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Description of two new *Drepanomonas* taxa and an account on features defining species in *Drepanomonas* Fresenius, 1858 (Ciliophora, Microthoracida)

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Abstract

Using standard methods, we describe two new *Drepanomonas* taxa: *Drepanomonas hymenofera* (Horváth 1956) nov. comb., which is composed of two (biogeographical?) subspecies, viz., *D. hymenofera venezuelensis* nov. subspec. and *D. hymenofera hymenofera* (Horváth 1956), was discovered in soil from Venezuela and Iceland, respectively. Both are comparatively large-sized (50 × 20 μm and 40 × 18 μm in vivo), differing in the cortex pattern and the structure of kineties 3 and 4. We agree with Corliss (1979) and Chardez (1990) that the genus *Pseudocristigera*, which was established by Horváth (1956) for *Drepanomonas hymenofera*, is a junior synonym of *Drepanomonas*. *Drepanomonas vasta* nov. spec., which was discovered in the mud of a tree hole in Austria, is a middle-sized species (35 × 18 μm) with thick body, wide left side ridges, a single anterior dikinetid in kinety 4, and an average of 99 basal bodies; it is unique in having the dorsal side much more flattened than the ventral side, thus being cuneate in transverse view. Ontogenetic data show that the ciliary pattern of *Drepanomonas* is homologous to that of *Leptopharynx*, specifically, the structure and origin of the postoral complex. Main features for distinguishing *Drepanomonas* species are discussed.

Keywords: Austria; Biogeography; Iceland; *Pseudocristigera*; Soil ciliates; Venezuela

Introduction

The present study continues our effort to clarify species features and phylogeny of the Microthoracidae by investigating the morphology and ontogeny of the generic type species (Omar and Foissner 2012b) and of new species discovered in various habitats globally (Foissner et al. 2011; Omar and Foissner 2011, 2012a,b). *Drepanomonas* Fresenius, 1858 is commonly found in terrestrial and semi-terrestrial habitats, such as mosses and soil from floodplains. Most *Drepanomonas* species are small and have a complex cortex. Thus, they are difficult to investigate in the light microscope. Scanning electron microscopy is very helpful for this kind of ciliates because it shows clearly the cortical ridge and furrow pattern (Foissner 1999; Foissner et al. 1994, 2011; present study).

As yet, ten nominal species have been described, four of which have been investigated or reinvestigated with modern methods: *D. exigua* Penard, 1922, *D. pauciciliata* Foissner, 1987, *D. revoluta* Penard, 1922, and *D. sphagni* Kahl, 1931 (Foissner 1979, 1987, 1999). Most data are available from *D. revoluta*, a frequent species occurring also in freshwater (reviewed by Foissner et al. 1994). The present study adds

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three taxa and can thus meaningfully discuss the features used for species discrimination, for instance, body size which has low variability coefficients and is thus a useful character.

Many microthoracids have the somatic ciliature strongly reduced; thus, the homologization of the ciliary patterns is difficult, needing special structures and/or ontogenetic data. We shall show that the ciliary pattern of *Drepanomonas* is homologous to that of *Leptopharynx* because we could homologize the postoral complex, a structure with a special ontogenesis (Omar and Foissner 2012b).

Material and Methods

For details on samples and locations, see the individual species descriptions. All were reactivated from the resting cysts of air-dried soil samples by the non-flooded Petri dish method (NFPM). Briefly, the NFPM involves placing 50–500 g litter and soil in a Petri dish (13–18 cm wide, 2–3 cm high) and saturating, but not flooding it, with distilled water. Such a culture is analysed for ciliates by inspecting about 2 ml of the run-off on days 2, 7, 14, 21, and 28; for a detailed description of the NFPM, see Foissner et al. (2002).

Cells were studied in vivo using a high-power oil immersion objective and differential interference contrast optics. The infraciliature and various cytological structures were revealed by protargol impregnation and the Klein–Foissner silver nitrate technic (Foissner 1991); *Drepanomonas hymenofera venezuelensis* was investigated also with the scanning electron microscope (SEM). Counts and measurements on silvered specimens were conducted at a magnification of 1000×. The "total number of basal bodies" excludes those of the adoral membranelles, which are difficult to count. In vivo measurements were performed at magnifications of 40–1000×. For kinety designation and numbering, see Fig. 5. The data available suggest classifying the microthoracid body length as (in vivo average): very small (10–19 μm), small (20–29 μm), middle-sized (30–39 μm), large (40–49 μm), and very large (≥50 μm). Terminology is according to Omar and Foissner (2012b). Drawings of live specimens were based on free-hand sketches and micrographs, while those of impregnated cells were made with a drawing device.

Results

Drepanomonas hymenofera (Horváth 1956) nov. comb.

Improved diagnosis. Size in vivo about 50 × 20 μm or 40 × 18 μm. Body semi-ellipsoidal with convex dorsal margin and flat but highly structured ventral side. Right side basically smooth, left with a shallow, narrow furrow in middle third or with a distinct, narrow furrow whole body length. Somatic kinety 3 with basal bodies throughout or with a break in middle third. Kinety 4 with narrow vs. very wide break in middle third. Kinety 6 only partially ciliated. On average a total of about 100 basal bodies. Oral apparatus slightly above mid-body.

Drepanomonas hymenofera venezuelensis nov. subspec. (Figs 1–29; Tables 1 and 2)

Diagnosis. Size in vivo about 50 × 20 μm. Left side with shallow, narrow furrow in middle third of body. Somatic kinety 3 with basal bodies throughout. Kinety 4 with narrow break in middle third.

Type locality. Soil and litter under a large tree with leguminose understorey in the floodplain of the Lower Orinoco River near to the village of Cabruta, Venezuela, N7°38′ W66°14′.

Type material. One holotype slide with protargol-impregnated specimens and eight paratype slides with protargol-impregnated and Klein–Foissner silver nitrate-impregnated specimens have been deposited in the Biology Centre of the Museum of Upper Austria, Linz (LI), reg. no. 2012/116–125. The holotype (Figs 8 and 9) and important paratype specimens have been marked by black ink circles on the coverslip.

Etymology. Named after the country in which it was discovered.

Description. Size in vivo 40–60 × 15–25 μm, usually about 50 × 20 μm, as calculated from some in vivo measurements and the morphometric data (Table 1), assuming 15 and 25% preparation shrinkage in protargol and SEM preparations, respectively. Body semi-ellipsoidal to slenderly semi-ellipsoidal, length:width ratio 2.3:1 in live micrographs and protargol preparations, 2.1:1 in silver nitrate-impregnated cells, and 2.4:1 in SEM preparations; usually slightly wider in posterior than anterior half. Laterally flattened up to 3:1, right side flat, left slightly convex (Figs 1, 2, 6, 7, 12–16, 25–27; Table 1). Nuclear apparatus in or near mid-body, slightly right of body midline, i.e., in curve formed by oral basket. Macronucleus about 8 μm across in vivo and in protargol preparations, globular to very broadly ellipsoidal, with many peripheral nucleoli; micronucleus near or attached to ventral side of macronucleus, globular (Figs 1, 9, 12, 15, 16, 19; Table 1). Contractile vacuole posterior to and slightly dorsal of buccal cavity, with tube recognizable in protargol preparations and extending into buccal cavity posterior to adoral membranelles (Figs 1, 8, 14, 19; Table 1). Cytopyge posterior and slightly left of contractile vacuole in lateral view, usually forming a blister containing some food remnants (e.g., bacterial spores); in silver nitrate preparations represented by a thick, short silverline posterior to buccal cavity; in SEM micrographs appearing as a slightly oblique concavity posterior to oral cavity (Figs 10, 11, 16, 23, 25, 27–29). Extrusomes left of somatic kineties and posterior to preoral kineties, lenticular, not as compact as in other microthoracids (e.g., *Leptopharynx costatus*), i.e., with fluffy centre, about