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Trichodinid ciliates (Peritrichia: Trichodinidae) from the Bay of Kiel, with description of *Trichodina claviformis* sp. n.

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Abstract. Investigations on the epizoic fauna of *Gadus morhua* (L.), *Platichthys flesus* (L.) and *Oncorhynchus mykiss* (Walbaum) from the Kiel Fjord and Kiel Bight were carried out from September 1996 to March 1997. Smears from 120 *G. morhua* and 92 *P. flesus* caught using fish traps and trammel nets, and of 35 *O. mykiss* obtained from a local fish farm in the Kiel Fjord revealed the presence of three species of trichodinid ciliates, *Trichodina claviformis* sp. n., *Trichodina jadranica* Haider, 1964 and *Trichodina raabei* Lom, 1962. The new species can be distinguished from other trichodinids by its large size in combination with the characteristically shaped adhesive disc containing denticles with club-like formed thorns. The thorns are directed anteriorly and not towards the centre of the adhesive disc. As the Kiel Bight and Kiel Fjord are new locality records for *T. jadranica* and *T. raabei*, morphological data are provided for both species. *Trichodina claviformis* is the first record of a peritrichous mobiline ciliate from Atlantic cod of the Baltic Sea. An identification key for 16 *Trichodina* species occurring on Baltic Sea fishes is provided based on the morphology of the adhesive disc and other well-established features. The occurrence of trichodinid ciliates on *G. morhua* and *P. flesus* in the Baltic Sea is discussed, especially considering the biology of the host and a possible host specificity of the species.

Marine trichodinid ciliates (Ciliophora: Peritrichia) live as commensals and parasites on various hosts, such as ctenophores (Estes et al. 1997), echinoderms (Precht 1935), echiuroids (Noble 1940), molluscs (Raabe and Raabe 1959, Fenchel 1965, Xu et al. 1995), and fishes. Most of the species are described from the body surfaces and gills of teleosts (Raabe 1959, Lom 1962, Calenius 1980, Van As and Basson 1987), where they feed on waterborne bacteria, small algae, detritus and particles from the host surface (Lom 1973).

In high densities, trichodinid ciliates have been reported to cause severe damage and mortality in juvenile and adult fish populations (trichodiniasis) in aquaculture facilities (Van As and Basson 1987), resulting in heavy financial losses for fish farmers (Moksness et al. 1989). Because of their direct transmission trichodinid ciliates are able to invade their hosts within a short period, especially fish that are kept under less than optimal conditions (Lom 1995). In such cases, they additionally feed on host-cell debris (Lom 1973). Today, trichodinid ciliates have been considered as one of the most common fish parasites in the aquatic environment (Körting et al. 1985). However, the majority of reports focus on trichodinids from freshwater fish, whereas reports from the marine environments are rare (Grupcheva et al. 1989).

In contrast to their economical importance and abundance in the aquatic environment the exact identification of trichodinid ciliates often remains unclear. Today, about 200 species representing ten genera are described within the family Trichodinidae, which are characterised by the length of their adoral ciliary spiral and the shape of the denticles of the adhesive disc (Basson and Van As 1989, Van As and Basson 1993). The largest genus *Trichodina* comprises more than 170 species. Probably due to the species-richness within this family, the recent literature often deals with trichodinids at the genus level. The purpose of the present study is to examine and describe trichodinid ciliates of Atlantic cod *Gadus morhua* (L.) and common flounder *Platichthys flesus* (L.), both important economical fish species from the North and Baltic Sea, and of rainbow trout *Oncorhynchus mykiss* (Walbaum) kept in a net cage in the Kiel Fjord. A new species, *Trichodina claviformis* sp. n. is described, and an identification key is presented for all currently known trichodinid species from Baltic Sea fish, which enables an exact identification to the species level.

MATERIALS AND METHODS

A total of 120 *Gadus morhua* (11-66 cm) and 92 *Platichthys flesus* (10-50 cm) were collected between October 1996 and March 1997 by fish traps (emptied after 3 days) and trammel nets (emptied each 24 h) in Kiel Fjord, and in January 1997 by trawl-fisheries in Kiel Bight (also see Palm and Dobberstein 1999). Thirty-five *Oncorhynchus mykiss* (54-64 cm) were obtained from a local fish farm (Aquakultur-gesellschaft Ostseeforelle Gbr.) in Kiel Fjord. Smears of skin and fins of nearly equal size (7 cm^2) were taken from living or freshly killed specimens. Gill-scrapings were taken from the

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first gill arch. From fish caught by trawl fisheries, only the scrapings of the gills were examined for the presence of trichodinid ciliates. Klein's silver-impregnation technique (Lom 1958) was used to demonstrate the components of the adhesive disc and the adoral ciliary spiral. Air dried smears were slightly washed with distilled water to remove chloride ions by using a Pasteur pipette, left to air dry again, impregnated with a 5% aqueous solution of silver nitrate ($AgNO_3$) for 30 min, again washed with distilled water and exposed to UV light for 30-40 min. All morphological measurements were carried out by oil-immersion light microscopy (Orthoplan, LEITZ). Methods and terminology for measurements of the components of the adhesive disc and the position of the micronucleus in relation to the macronucleus follow those given by Lom (1958). The arithmetic mean, standard deviation and range of the morphometrical data are given in µm unless otherwise indicated. The classification follows Lom (1994).

RESULTS

During the present study three species of trichodinid ciliates were found. *Gadus morhua* and *Platichthys flesus* from the Kiel Bight and the Kiel Fjord were infested with *Trichodina claviformis*, *Trichodina jadranica* Haider, 1964 and *Trichodina raabei* Lom, 1962, the latter being the most common. *T. claviformis* is the first trichodinid ciliate being described from *G. morhua* of the Baltic Sea. In the following, descriptions and photomicrographs of silver-impregnated specimens of all three species are presented. Prevalence and density data as well as ecological consideration are subject of an other communication (Palm and Dobberstein 1999). The resulting identification key comprises 16 known trichodinid species from the Baltic Sea.

Trichodina claviformis sp. n. Figs. 1-4

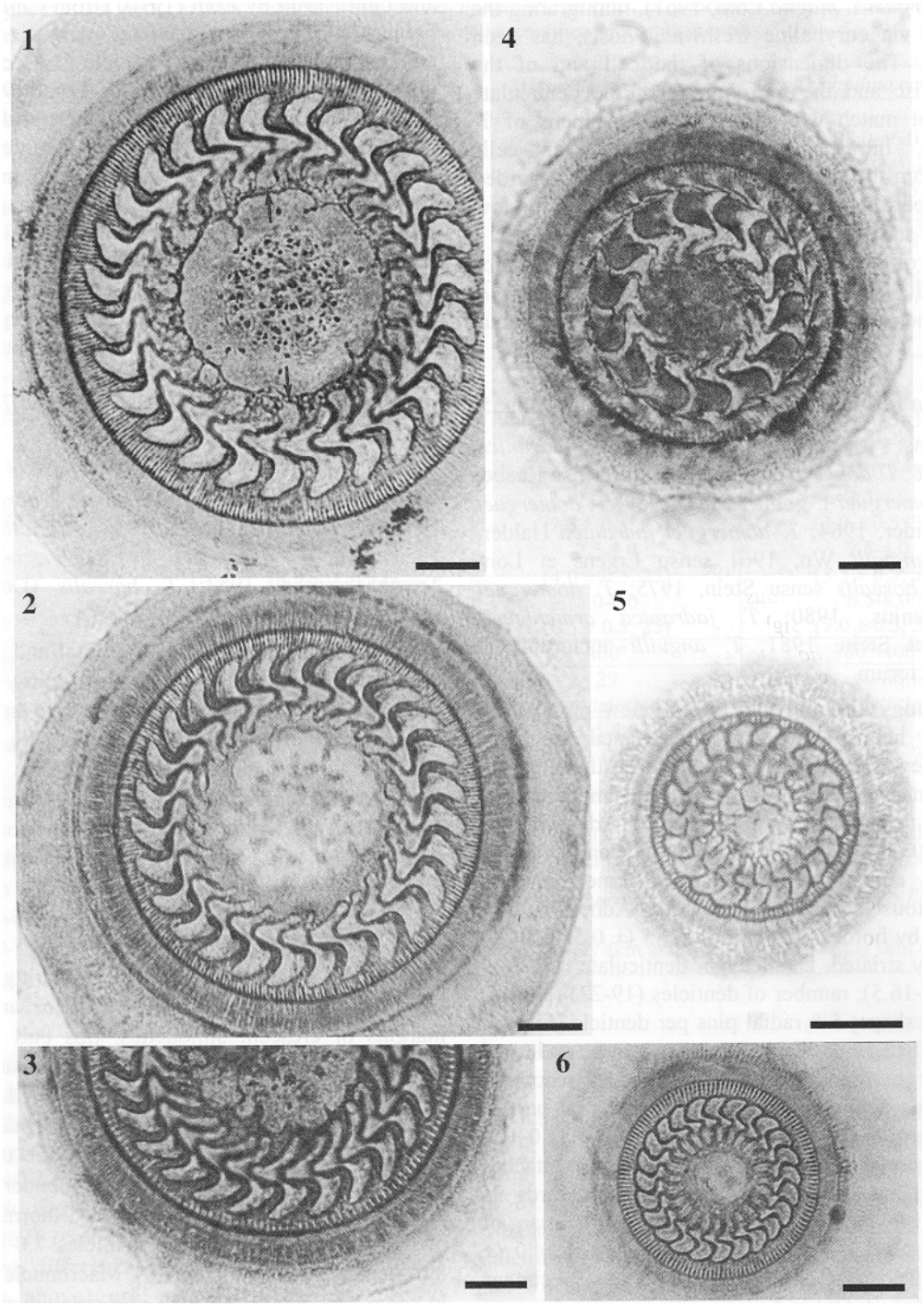
Description: *Trichodina claviformis* is the largest *Trichodina* species found during this investigation (Figs. 1-3), its cell diameter being about 85.3 (± 6.7; 74.7-100.9). In lateral view living cells flattened cylindrical-shaped; in aboral and oral view circular. Adoral ciliary spiral turns 330°-370° before plunging into buccal cavity where it is divided up to the conspicuous buccal ciliature leading to cytostome (Hausmann and Hausmann 1981). Silver-impregnated specimens with bright centre within adhesive disc containing dark granules of irregular shape and size. Diameter of adhesive disc 59.3 (± 3.9; 51.1-66.8); denticulate ring 39.2 (± 3.5; 28.2-43.9). Width of border membrane 5.4 (± 0.6; 3.9-6.6). Denticulate ring consists of 26-27 (25-29) denticles which appear closely connected; 10-11 radial pins per denticle. Number of denticles (Fig. 7) and number of radial pins per denticle (Fig. 8) varies between different specimens. Blade, measuring 5.7 (± 0.7; 3.9-7.2), slightly curved, tapering towards end; connection to central part narrow. In some specimens blade reveals sharply curved edge at aperture to central part. Posterior process of central part reaches far into aperture of the following denticle; width of central part 2.3 (± 0.4; 1.7-3.3). Thorn short: 3.9 (± 0.5; 3.3-5.2). Insertion to central part quite thin, thorn directed anteriorly with characteristic club-like end. Span of denticle 11.7 (± 1.1; 9.2-14.4), length of denticle 8.9 (± 0.7; 7.9-10.1). Macronucleus horseshoe-shaped; outer diameter 45-60. Micronucleus located at inner diameter near the end of the macronucleus in $-y^1$=2 µm position. The morphometrical data are summarised in Table 1.

Some cells have completed binary fission, recognisable by a smaller diameter of the cell and by half the number of radial pins compared to adult cells (Fig. 3). The denticulate ring is divided in two concentric rings; an inner one, revealing about half the number of the denticles (14 in Fig. 4) compared to mature specimens, and being partly resorbed. The second outer ring is newly synthesised (26 denticles in Fig. 4) in order to complete the denticle number.

Host, site and locality: *Trichodina claviformis* was most commonly found on the gills of *G. morhua*, rarely on skin and fins. The hosts were collected from the western Baltic Sea (Kiel Bight and Kiel Fjord), with *G. morhua* being the type host; few cells were found on the body surfaces of *P. flesus*, the number of specimens were insufficient for statistical analyses of the intraspecific variation.

Type hosts: *Gadus morhua* and *Platichthys flesus.*

Remarks: No corresponding descriptions of marine or brackish fish trichodinids were found. Species of similar size (ranging from about 65-110) are *Trichodina cooperi* Poynton et Lom, 1989, *T. domerguei* f. *magna* Lom, 1961, *T. domerguei* f. *maris-negri* Lom, 1962, *T. fultoni* Davis, 1947, *T. hippoglossi* Nilsen, 1995, *T. murmanica* Polyanskiy, 1955 and *T. tenuidens* Fauré-Fremiet, 1943. The occurrence of *T. murmanica* on *G. morhua* is recorded by Polyanskiy (1955), Zhukov (1964), Stein (1976) and Poynton and Lom (1989), but this species is smaller (diameter of the cell: 51-72), the number of radial pins per denticle is smaller (7-10), and the thorns of *T. murmanica* are nearly twice as long (6.1). Both, *T. cooperi* and *T. tenuidens*, reveal a dark centre of the adhesive disc in silver-impregnated specimens, and *T. domerguei* f. *maris-negri* reveals a markedly different morphology of the adhesive disc, with larger diameters of cell, adhesive disc and denticulate ring. The description of *T. hippoglossi* was found to be inappropriate because of its different morphology of the adhesive disc and the position of the micronucleus in +y-position (*Trichodina claviformis*: $-y^1$-position). The thorns of *T. domerguei* f. *maris-negri* and *T. hippoglossi* point towards the centre of the adhesive disc. As the western Baltic Sea reveals a salinity of about 12-17 PSU, the possibility of the occurrence of euryhaline trichodinids, such as *T. fultoni*



Figs. 1-4. *Trichodina claviformis* sp. n. from gills of *Gadus morhua*; adhesive disc, silver impregnation. **Fig. 1.** Specimen with denticles having club-like thorns (arrow). **Fig. 2.** Intraspecific variability of the adhesive disc morphology. **Fig. 3.** Young specimen, indicated by half the number of radial pins per denticle. **Fig. 4.** Cell after binary fission. **Fig. 5.** *Trichodina jadranica* Haider, 1964 from gills of *Platichthys flesus*; adhesive disc, silver impregnation. **Fig. 6.** *Trichodina raabe*i Lom, 1962 from gills of *Platichthys flesus*; adhesive disc, silver impregnation. Scale bars = 10 µm.

(= *T. domerguei* f. *magna* Lom, 1961), immigrating the Baltic Sea via euryhaline freshwater hosts, has been considered. The dimensions of the cell and of the adhesive disc and the morphology of the denticulate ring do not match with the present specimens of *T. claviformis*. Intraspecific variability between cells sampled from the two different hosts was not regarded as the number of specimens from *P. flesus* were too low for detailed statistical examinations.

Because of the characteristic anteriorly directed club-like formed thorns, which distinguishes *T. claviformis* from all other currently known species within the genus *Trichodina*, we suggest to establish it as a new species.

Trichodina jadranica Haider, 1964 Fig. 5

Synonyms: *Trichodina domerguei* f. *jadranica* Raabe, 1958; *T. domerguei* f. *pleuronectes* sensu Raabe, 1958; *T. domerguei* f. *gobii* Raabe, 1959; *T. domerguei* f. *gobii* Haider, 1964; *T. domerguei jadranica* Haider, 1964; *T. anguilli* Wu, 1961 sensu Ergens et Lom (1970); *T. borealis* sensu Stein, 1975; *T. domerguei* sensu Calenius, 1980; *T. jadranica armeniensis* Grigorian et Stein, 1981; *T. anguilli* auctorum; *T. borealis* auctorum

Morphology: In oral and aboral view circular, in lateral view hemispherical or dome shaped; height of cell-body never reaches body diameter. Adoral ciliary spiral extends about 400°. In silver impregnation, diameter of cells 34.0 (± 4.5; 26.0-44.5). Adhesive disc (23.0 ± 3.0; 17.0-29.0) reveals clear centre, which occasionally contains dark irregularly formed granules or filamentous structures (Fig. 5). Adhesive disc surrounded by border membrane of 2.5 (± 0.5; 1.5-4.0) width, finely striated. Diameter of denticulate ring 14.0 (± 1.5; 10.0-16.5); number of denticles (19-22) (Figs. 5, 7) of sturdy shape; 5-8 radial pins per denticle (Figs. 5, 8). Blades (2.5 ± 0.5; 2.0-3.5) broad and end semicircular in rounded tip; anterior edges reach far onto previous denticle. Blades insert at central part in front of thorn. Short central part (1.2 ± 0.1; 1.0-1.5) opens posteriorly of transition of blade. Thorn attaches in thickened base at central part tapering towards its end. Length of thorn 2.5 (± 0.5; 2.0-3.5); span of denticle 6.5 (± 0.5; 5.0-8.0), length of denticle 4.0 (± 0.5; 2.5-5.0). Macronucleus in some specimens horseshoe-shaped. Outer diameter 29, micronucleus not detected. The principal morphometrical data are summarised in Table 1.

H o s t, s i t e a n d l o c a l i t y : *Trichodina jadranica* was commonly found on the gills of *Platichthys flesus*, seldom and in a lower intensity on fins and skin. The hosts were collected from the western Baltic Sea (Kiel Bight and Kiel Fjord).

Remarks: This species was identified on basis of the original descriptions of *Trichodina jadranica* Haider, 1964 by Arthur and Lom (1984) (from *Citharichthys spilopterus*, Cuba) and *T. jadranica* (Raabe, 1958) Lom and Laird, 1969 by Lom (1970) (from *Calionymus lyra*, France). Values for denticle number (19-22) and number of radial pins per denticle (5-8) correspond to the data given for *T. jadranica* by Lom (1970) (denticle number: 18-23; number of radial pins per denticle: 6-7). Plate IV (figs. 1-4) in Lom (1970) also demonstrates a similar morphology as given in Fig. 5 in the present study. However, the absolute values for diameters of cell, adhesive disc and denticle ring slightly differ between these specimens (compare Table 1 to table 1 in Lom 1970), and *T. jadranica* in figs. 1, 2 by Arthur and Lom (1984) show a slightly different morphology than that reported for the present specimens. These differences are recognised as cases of intraspecific variation within the species (also see Figs. 7, 8).

Trichodina raabei Lom, 1962 Fig. 6

Synonyms: *Trichodina domerguei* f. *borealis* Dogiel, 1940; *T. cottidarum* Dogiel, 1948; *T. multidentis* Laird, 1953 part.; *T. domerguei* f. *pleuronectes* Stryjecka-Trembaczowska, 1953; *T. borealis* (Dogiel, 1940) Shulman et Shulman-Albova, 1953.

Morphology: Cells circular in oral and aboral view, in lateral view flat conical. Adoral ciliary spiral turns about 380°-400° before it plunges into buccal cavity. Diameter of silver-impregnated cells (Fig. 6) 43.0 (± 3.0; 38.0-46.0), diameter of adhesive disc 26.5 (± 2.0; 22.5-31.5) revealing darkly stained centre, similar to area between denticles (Fig. 6). Diameter of denticulate ring 17.5 (± 1.5; 14.0-21.0). Border membrane 3.0 (± 0.5; 2.0-3.5) wide, containing fine striation of peripheral pins. Denticulate ring consists of 26-27 (23-29) compactly arranged denticles (Figs. 6, 7), 5-8 radial pins per denticle (Figs. 6, 8). Blades measuring 3.0 (± 0.5; 2.5-4.0), reveal nearly parallel anterior and posterior margins or crescent silhouettes; tips end bluntly and slightly bend backwards. Central parts relatively short, connection with blades relatively broad. Width of central part 1.3 (± 0.1; 1.0-1.5). Thorns broadly insert at central part, taper towards ends, 3.0 (± 0.5; 2.5-4.0) long. The whole shape of denticles slender with knee-like curve at transition to central part, thorns and blades of the same length. Span of denticles 7.0 (± 0.5; 6.5-8.0), length 3.5 (± 0.5; 2.5-4.0). Macronucleus observed in some specimens about 30 in diameter, micronucleus not detected. A summary of the morphometrical data is given in Table 1.

H o s t, s i t e a n d l o c a l i t y : *Trichodina raabei* was found on *P. flesus*, especially on gills rarely on skin and fins. The hosts were collected from the western Baltic Sea (Kiel Bight and Kiel Fjord).

Remarks: The identification is based on the original description of *Trichodina raabei* in Lom (1962; plate 1, fig. 11) from *Platichthys flesus* (Black Sea). Later descriptions by Stein (1976; plate 2, figs. 10, 11) from *Limanda limanda* (White Sea) and Calenius (1980;

Table 1. Morphometrical data, locality, host and site of *Trichodina claviformis*, *T. jadranica*, and *T. raabei* (range with arithmetic mean, standard deviation, and number measured in parentheses) (measurements in µm).

Species	*Trichodina claviformis*	*Trichodina jadranica*	*Trichodina raabei*
Diameter of:			
cell	74.7-100.9 (85.3 ± 6.7; 32)	26.0-44.5 (34.0 ± 4.5; 19)	38.0-46.0 (43.0 ± 3.0; 26)
adhesive disc	51.1-66.8 (59.3 ± 3.9; 32)	17.0-29.0 (23.0 ± 3.0; 25)	22.5-31.5 (26.5 ± 2.0; 34)
denticulate ring	28.2-43.9 (39.2 ± 3.5; 32)	10.0-16.5 (14.0 ± 1.5; 25)	14.0-21.0 (17.5 ± 1.5; 34)
number of denticles	26-27 (25-29; 32)	19-22 (25)	26-27 (23-29; 34)
number of radial pins per denticle	10-11 (32)	5-8 (21)	5-8 (33)
Shape of denticle:			
length of blade	3.9-7.2 (5.7 ± 0.7; 32)	2.0-3.5 (2.5 ± 0.5; 25)	2.5-4.0 (3.0 ± 0.5; 34)
width of central part	1.7-3.3 (2.3 ± 0.4; 32)	1.0-1.5 (1.2 ± 0.1; 25)	1.0-1.5 (1.3 ± 0.1; 34)
length of thorn	3.3-5.2 (3.9 ± 0.5; 30)	2.0-3.5 (2.5 ± 0.5; 25)	2.5-4.0 (3.0 ± 0.5; 34)
length of denticle	7.9-10.1 (8.9 ± 0.7; 32)	2.5-5.0 (4.0 ± 0.5; 25)	2.5-4.0 (3.5 ± 0.5; 34)
span of denticle	9.0-14.4 (11.7 ± 1.1; 31)	5.0-8.0 (6.5 ± 0.5; 25)	6.5-8.0 (7.0 ± 0.5; 34)
turns of adoral ciliary wreath	330°-370°	400°	380°-400°
diameter of macronucleus	45-60	29	ca. 30
position of micronucleus	- $y^1 = 2$	not detected	not detected
width of border membrane	3.9-6.6 (5.4 ± 0.6; 32)	1.5-4.0 (2.5 ± 0.5; 23)	2.0-3.5 (3.0 ± 0.5; 33)
position of contractile vacuole	central	central	central
locality	Kiel Fjord, Kiel Bight	Kiel Fjord, Kiel Bight	Kiel Fjord, Kiel Bight
host	*Gadus morhua*, *Platichthys flesus*	*Platichthys flesus*	*Platichthys flesus*
site	gills, most rarely skin and fins	gills, rarely skin and fins	gills, rarely skin and fins

plate 1, fig. 6) from *Platichthys flesus* (Åland Islands) also correspond to the present specimens. Values for the diameter of the cell and denticle ring are slightly higher than data given by Lom (1962). However, the dimensions of the denticles, length of the blade, thorn, and the width of the central part correspond to the data by Lom (1962) (compare Table 1 to table 1 in Lom 1962). Slight differences demonstrated in the given figures (see above) are interpreted as intraspecific variability according to Kazubski (1982).

Findings of trichodinid ciliates on *Oncorhynchus mykiss* were scarce. The small number of specimens found indicates that *O. mykiss* is not a preferred host for the three detected trichodinid species, *Trichodina claviformis*, *T. jadranica* and *T. raabei*. The two cells found were insufficient for a proper identification, especially due to the light staining. However, the cell diameter and the number of denticles was within the range as given for *Trichodina claviformis*, and not as given for *T. jadranica* or *T. raabei*.

Identification key to trichodinid ciliates of Baltic Sea fishes

This identification key to trichodinid ciliates from the Baltic Sea is based only on reliable original descriptions using Klein's silver-impregnation technique (Lom 1958). The characters used are taken according to Albaladejo and Arthur (1989), Arthur and Lom (1984), Calenius (1980), Kazubski and Migala (1968), Kazubski and Pilecka-Rapacz (1981), Lom (1962, 1970), Lom and Haldar (1976), Lom and Hoffman (1964), Raabe (1959), Rauckis (1983) and Stein (1982).

1 epizoic on gills, skin or fins of fish 2
– endozoic in the urinary tract of perch .... *Trichodina urinaria* (diam. of cell 74 (64-91), diam. of adhesive disc 48 (40-60), diam. of denticulate ring 24 (21-29), number of denticles 35 (32-37), number of radial pins per denticle 6-8)

2 (1) adhesive disc with bright centre (brighter than between denticles) 3
– adhesive disc not completely bright 8

3 (2) number of denticles ≥ 25 4
– number of denticles < 25 7

4 (3) number of radial pins per denticle ≥ 10 5
– number of radial pins per denticle < 10 6

5 (4) thorn club-shaped, shorter than blade .... *Trichodina claviformis*
(diam. of cell 82 (71-100), diam. of adhesive disc 57 (47-67), diam. of denticulate ring 38 (28-44), number of denticles 26-27 (25-29), number of radial pins per denticle 10-11)
– thorn straight, nearly as long as blade .... *Trichodina fultoni*
(diam. of cell 101 (91-112), diam. of adhesive disc 78 (71-86), diam. of denticulate ring 52 (47-58), number of denti-cles 28 (26-31), number of radial pins per denticle 12-14)

6 (4) number of radial pins per denticle 8, centre of adhesive disc with dark granules, thorn relatively short compared to blade .... *Trichodina domerguei* subsp. *domerguei*
(diam. of cell 52 (36-60), diam. of adhesive disc 40 (33-48), diam. of denticulate ring 25 (21-28), number of denticles 25 (23-28), number of radial pins per denticle 8)
– number of radial pins per denticle ≤ 8, bright centre of the adhesive disc not contrasted to the area between denticles ..... *Trichodina borealis*
(diam. of cell 50 (42-52), diam. of adhesive disc 37 (33-40), diam. of denticulate ring 25 (23-26), number of denticles 27 (25-30), number of radial pins per denticle 7-8)
(*T. borealis* is considered *nomen dubium*, and transferred partly to *T. jadranica* and *T. raabei*)

7 (3) number of radial pins per denticle ≥ 10 .... *Trichodina acuta*
(diam. of cell 57 (52-67), diam. of adhesive disc 48 (42-57), diam. of denticulate ring 30 (28-36), number of denticles 18 (17-19), number of radial pins per denticle 10-12)
– number of radial pins per denticle < 10 .... *Trichodina jadranica*
(diam. of cell 43 (34-51), diam. of adhesive disc 25 (20-31), diam. of denticulate ring 14 (11-17), number of denticles 19 (17-21), number of radial pins per denticle 5-7)

8 (2) centre of adhesive disc bright with dark crossing filaments ..... *Trichodina reticulata*
(diam. of cell 61 (57-69), diam. of adhesive disc 46 (46-57), diam. of denticulate ring 34 (31-37), number of denticles 24 (22-26), number of radial pins per denticle 10-12)
– centre of adhesive disc as dark as the area between denticles 9

9 (8) number of radial pins per denticle ≥ 10 10
– number of radial pins per denticle < 10 12

10 (9) number of denticles ≥ 24 11
– number of denticles < 24 ..... *Trichodina nigra*
(diam. of cell 49 (43-54), diam. of adhesive disc 39 (33-44), diam. of denticulate ring 25 (22-29), number of denticles 21 (19-23), number of radial pins per denticle 9-12)

11 (10) number of radial pins per denticle ≥ 12, width of the border membrane ≥ 6 µm .... *Trichodina nobilis*
(diam. of cell 79 (70-90), diam. of adhesive disc 65 (58-77), diam. of denticulate ring 44 (39-53), number of denticles 25 (23-28), number of radial pins per denticle 12-14)
– number of radial pins per denticle < 12, width of the border membrane < 6 ... *Trichodina tenuidens*
(diam. of cell 64 (52-81), diam. of adhesive disc 50 (40-65), diam. of denticulate ring 41 (33-53), number of denticles 26 (25-33), number of radial pins per denticle 10)

12 (9) diameter of adhesive disc ≥ 40 13
– diameter of adhesive disc < 40 14

13 (12) thorn nearly twice as long as blade, reaching far into centre of adhesive disc .... *Trichodina pediculus*
(diam. of cell 71-104, diam. of adhesive disc 49-58, diam. of denticulate ring 32-38, number of denticles 28-29, number of radial pins per denticle 7-8)
– length of thorn not twice as long as blade .... *Trichodina tisae*
(diam. of cell 53 (48-57), diam. of adhesive disc 42 (40-45), diam. of denticulate ring 28 (26-30), number of denticles 25 (23-27), number of radial pins per denticle 7-8)

14 (12) number of denticles 26-27, number of radial pins per denticle < 12 ..... *Trichodina raabei*
(diam. of cell 38 (35-40), diam. of adhesive disc 28 (26-32), diam. of denticulate ring 16 (14-18), number of denticles 26 (23-29), number of radial pins per denticle 6)
– number of denticles < 26, number of radial pins per denticle < 12 15

15 (14) number of denticles 22-23, number of radial pins per denticle 7-8 ..... *Trichodina modesta*
(diam. of cell 39 (34-45), diam. of adhesive disc 26 (25-27), diam. of denticulate ring 15 (13-16), number of denticles 22 (21-23), number of radial pins per denticle 7-8)
– number of denticles about 19-26, number of radial pins per denticle 8, blade crescent-shaped, tip pointing posteriorly .... *Trichodina cottidarum*
(diam. of cell 42 (33-46), diam. of adhesive disc 32 (25-36), diam. of denticulate ring 16 (14-18), number of denticles 23 (19-26), number of radial pins per denticle 8)

In the key, both euryhaline and stenohaline trichodinids are considered due to the high salinity differences between the western and eastern Baltic Sea. However, *Trichodina convictor* from *Alburnus alburnus*, *Gobio gobio* and *Scardinius erythrophthalmus*; *Trichodina esocis* from *Perca fluviatilis* and *Stizostedion lucioperca*; *Trichodina rectangli rectangli* from *Rutilus rutilus*, all recorded by Stein (1982), and *Trichodina meridionalis* from the body surfaces of *Vimba vimba* (Rauckis 1983), were recorded from the Kurish Lagoon and adjacent rivers (freshwater). These species were not enclosed as their occurrence is restricted to the freshwater environment.

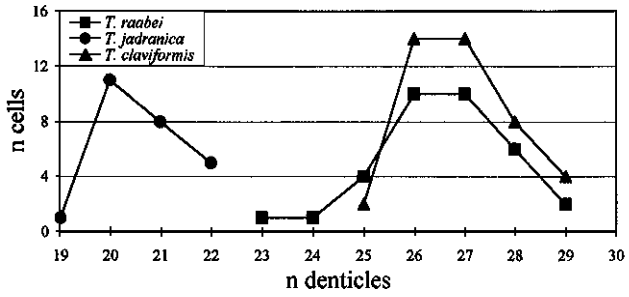


Fig. 7. Denticle number in *Trichodina claviformis*, *Trichodina jadranica* and *Trichodina raabei*, showing intraspecific morphological variability.

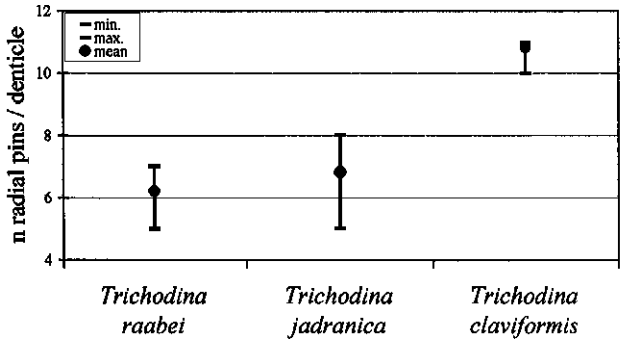


Fig. 8. Number of radial pins per denticle in *Trichodina claviformis*, *Trichodina jadranica* and *Trichodina raabei*, showing intraspecific morphological variability.

DISCUSSION

The only data on trichodinid ciliates from the western Baltic Sea go back to Precht (1935) and Lüthen (1989). Precht (1935), following the classification of Wallengren (1897), identified trichodinids from three-spined sticklebacks in Kiel Fjord as *Trichodina domerguei*. As these trichodinid ciliates were described without using the silver-impregnation technique (Lom 1958), this finding still needs taxonomical revision. Lüthen (1989), though using the silver-impregnation technique, identified *T. jadranica* and *T. borealis* from economically important flatfish (common dab, European flounder and turbot) off the coast of the former GDR. However, *T. borealis* is not a valid species due to its original description without using the silver-impregnation technique, no decisive picture of the adhesive disc and a variable size. Thus, the present study establishes new locality records for *T. jadranica* and *T. raabei*.

Gadus morhua is known to be infested with trichodinid ciliates in North Atlantic waters off Nova Scotia (Poynton and Lom 1989) and in Russian waters (Polyanskiy 1955, Zhukov 1964, Stein 1976). A few species of trichodinid ciliates have been reported previously: *Trichodina murmanica* mainly infests fins and, occasionally gills of *G. morhua* in the Barents Sea (Polyanskiy 1955); Poynton and Lom (1989) reported *T. murmanica*, *T. cooperi* and *Trichodina* sp. infesting skin and fins of *G. morhua* from Nova Scotian waters. *Trichodina claviformis*, which mainly infests gills of *G. morhua*, can be added to this list based on the present study. This is the first record of a trichodinid ciliate on *G. morhua* from the Baltic Sea. The geographical distribution of members within the family Trichodinidae living on *G. morhua* is therefore extended to the western Baltic Sea.

Platichthys flesus of the Baltic Sea is known to be a common host for trichodinid ciliates, namely *Trichodina borealis* by Calenius (1980), Lüthen (1989), Rokicki and Morozinska (1994), *T. jadranica* by Lüthen (1989), Vismanis and Kondratovics (1994) and *T. raabei* by Calenius (1980), Tabolina (1994) and Vismanis and Kondratovics (1994). Additionally, Calenius (1980) found an unidentified trichodinid ciliate which was tentatively identified as *Trichodina domerguei* subsp. sp. due to the morphology of the denticles. The present study records *T. jadranica* and *T. raabei* from the gills of *P. flesus* caught in the Kiel Fjord and Kiel Bight, confirming that *T. jadranica* and *T. raabei* are the typical parasites of *P. flesus* from the Baltic Sea, as previously stated by Tabolina (1994) and Vismanis and Kondratovics (1994). Pleuronectiform fish species from various localities of the northern hemisphere were found to be infected by six trichodinid species (*T. borealis* [see below], *T. cottidarum, T. frequentis, T. jadranica, T. nigra* and *T. raabei*) (Zhukov 1964, Stein 1967, 1979, MacKenzie 1969, Lom 1970, MacKenzie et al. 1976).

Only two trichodinid cells found on 35 specimens of *Oncorhynchus mykiss* indicate that this fish is not a preferred host for *Trichodina* in the western Baltic Sea. Due to the large cell size, the specimens found do not belong to *T. jadranica* or *T. raabei* but were similar in size to *T. claviformis*, which was also detected on *Platichthys flesus* and *Gadus morhua*. Thus, *T. claviformis* might have a wide host range in the eastern Baltic Sea.

The biology of the host influences the prevalence and intensity of its trichodinid burden (Palm and Dobberstein 1999). Bacteria are known to occur adsorbed at surfaces of organic and inorganic particulate matter in a much higher biomass as compared to the free water column (Meyer-Reil 1983). A demersal host such as *P. flesus* enables trichodinids to take advantage of a rich and more stable food supply, compared to a host living temporarily demersal (*G. morhua*) or pelagic (*Clupea harengus*, *O. mykiss*) (Palm and Dobberstein 1999). The free water column has a lower bacterial biomass. Therefore, marine trichodinids can be considered typical parasites of bottom-living fish

species (Palm and Dobberstein 1999). During the present study, *T. jadranica* and *T. raabei* were found to infest only the flatfish *P. flesus*, whereas *T. claviformis* could be detected additionally on *G. morhua*. This finding suggests a different host specificity within *Trichodina* species (see above), although the host-specificity of trichodinids in general is considered to be low (Van As and Basson 1992). However, in the northern hemisphere *T. jadranica* was found to infest fish of different families and, in a single case a mollusc (Xu et al. 1995), in both brackish/marine (Raabe 1958, Lom 1970, Stein 1979, 1982, Arthur and Lom 1984, Grupcheva et al. 1989, Vismanis and Kondratovics 1994, Loubser et al. 1995, Imai et al. 1997, Ogawa and Inouye 1997) and freshwater environments (Jusupov and Urasbaev 1980, Grigorian and Stein 1981, Imai et al. 1991). Thus, *T. jadranica* can be considered a widely distributed non-specific ciliate on aquatic organisms. A similar wide range of distribution is known for *Trichodina domerguei* and *Trichodina tenuidens*, both living on Gasterosteidae in marine and freshwater environments (Arthur and Lom 1984). *T. raabei* is reported solely from fish of the family Pleuronectidae from the Baltic Sea (see above), Black Sea (Lom 1962), White Sea (Stein 1976) and in a single case from *Pleurogrammus azonus* (Hexagrammidae) of the Pacific Basin (Stein 1979). *T. raabei* demonstrates a preference for flatfishes independently of locality.

The morphometrical data of both *T. jadranica* and *T. raabei* fall within the same ranges as given for *T. borealis*. This finding supports the results by Lom (1970) considering *T. borealis* an invalid species, most probably standing for *T. jadranica* and *T. raabei*. Due to its original description without using the silver-impregnation technique, no given decisive picture of the adhesive disc, and the variable size, *T. borealis* must be considered invalid, questioning the findings by MacKenzie (1969), MacKenzie et al. (1976), Stein (1976), Calenius (1980), Lüthen (1989) and Rokicki and Morozinska (1994). The real identity of the specimens found by these authors still needs to be confirmed. Similar to *T. borealis*, other trichodinids in fact might consist of more than a single species. The wide distribution and low host specificity (see above) might have caused several new descriptions of already existing species. This can explain the enormous amount of about 190 different species within the genus (Lom 1995). Additionally, other events such as temperature were found to cause a changed morphology of the components of the adhesive disc within a single species (Kazubski and Pilecka-Rapacz 1981). The present study also indicates that morphological data of *T. jadranica* and *T. raabei* by other authors do not completely match the mean values of the present specimens (Figs. 7, 8). This can be interpreted as an intraspecific morphological variability within these trichodinids, depending on the host and the temperature of the environment (Kazubski and Pilecka-Rapacz 1981, Kazubski 1982). Thus, descriptions of similar species from different hosts and localities have to be regarded with care, unless further morphological data on intraspecific and interspecific variability within trichodinids are available.

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