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First Records of Trichodinid Ectoparasites (Ciliophora: Peritrichia) from Introduced Freshwater Fishes in Tasmania, Australia, with Comments on Pathogenicity

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Summary. During parasitological surveys in Tasmania (Australia), four introduced fish species were investigated for the presence of trichodinid ectoparasites. Five trichodinid species were found on the skin, fins and gills of two of these fishes, i.e. the tench *Tinca tinca* Linnaeus, 1758 and the red fin perch *Perca fluviatillis* Linnaeus, 1758. Four trichodinids are known species for which comparative descriptions are provided, i.e. *Trichodina acuta* Lom, 1961, *T. esocis* Lom, 1961, *T. lepsii* Lom, 1962 and *Trichodinella epizootica* (Raabe 1950) Šrámek-Hušek, 1953. A fifth species, i.e. *Trichodina tunnae* sp. n. is described as a new species from the red fin perch. All species are described using silver impregnated and hematoxylin stained specimens.

Key words: *Trichodina*, *Trichodinella*, introduced fish, tench, perch.

INTRODUCTION

The introduced freshwater fish fauna of Tasmania consists of eight species represented by three families, while the native fish fauna is represented by some 25 species. The introduced species therefore make up more than 25% of the fauna on this island.

According to Fulton (1990) the most noteworthy introduction into Tasmania was the brown trout, *Salmo trutta* Linnaeus, 1758, in 1864, now common in most waterbodies on the island. The tench, *Tinca tinca* Linnaeus, 1758 (family Cyprinidae) has been firmly established in Tasmania since 1882. A cyprinid which proved to be very unpopular is the common or European carp, *Cyprinus carpio* Linnaeus, 1758, which was introduced into Tasmania in the early 1960's. It is indicated by Fulton (1990) as being successfully eradicated by a poisoning campaign carried out in the 1970's, however, it still occurs in small numbers in some localities on the island. The redfin or European perch, *Perca fluviatilis* Linnaeus, 1758, was successfully introduced to Tasmania in 1861 and according to Fulton (1990) is now widely distributed and abundant in the central and eastern parts of the island.

Very few fish parasitological investigations have been carried out in Tasmania. Only a single taxonomic study on the parasites of freshwater fish exists, i.e. Fry-

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er (1969) who described a new species of a branchiuran parasite from a galaxiid. As far as trichodinids go, a single publication on the trichodinids of marine fish has been published, Su and White (1995) who described three species, of which two were new.

The present study therefore presents the first report of freshwater trichodinids from Tasmania, specifically five species from the skin, fins and gills of two introduced fishes (*P. fluviatilis* and *T. tinca*), of which four trichodinids are known species. These are *Trichodina esocis* Lom, 1961 and *T. lepsii* Lom, 1962 from *P. fluviatilis*, while *T. acuta* Lom, 1961 and *Trichodinella epizootica* (Raabe, 1950) Šrámek-Hušek, 1953 were both encountered on *T. tinca*. A fifth and new species, *T. tunnae* sp. n., is also described from *P. fluviatilis*.

MATERIALS AND METHODS

Three fish parasite surveys, i.e. in 1998, 2000 and another in 2002, were carried out in various Tasmanian localities. The first survey in 1998 was in late summer to early autumn (February to April), while both 2000 and 2002 surveys were in early to mid winter (June–July). In total four introduced fish species represented by three families were collected and examined for trichodinids, i.e. *Salmo trutta* (family Salmonidae), *Perca fluviatilis* (family Percidae), as well as *Cyprinus carpio* and *Tinca tinca*, both from the family Cyprinidae (see Table 1). Two populations of 10 and six specimens of *S. trutta* were collected from the Sandy Bay Rivulet and Judd's Creek respectively in 2000. Specimens of *P. fluviatilis* were collected during 2000 (two fish from the Jordan River) and 2002 (33 fish from the Blackman River at Tunbridge). During 1998 four specimens of tench were collected from Pawleena Dam with a further nine specimens in 2000 from the Jordan River, while five large specimens of *C. carpio* were provided by Inland Fisheries Services for examination from Lake Crescent in 2000 (Fig. 1). All fish specimens were examined live for ectoparasites.

Permits for collection of freshwater fishes were supplied by Inland Fisheries Services. In 2000 two permits were issued (PWS Permit Number FW00022; IFS Permit Numbers 2000/32 & 2000/48) and in 2002 Permit No 2003/23.

Wet smears of the skin and gills were prepared and examined immediately for the presence of trichodinids with the use of a compound microscope. Air-dried smears were impregnated with silver nitrate in order to study details of the adhesive disc. Some air-dried smears were also stained with Mayer's haematoxylin for studying the nuclear apparatus. Differential interference contrast (DIC) was used in all photomicrographs. All measurements are presented in micrometres (µm) and follow the uniform specific characteristic system proposed by Lom (1958). Detailed descriptions of the denticles are presented in accordance with the method proposed by Van As and Basson (1989). Minimum and maximum values are given, followed in parentheses by the arithmetic mean and standard deviation, but standard deviation is not supplied for populations where less than ten specimens were measured. In the case of the denticles and radial pins, the mode is provided instead of the arithmetic mean. Body diameter is measured as the adhesive disc plus border membrane. These measurements are provided in Tables 2–5.

Reference material of known species is deposited in the collection of the author, while type material is deposited in the collecion of the National Museum, Bloemfontein (South Africa).

RESULTS AND DISCUSSION

No trichodinid infestations were found on the brown trout, *S. trutta* or the carp, *C. carpio* (Table 1). The tench harboured two known species of trichodinids, i.e. *Trichodina acuta* and *Trichodinella epizootica*, whilst three trichodinids (two known and one new species) were found on the perch, *T. esocis*, *T. lepsii* and *T. tunnae*. Comparative descriptions of these five species are presented below.

Trichodina esocis Lom, 1961 (Figs 2, 3, 12; Table 2)

Host and site: *Perca fluviatillis* (red finned perch), on gills.

Reference material: Slide 2002/08/07-18 in the collection of the author.

Locality: Tunbridge (Blackman River, Tasmania, Australia).

Description: Body dimensions are provided in Table 2. Centre of adhesive disc with central circle that impregnates almost as dark as rest of adhesive disc. Denticles tightly packed, with little space between them. Blade sickle-shaped and broad, filling most of space between y-axes. Tangent point slightly rounded. Distal blade margin almost parallel to border membrane

Table 1. Introduced fish investigated for trichodinids in Tasmania, Australia.

Fish species	Locality	Number of fish examined	Number of fish infested with trichodinids
Salmonidae			
Salmo trutta	Sandy Bay Rivulet	10	0
	Judd's Creek	6	0
Cyprinidae			
Cyprinus carpio	Lake Crescent	5	0
Tinca tinca	Pawleena Dam	4	4
	Jordan River	9	1
Percidae			
Perca fluviatilis	Jordan River	2	1
	Tunbridge	33	33

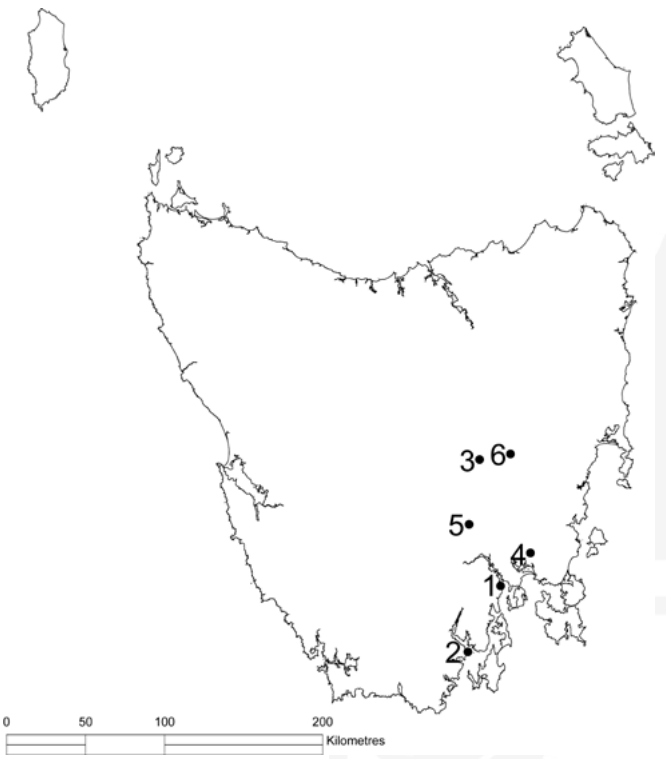


Fig. 1. Map of Tasmania (Australia) indicating the localities where freshwater fishes were sampled. **1** – Sandy Bay Rivulet in Hobart; **2** – Judd's Creek at the mouth of the Huon River; **3** – Lake Crescent; **4** – Pawleena Dam near Sorell; **5** – Jordan River near Elderslie and **6** – Blackman River at Tunbridge.

posteriorly, curving in anterior direction. Anterior blade margin touching y + 1 in some cases, in most extending slightly beyond this point. Blade apex rounded, situated more than halfway towards central part, coinciding with deepest point of posterior margin. Posterior blade margin forming almost triangular surface, with deepest point situated more proximal, almost at same level as blade apex. Blade apophysis strongly developed, coinciding with slightly developed posterior projection of previous denticle. Blade connection strongly developed. Central part narrow, but strongly developed, extending more than halfway to y – 1 axis. Lower central part indentation prominent on most denticles. Central part above (distal) x-axis almost triangular in shape with posterior slanting distal edge, while part below x-axis (proximal) basically of equal width anteriorly. Ray connection strongly developed. Ray apophysis prominent, curving slightly distally and coinciding with central part indentation. Rays thick, strongly developed, of equal thickness throughout, ending in rounded blunt points, in some specimens with almost angular ends. Rays mostly directed strongly posteriorly, in some specimens rays slant slightly, almost running parallel to y-axes. Adhesive disc centre showing a central circle that impregnates as dark as the rest, but with obvious undulating edges, showing up where edge is touched by rays. Centre shows dark granular appearance. Ratio between section of denticle above and below x-axis slightly more than 1 (1.1).

Discussion: *Trichodina esocis* was originally described as *T. domerguei* f. *esocis* by Lom (1961) from the skin of *Esox lucius* in Bohemia (Czech Republic). Since that description various authors from Russia (Kulemina 1968, Lyubarskaya 1968, Kashkovsky 1974) described this form from the gills as well as body surface of *E. lucius*, and this form appears to show strong affinities for this pike host. However, Kashkovsky also reported this form from the gills of two members of the Percidae, i.e. the pike-perch *Lucioperca lucioperca* and the European perch *Perca fluviatilis*.

In 1966 Lom and Stein decided to abandon the use of the term "forma" and to designate infraspecific categories as "subspecies," specifically in the *Trichodina domerguei* – group and since then the present form was known as *T. domerguei* subsp. *esocis*, although not used in this manner by the above-mentioned Russian authors. Lom (1970) subsequently elevated this subspecies to species level, i.e. *T. esocis.* The recommendation by Lom and Stein (1966), to abandon the use of forms and the elevation of this species by Lom (1970), was either not known or used by workers such as Kulemina (1968), Lyubarskaya (1968) and Kashkovsky (1974) who still referred to it as a form of *T. domerguei*.

The results of the present study represents the second report of *T. esocis* from *P. fluviatilis.* The present population of *T. esocis* shows similarities in many instances regarding general body dimensions and denticle shape with the other populations of Kulemina (1968), Lyubarskaya (1968) and Kashkovsky (1974). Differences include larger body dimensions in the populations of Lyubarskaya (1968) and Kashkovsky (1974) compared to the present population. However, this is not surprising, as Russian scientists measured the body diameter as the total body diameter including the soft part. The overall denticle morphology conforms to most populations of *T. esocis*, when comparing the various micrographs presented by the Russians mentioned above, as well as that of Lom (1961). It is not feasible, however,

to compare denticle dimensions with most of the Russian data, as they tended to measure these dimensions differently, making comparisons impossible. The present population does show most similarity in denticle shape with the micrographs presented by Kashkovsky (1974) and Grupcheva *et al.* (1982), although the latter authors did not supply a description.

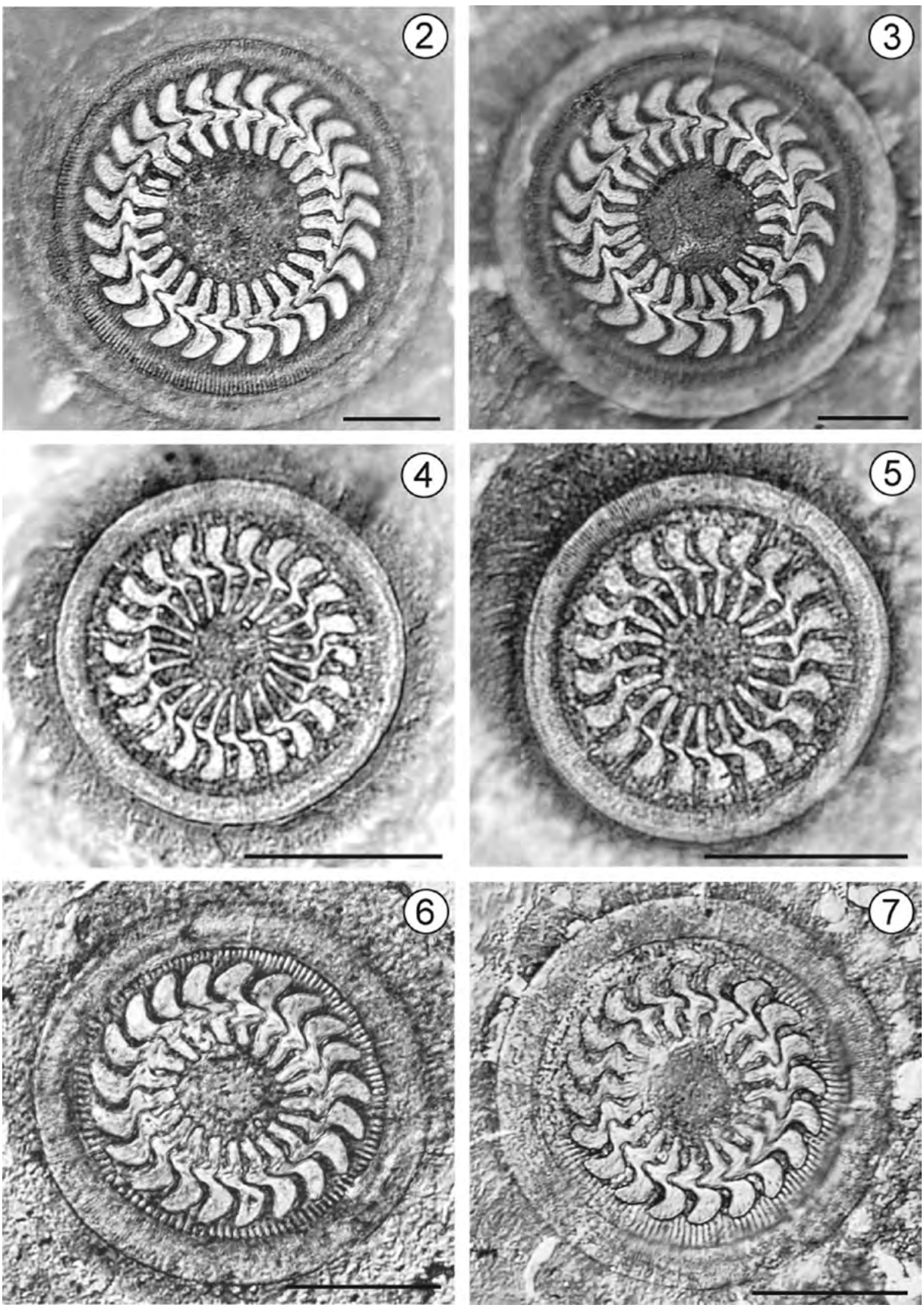
The present population differs from the original description of Lom (1961) in the length of the denticle and the ray, as well as the width of the central part that seem to have larger dimensions in the population of Lom, compared to that of the present population. As for the shape of the denticles, there are some differences in the shape of the blade and direction of the rays. In the

Table 2. Biometrical data (in µm) of different populations of *Trichodina esocis* Lom, 1961 where the present population is compared to data from Lom (1961) and Kashkovsky (1974).

Host	*Esox lucius*	*Esox lucius*	*Perca fluviatilis*	*Perca fluviatilis*
Locality	Czech Republic	Ural Region (Russia)	Ural Region (Russia)	Tunbridge (Blackman River, Tasmania)
Position on host	Skin			Gills
Reference	Lom (1961)	Kashkovsky (1974)	Kashkovsky (1974)	Present study
Body diameter	50–78 (65–66)	69–78 (70)	62–84 (62)	55.8–68.8 (62.3 ± 3.1)
Adhesive disc diameter	38–62 (49)	52–69 (60)	40–62 (50)	46.1–58.0 (51.9 ± 3.0)
Border membrane width	3.5–5	3–6	3.6–4.8	4.4–5.9 (5.1 ± 0.3)
Denticle ring diameter	22–39 (31–32)	32–40 (24)	28–39 (31)	28.9–33.3 (31.0 ± 1.4)
Central circle				15.8–21.3 (18.3 ± 1.3)
Denticle number	20–27 (22–24)	23–28 (25)	24–28 (26)	23–27 (25)
Radial pins/denticle	10 (8,9)	8–10	10	9–11 (10)
Denticle length	10–11			6.6–9.0 (7.6 ± 0.6)
Blade length	5–6.6	4/5–6	4.8–7 (5)	4.7–6.1 (5.5 ± 0.4)
Central part width	2.5–3	1.8–3 (2.6)	1.8–3 (2)	1.7–2.7 (2.3 ± 0.2)
Ray length	5.7–6	6–8 (6.8)	3.6–6 (4.5)	3.8–5.7 (5.0 ± 0.4)
Denticle span				11.2–13.8 (12.8 ± 0.6)
Macronucleus – shape				C-shape
Macronucleus – external diameter				30.2–48.7 (41.3 ± 4.8)
Macronucleus – thickness				4.3–12.5 (7.0 ± 1.4)
Macronucleus – x value				8.9–31.4 (19.3 ± 5.5)
Micronucleus – shape				Oval – elongated
Micronucleus – length	3.5			1.3–9.6 (4.2 ± 2.6)
Micronucleus – width	1.5			0.9–3.0 (2.0 ± 0.6)
Micronucleus – y position				Mostly in +y
Micronucleus – y value				4.3–38.2 (14.9 ± 8.4)
Adoral spiral				405–470°
n1				31
n2				31 (Ma), 22 (Mi)

n1 – number of silver impregnated specimens measured, n2 – number of haematoxylin stained specimens measured for nuclear apparatus. Kashkovsky (1974) measured the body diameter as the total body diameter including the soft part.

Figs 2–7. Photomicrographs of silver impregnated adhesive discs of *Trichodina* Ehrenberg, 1838 species from the red-fin perch, *Perca fluviatilis*. **2**, **3** – *Trichodina esocis* Lom, 1961 from the gills; **4**, **5** – *Trichodina lepsii* Lom, 1962 from the gills; **6**, **7** – *Trichodina tunnae* sp. n. from the skin and fins. Scale bars: 15 µm.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present population the blade's tangent point is rounded, while it is more pointed in Lom's population, with the posterior blade margin also curving far more, showing an equal curve with the deepest point in the middle of the margin. Lom's population also shows more robust central parts and rays that are strongly slanted anteriorly, while the deepest point of the posterior blade margin curves lower in the Tasmanian specimens, and the central parts are slightly narrower with the rays projecting mostly posteriorly. The central circle in specimens of both populations are very characteristic, impregnating faintly and not showing a well defined clear centre in either populations, with ray points closely hugging this centre.

Trichodina lepsii Lom, 1962 (Figs. 4, 5, 13; Table 3)

Host and site: *Perca fluviatillis* (the red finned perch), mostly on gills, occasionally on skin and fins.

Reference material: Slide 2002/08/06-14, in the collection of the author.

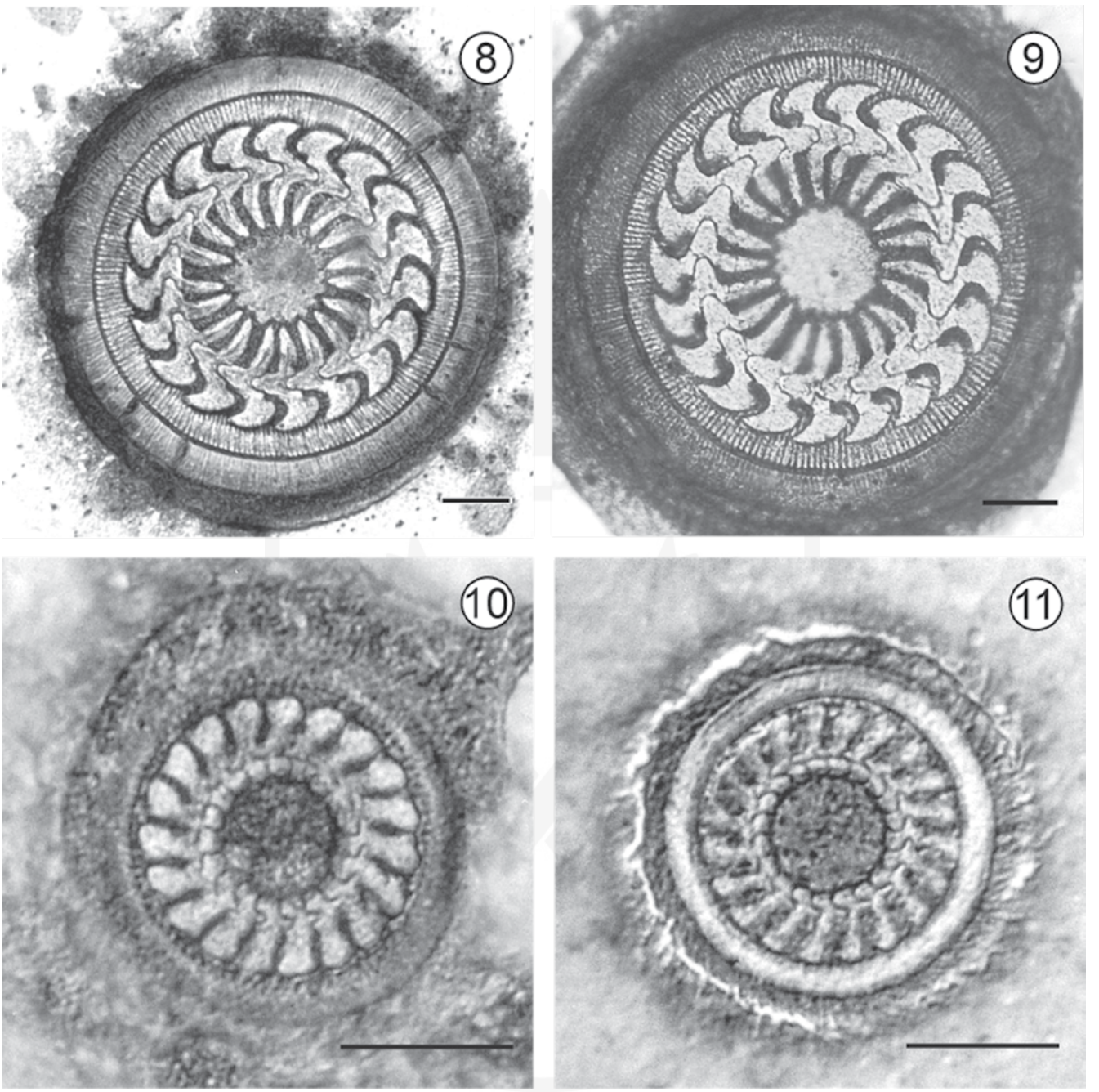
Locality: Tunbridge (Blackman River, Tasmania, Australia).

Description: Body dimensions are presented in Table 3. Centre of adhesive disc with uniform dark granular appearance. Denticles loosely packed with big spaces between them. Blade narrow, slightly sickle-shaped, filling a little more than half of space between y-axes with distal part of blade larger, narrowing proximally. Tangent point long, forming line with y-axes. Distal

Table 3. Biometrical data (in μm) of different populations of *Trichodina lepsii* Lom, 1962.

Host	*Mugil auratus*	*Mugil cephalus*	*Perca fluviatilis*
Locality	Constanta (Rumanian Black Sea Coast)	Bourgas Lake (Bulgaria)	Tunbridge (Blackman River, Tasmania)
Position on host	Gills	Gills	Mostly gills, occasionally skin and fins
Reference	Lom (1962)	Grupcheva (1975)	Present study
Body diameter	28–42 (35)	36.0–44.0	25.4–31.3 (27.7 ± 1.6)
Adhesive disc diameter	19–27 (21)	24.0–27.0	20.5–25.6 (22.8 ± 1.4)
Border membrane width	2	2.6–3.5	2.1–2.9 (2.5 ± 0.2)
Denticle ring diameter	11–14 (12)	14.0–16.0	11.0–16.1 (13.4 ± 1.1)
Denticle number	18–25 (21)	22–24	18–22 (20)
Radial pins/denticle		5	6–8 (7)
Denticle length	3		2.7–4.1 (3.3 ± 0.3)
Blade length	2.5	2.6–3.5	2.5–3.6 (3.0 ± 0.3)
Central part width	1	0.9–1.3	0.6–1.0 (0.8 ± 0.1)
Ray length	1.5	1.7–2.6	2.4–4.3 (3.1 ± 0.4)
Denticle span			5.7–8.0 (6.7 ± 0.5)
Macronucleus – shape	Arc – to horseshoe		C-shaped
Macronucleus – external diameter	20–22		15.3–28.4 (21.8 ± 2.9)
Macronucleus – thickness			1.9–4.1 (2.9 ± 0.5)
Macronucleus – x value			6.3–17.3 (10.1 ± 2.2)
Micronucleus – shape			Round – oval
Micronucleus – length	3		1.2–7.3 (2.5 ± 1.4)
Micronucleus – width	2		0.7–2.3 (1.2 ± 0.4)
Micronucleus – y position	In front of left arm		Mostly +y
Micronucleus – y value	5–6		0.9–11.7 (4.5 ± 3.0)
Adoral spiral	360–370°		380–420°
n1			35
n2			41 (Ma), 29 (Mi)

n1 – number of silver impregnated specimens measured, n2 – number of haematoxylin stained specimens measured for nuclear apparatus.



Figs 8–11. Photomicrographs of silver-impregnated adhesive discs of trichodinid species from the tench, *Tinca tinca*. **8**, **9** – *Trichodina acuta* Lom, 1961 from the skin and fins; **10**, **11** – *Trichodinella epizootica* (Raabe, 1950) Šrámek-Hušek, 1953 from the gills. Scale bars: 10 µm.

blade margin flat, parallel to border membrane. Anterior blade margin angular, extending slightly more than halfway in y-quadrant. Blade with flattened anterior margin, mostly parallel to y + 1 axis with no clear blade apex. Posterior blade margin hugging y-axes closely in most specimens, forming slight triangle in some specimens, with deepest point situated more proximal in these. Blade apophysis not prominent, only slightly developed, not coinciding at all with slightly developed posterior projection of previous denticle. Blade connection strongly developed. Central parts arranged loosely, not fitting tightly into each other. Central parts narrow

and elongated, extending somewhat more than halfway to y – 1 axis. Lower central part indentation not visible on most denticles with lower edge forming almost right angle with ray. Central part above (distal) x-axis almost triangular in shape with distal edge slanting posteriorly, while part below x-axis (proximal) of equal width. Ray connection thinner than rest of ray, but strongly developed. No ray apophysis visible, rays becoming slightly thicker after ray connection, curving at first in posterior direction (parallel or on y-axes), then slanting anteriorly towards rounded to blunt points (crossing y-axes), creating rays with distinct curves. In some specimens proximal part of ray becomes slightly thicker. Adhesive disc centre showing uniform dark granular appearance. Ratio between section of denticle above and below x-axis in most cases less than one (0.9–1.1).

Discussion: To date *Trichodina lepsii* has mostly been reported from fishes collected from brackish water bodies or marine coastal areas in Eurasia. It was originally described by Lom (1962) from the gills of *Mugil auratus* collected in an outlet of the brackish Lake Tabacaria (Rumania) that has a connection with the Black Sea. Grupcheva (1975) reported it from *Mugil cephalus* from Bourgas Lake (a Bulgarian lake on the Black Sea Coast), while Grupcheva *et al*. (1989) found it on the gills of *Syngathus typhle argenteus* in the Black Sea and Loubser *et al.* (1995) described it from the gills of *Pagrus caeruleostictus* from the Bay of Dakar (Senegal). Authors such as Stein (1962) and Shulman (1984) both mentioned this species from freshwater fishes from the former USSR. The present description, however, represents not only the first time this species has been reported from the perch, but also the first report from a freshwater environment quite a distance from the sea (see Fig. 1).

The present population's dimensions correlate well with the following populations: the original population of Lom (1962) from *M. auratus*, of Grupcheva (1975) from *M. cephalus* (Table 3), of Loubser *et al*. (1995) from the spariid *P. caeruleostictus*, as well as from the broad-nosed pipefish, *S. typhle argenteus* of Grupcheva *et al*. (1989). The only differences are in the ray of the present population that are longer than any in the above-mentioned populations, as well as the adoral spiral in the present population that is also longer than in the specimens found by Lom (1962) (see Table 3).

The denticle shape of this species is very characteristic. The various populations of this species all show the very shallow posterior blade margin and delicate central parts not fitting tightly into one another, forming very loosely packed denticles. Furthermore, this species is characterised by rays that prominently curve anteriorly and bulge at their proximal ends into broad tips. This latter characteristic, i.e. the bulging ray tip, is far more pronounced in specimens of Lom (1962) and Shulman (1984) than in the present population. However, the present population shows similarities in this regard with specimens provided by Grupcheva (1975) and Grupcheva *et al*. (1989).

Trichodina tunnae sp. n. (Figs 6, 7, 14; Table 4)

Type host and site: *Perca fluviatillis* (the red finned perch), mostly on skin and fins, occasionally also on gills.

Type material: Holotype, slide 2002/08/06-15 (NMBP 309), and paratype, slides 2002/08/05-49 (NMBP 310) and 2002/08/05-65 (NMBP 311), in the collection of the National Museum, Bloemfontein, South Africa.

Type locality: Tunbridge (Blackman River, Tasmania, Australia) (42°8′19.79″S, 147°25′14.34″E).

Etymology: Named after the locality where it was collected, near the small historic coach town of Tunbridge in the Tasmanian Midlands.

Description: Body dimensions are presented in Table 4. Centre of adhesive disc impregnates lighter, forming indistinct circle. Denticles very tightly packed, with small spaces between them. Blade strongly developed, sickle-shaped, filling biggest part of space between y-axes. Tangent point ranges from sharp point to forming a line of contact, lower than distal blade margin. Distal and anterior blade margins rounded, slanting distinctly towards apex. Blade apex touching or extending slightly beyond y-axes. Blade apex higher than deepest point of posterior margin in most specimens. Posterior blade margin forming slight triangle with deepest point well below blade apex in most denticles. Blade apophysis prominent, coinciding with well developed posterior projection of previous denticle. Blade narrows strongly towards blade connection, though latter is still well developed. Central parts irregular, broad and squat, extending more than halfway to y – 1 axis. Lower central part indentation clearly visible on most denticles. Central part above (distal) x-axis mostly shorter, almost triangular in shape with distal edge slanting posteriorly, while part below x-axis (proximal) almost angular and of equal width. Ray connection very strongly developed. Ray apophysis strongly developed, slanted slightly distally, coinciding with central part indentation. Rays very thick and straight, running along y-axes, in some specimens slanted slightly in posterior

Table 4. Biometrical data (in µm) of different populations of *Trichodina nigra* Lom, 1961 and *T. tunnae* sp. n.

Trichodinid species	*Trichodina nigra* Lom, 1961	*Trichodina nigra* Lom, 1961	*Trichodina tunnae* sp. n.
Hosts	Various Cyprinidae, *Perca fluviatilis*	*Perca fluviatilis*	*Perca fluviatilis*
Locality	Bohemia in former Czechoslovakia	Lake Seliger (Russia)	Tunbridge (Blackman River, Tasmania)
Position on host	Skin, rarely gills	Skin, fins, gills and buccal cavity	Skin and fins
Reference	Lom (1961)	Kulemina (1968)	Present study
Body diameter	61–79		36.6–43.0 (40.4 ± 2.7)
Adhesive disc diameter	43–54	46.0–47.0 (42.0–43.0)	26.4–34.9 (31.4 ± 3.4)
Border membrane width	4–5		4.0–4.7 (4.4 ± 0.3)
Denticle ring diameter	27–33	*40.0–47.0 (44.0–46.0)	14.5–19.8 (17.5 ± 2.2)
Central circle			
Denticle number	25–29 (21–23)	20–23 (22–23)	19–22 (20)
Radial pins/denticle	8–10	9–10–11	7–8 (8)
Denticle length	9–11		3.4–6.2 (5.0 ± 0.8)
Blade length	4.5–7	* 7.0–9.0 (8.3–9.0)	2.7–4.1 (3.6 ± 0.5)
Central part width	2–3.3		1.8–2.1 (2.0 ± 0.1)
Ray length	5–9	* 6.0–7.0 (6.5–7.0)	3.0–4.4 (3.5 ± 0.5)
Denticle span			7.7–10.2 (9.1 ± 0.8)
Macronucleus – shape			Open C-shape
Macronucleus – external diameter	32–52	31.2–48.1	22.4–40.5 (30.3 ± 4.9)
Macronucleus – thickness			2.9–6.6 (4.4 ± 0.8)
Macronucleus – x value		9.09–21.2	4.6–27.6 (15.2 ± 5.9)
Micronucleus – shape			Round – oval
Micronucleus – length	3–5.5	2.6–6.0	1.4–6.6 (3.8 ± 1.7)
Micronucleus – width	1–2.5	1.3–3.9	1.1–4.6 (2.3 ± 1.1)
Micronucleus – y position			Mostly +y
Micronucleus – y value	5–22	0–27.3	2.7–32.2 (11.2)
Adoral spiral	380–390°		390–415°
n1			30
n2			33 (Ma), 9 (Mi in +y)

n1 – number of silver impregnated specimens measured, n2 – number of haematoxylin stained specimens measured for nuclear apparatus. * Kulemina (1968) measured the denticle ring diameter from the outer distal edges of the denticles, the blade length from the distal end to the centre of central part and the ray length from the proximal end to the centre of the central part.

direction. Rays characteristically becoming thicker on posterior edge after ray connection. Ray points rounded to almost angular, narrow in a few cases. Adhesive disc centre impregnates lighter, forming white, clear circle in some specimens, granular in others. Rays touch circle, with circle seemingly flowing between rays in some specimens. Ratio between section of denticle above and below x-axis always more than one (1.1–1.3).

Discussion: *Trichodina tunnae* was found in only one locality and on an introduced fish species. It shows some similarity in denticle shape with *T. nigra* Lom, 1961, a widely distributed species reported from North America, Eurasia, Africa, United Kingdom and islands such as the Republic of China and the Philippines (Basson and Van As 2006). This species is also known to occur on *P. fluviatili*s as reported by Lom (1961) from the former Czechoslovakia, Kulemina (1968) from Lake Seliger (Russia) and Halmetoja *et al.* (1992) from Finland lakes. *Trichodina nigra* shows a wide range of morphological variability, especially in the denticle shape and overall adhesive disc dimensions. In the case of the present species, *T. tunnae*, the denticles differ from that of *T. nigra* by being more robust and compact, fitting very tightly into one another. The denticle

dimensions of *T. tunnae* are overall smaller than those in the various populations of *T. nigra*, with a smaller blade and ray length, as well as smaller denticle length and denticle span. *Trichodina nigra* described by Lom (1961) shows denticles somewhat more loosely arranged with blades almost scimitar-shaped, whilst the blades of *T. tunnae* are more triangular in overall shape. A further difference between these two species is the length of the ray. In *T. nigra* the rays are longer than the blade, whilst the blades and rays are the same length in *T. tunnae*. Furthermore, the rays in *T. nigra* are slender, clearly narrowing towards the tips, whilst in the case of *T. tunnae* the rays are very thick and strong, becoming thicker after the ray connection, ending in almost angular tips, only narrowing in some cases. A further difference is a white, clear circle present in *T. tunnae,* where the denticles touch the circle with the edge appearing to flow between the rays in some specimens. This characteristic is absent in *T. nigra*. The finding of *T. tunnae* from *P. fluviatilis* represents the first new species from freshwater fish in Tasmania.

Trichodina acuta Lom, 1961 (Figs 8, 9, 15; Table 5)

Host and site: *Tinca tinca* (tench), on skin and fins.

Reference material: Slide 98/02/23-01 in the collection of the author.

Locality: Pawleena Dam (Tasmania, Australia).

Description: Body dimensions are presented in Table 5. Centre of adhesive disc with clear circle. Denticles fit tightly into one another. Blades well developed, strongly sickle-shaped and broad, filling most of space between y-axes. Tangent point sharp, with distal margin slightly higher or at same level as tangent point. Distal surface with slight slope towards prominent blade apex that almost touches or extends only slightly beyond y-axes. Posterior blade margin forming deep curve, with deepest point lower than blade apex. Blade apophysis strongly developed and angular, coinciding with well developed posterior projection in previous denticle. Blade connection very well developed and strong. Central parts squat and well developed, extending slightly more than halfway towards y – 1 axis. Lower central part indentation very prominent in most denticles, with

Table 5. Biometrical data (in µm) of different populations of *Trichodina acuta* Lom, 1961 and *Trichodinella epizootica* (Raabe, 1950) Šrámek-Hušek, 1953.

Trichodinid species	*Trichodina acuta* Lom, 1961	*Trichodina acuta* Lom, 1961	*Trichodinella epizootica* (Raabe, 1950)	*Trichodinella epizootica* (Raabe, 1950)
Host	Different species	*Tinca tinca*	*Perca fluviatilis*	*Tinca tinca*
Locality	Bohemia in former Czechoslovakia	Pawleena Dam (Tasmania)	Former Czechoslovakia	Pawleena Dam (Tasmania)
Position in host	Skin, rarely gills	Skin and fins	Gills	Gills
Reference	Lom (1961)	Present study	Lom (1963)	Present study
Body diameter	59–78	58–75 (64.2 ± 3.9)	27–41 (35)	18–24 (21.1 ± 1.5)
Adhesive disc diameter	42–53	47–63 (52.8 ± 4.2)	17–30 (23)	14–20.5 (17.4 ± 1.5)
Border membrane width	3.5–5	5–6 (5.6 ± 0.5)	2.3	1–2 (1.6 ± 0.3)
Denticle ring diameter	23–32	26–36 (30.9 ± 2.4)	9–18 (12)	6.5–10 (8.5 ± 0.8)
Central circle		10.5–15 (12.7 ± 1.2)		
Denticle number	18–21	19–22 (20)	21–30 (25)	17–20 (19)
Radial pins/denticle	8	9–13 (10)	4–5	5–7 (5)
Denticle length	10–11	9–11 (9.7 ± 0.6)	4.0	2–3 (2.6 ± 0.3)
Blade length	4.5–6	5–6 (5.4 ± 0.5)	4.0	2–4 (3.2 ± 0.5)
Central part width	3–4	3–4.5 (3.9 ± 0.3)	1.3	0.5–1 (1.0 ± 0.1)
Ray length	4–7	6–8.5 (6.9 ± 0.7)		
Denticle span		15–19 (16.4 ± 1.1)		3–5 (4.3 ± 0.6)
Adoral spiral	380–390°			
n		25		25

n – number of silver impregnated specimens measured.

strongly developed and rounded ray apophyses fitting well into these indentations. Central part above (distal) x-axis with angular slanting distal edge, while central part below (proximal) x-axis with straight edge running almost parallel to x-axis. Ray connection thick and strongly developed. Rays thick, becoming thicker after ray connection, strongly developed, of equal thickness for most of length, becoming narrower towards tips. Rays directed straight, parallel to y-axes, almost touching central circle. Adhesive disc centre showing clear central circle that impregnates lighter than rest, with clear undulating edges hugging rays. Ratio between section of denticle above and below x-axis less than one (0.8–0.9).

Discussion: *Trichodina acuta* is a widely distributed species found on freshwater fishes, mainly on the skin. This species, with a characteristic clear centre in the adhesive disc, has been reported from most families of fishes in Eurasia, North America, the Philippines and Africa (Basson and Van As 2006). The present population conforms well with the original description presented by Lom (1961), with the present population showing slightly larger maximum dimensions as far as the diameter of the adhesive disc and denticle ring are concerned (see Table 5). However, the denticle dimensions are very similar between these two populations as is the morphology of the denticles.

A single specimen tentatively identified as *T.* cf. *acuta* was reported by Dove and O'Donoghue (2005) from the skin of *Poecilia reticulata* from Walkamin Research Station in northern Queensland (Australia). The authors considered this as a problematic specimen as it had 16 denticles, two fewer than the smallest number seen in any of the figures they studied, although Lom (1961) did provide an absolute range of 15–23. Dove and O'Donoghue (2005) therefore tentatively assigned their specimen to *T. acuta*. The present identification of *T. acuta* from the skin of *Tinca tinca* in Tasmania, however, firmly establishes the presence of this wide spread species in Australia as well.

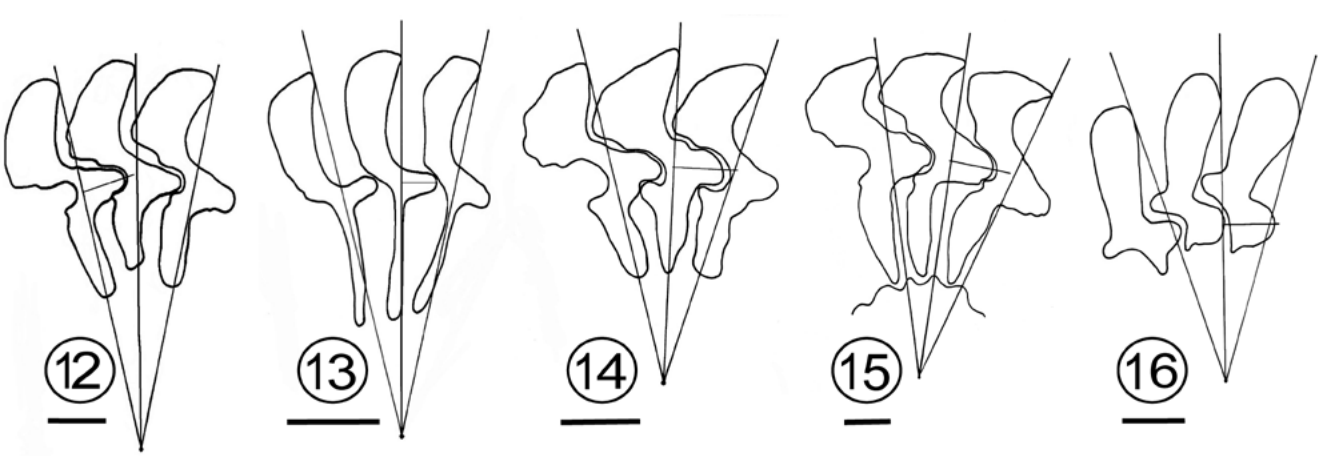
***Trichodinella epizootica* (Raabe, 1950) Šrámek-Hušek, 1953 (Figs 10, 11, 16; Table 5)**

Host and site: *Tinca tinca* (tench), on gills.

Reference material: Slide 98/02/23-03 in the collection of the authors.

Locality: Pawleena Dam (Tasmania, Australia).

Description: Body dimensions are presented in Table 5. Blades well developed, slanting strongly posteriorly and filling posterior part between y-axes. Tangent point rounded, well below strongly rounded distal margin. Distal surface slopes sharply anteriorly, but never touches y + 1 axis. No clear blade apex visible, anterior blade margin straight, slanting anteriorly. Posterior blade margin slants sharply in proximal direction, forming well developed triangle, with deepest point where central part starts and below blade apophysis. Blade apophysis large, strongly developed, slanted in distal direction and extending well beyond y + 1 axis. Blade apophysis fits into deepest part of posterior margin of



Figs 12–16. Diagrammatic drawings of the denticles of trichodinid species from *Perca fluviatilis* and *Tinca tinca*. **12** – *Trichodina esocis* Lom, 1961 from the gills of *P. fluviatilis*; **13** – *Trichodina lepsii* Lom, 1962 from the gills of *P. fluviatilis*; **14** – *Trichodina tunnae* sp. n. from the skin and fins of *P. fluviatilis*; **15** – *Trichodina acuta* Lom, 1961 from the skin and fins of *T. tinca*; **16** – *Trichodinella epizootica* (Raabe, 1950) Šrámek-Hušek, 1953 from the gills of *T. tinca*. Scale bar: 5 µm (Figs 12–15), 2 µm (Fig. 16).

previous denticle. Blade connection well developed and strong. Central parts well developed and squat, extending to and sometimes slightly beyond y – 1 axis. No central part indentation present. Central part above (distal) and below x-axis similar in shape. Ray connection present, but rays weakly developed. In most specimens rays are not visible. In those few denticles where rays are visible, these are very short and thin, directed proximally. Adhesive disc centre impregnates same as rest of disc. Ratio between section of denticle above and below x-axis 5.0–5.5.

Discussion: *Trichodinella epizootica* is one of the most widely distributed freshwater trichodinids in Eurasia, but has also been reported from Africa, the Pacific region and North America (Lom and Dykova 1992). It further shows a wide range of variation in body dimensions as well as denticle shape.

The present population shows less variability than the population presented by Lom (1963) (see Table 5). Overall the present population conforms well with the lower range as presented by Lom (1963) as well as the population presented by Basson *et al.* (1983) from *Cyprinus carpio* (South Africa).

CONCLUDING REMARKS

The present study represents not only the first report of trichodinds from freshwater fish in Tasmania, but also the first description of a new species from freshwater fish and the first occurrence of three known trichodinid species, i.e. *Trichodina esocis*, *T. lepsii* and *Trichodinella epizootica*, for the whole of Australia. The fifth species, *T. acuta*, is reported for the first time in Tasmania, but also firmly establishes the presence of this species in Australia.

The finding of *T. esocis* on *Perca fluviatilis* in Tasmania, constitutes the second report of this species on the perch and the first for Tasmania. The occurrence of *T. lepsii* on the perch, represents the first time this species has been reported from this fish species, as well as the first time it has been reported from a freshwater locality far from the marine environment. Published reports of this species till now were either from brakish water bodies or marine areas close to the coast.

The majority of trichodinids species are seldom involved in fish mortalities. However, *T. epizootica* is known to proliferate massively on stressed fish and become highly pathogenic under these circumstances. This species furthermore shows very little host specificity and has been reported from about 90 fishes from various families. It's presence on wild populations of tench in Tasmania, where native and endemic fishes such as galaxiids are also found, should be noted. The Galaxiidae family is only found in the southern hemisphere represented by some 50 species, of which Tasmania is home to 15 species. Ten of these are endemic. Galaxiids are gravely threathened by exotic fish. Three Tasmanian galaxiids were listed in 1986 as threatened, indicating that there was some cause for concern for the future survival of these fishes. Since this listing, studies have been launched to look into the long term conservation of each species. McDowall (2006) reported that numerous localised extinctions of galaxiids have been caused by the introduction of exotic salmonids, and a number of galaxiid species are threathened with overall extinction. However, no study seems to have given any attention to the parasite fauna in this equation and more specifically the effect introduced parasites, of which the opportunistic *T. epizootica* represents only one, might have on the endangered fish fauna of Tasmania.

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