Behan-Pelletier VM, Solhøy T. 1990. Systematic value of losses of some notogastral setae in adult Sphaerozetinae (Acari: Oribatida: Ceratozetidae) in the light of ontogenetic studies. *Acarologia* 31:385–400.
- Shaldybina ES. 1972. Some morphological characters of ceratozetid mites (Oribatei). *Scientific Notes of Gorki State Pedagogical Institute, Gorki* 130:35–66. (Rus).
- Strenzke K. 1943. *Hydrozetes thienemanni* n. sp. *Archiv für Hydrobiologie* 40:57–70.
- Subias LS. 2004. Systematic, synonymic and biogeographical check-list of the world's oribatid mites (Acariformes, Oribatida) (1758–2002). *Graellsia* 60:3–305 (Spanish).
- Travé J, Vachon M. 1975. François Grandjean 1982–1975 (Notice biographique et bibliographique). *Acarologia* 17:1–19.
- Weigmann G. 2006. Hornmilben (Oribatida). In: Dahl F, editor. *Die Tierwelt Deutschland und der angrenzten Meeressteile*. Volume 76. Keltern (Germany): Goecke & Evers. p 1–520.
- Weigmann G, Deichsel R. 2006. 4. Acari: Limnic Oribatida. In: Brauer A, editor. *Süßwasserfauna von Mitteleuropa*, 7/2-1. Elsevier, Spectrum Akademischer Verlag. p 89–112.
- Willmann C. 1931. Moosmilben oder Oribatiden (Oribatei). In: Dahl F, editor. *Die Tierwelt Deutschland und der angrenzten Meeressteile*. Jena: Verlag Gustav Fischer. p 79–200.
- Willmann C. 1932. Oribatiden aus dem Moosebruch. *Archiv für Hydrobiologie* 23:333–347.