

Eva Ciriero¹, Julián Parada-Albarracín², Javier Mendez², Anna M^a Huguet¹, Humbert Salvadó²

¹ Empresa Mixta d'Aigües de la Costa Brava S.A. Camí Arenes s/n, 17480 Roses – Girona

² Department of Evolutive Biology, Ecology and Environmental Sciences. Faculty of Biology, University of Barcelona. Av Diagonal 653, 08028 Barcelona. hsalvado@ub.edu.

INTRODUCTION

Biological processes in wastewater treatment plants (WWTP) are possible due to the activity of a diverse activated sludge biocenosis. Monitoring of certain microorganisms as indicators may offer several advantages in WWTP management. Thus, the potential use of microorganisms as bioindicators in wastewater treatment continues in progress to achieve an understanding of the microbial ecology of activated sludge. Microorganisms potential as indicators of nitrifying performance in different configuration of activated sludge processes have been studied statistically.

MATERIAL AND METHODS

Three full-scale WWTP in north west of Catalonia working with different configurations: anaerobic/anoxic/aerobic (A2O), anoxic/aerobic (AO), and oxidation ditch (OD) were used in this study. Samples of activated sludge from the aeration tanks in the final track of the aerobic zone of each system were collected once a month during five years (June 2011-June 2015) for microscopic examination. 152 samples were analysed, filamentous bacteria^{1,2,3,4} and micro-fauna (protozoan and metazoan) were identified and enumerated^{5,6,7,8}. Physicochemical parameters of influent and effluent were processed according to the Standard Methods (APHA 2012). Data was analysed using the Statgraphics Centurion XVII software package.

Table 1- . Physicochemical parameters of the WWTP.

WWTPs	PARAMETERS	ROSES	LLANÇÀ	CASTELLÓ D'EMPÚRIES
Influent	BOD ₅ (mg O/L)	152 ± 80	186 ± 113	222 ± 95
	NH ₄ -N (ppm)	33 ± 14	36 ± 19	42 ± 14
	Ntotal (ppm)	49 ± 20	59 ± 33	59 ± 19
Aeration Tank	MLSS (mg/L)	1734 ± 483	2160 ± 572	3683 ± 979
	F/M (Kg BOD ₅ /Kg SSVLM-d)	0,158 ± 0,142	0,079 ± 0,08	0,051 ± 0,037
	THR (h)	23 ± 4	44 ± 13	51 ± 11
	IVF (ml/g)	476 ± 151	235 ± 60	223 ± 56
Removal Efficiency (%)	BOD ₅ (mg O/L)	96 ± 3	97 ± 3	98 ± 2
	NH ₄ -N (ppm)	35 ± 38	93 ± 9	96 ± 6
	Ntotal (ppm)	37 ± 39	84 ± 14	87 ± 12

RESULTS

Table 2- Spearman's coefficient between abundance of microorganisms and N-removal efficiency.

Microorganisms	Spearman's correlation coefficient	p-Value	
Ciliates (ind/mL)	<i>Calyptotricha lanuginosa</i>	0,596	0,000
	<i>Metacystis</i> sp.	0,490	0,000
	<i>Chaetospora</i> sp.	0,427	0,000
	<i>Plagiocampa rouxi</i>	0,210	0,010
	<i>Aspidisca lynceus</i>	0,202	0,013
	<i>Acineta</i> sp.	0,078	0,339
	<i>Aspidisca cicada</i>	0,071	0,384
	<i>Metacineta</i> sp.	-0,042	0,605
	<i>Dexiotricha</i> sp.	-0,113	0,165
	<i>Trochilia minuta</i>	-0,136	0,095
	<i>Carchesium</i> sp.	-0,191	0,019
	<i>Acineria uncinata</i>	-0,199	0,015
	<i>Metopus</i> sp.	-0,274	0,001
	<i>Opercularia</i> sp.	-0,377	0,000
	<i>Euplotes</i> sp.	-0,436	0,000
	<i>Uronema nigricans</i>	-0,486	0,000
	Total ciliates	-0,069	0,394
Flagellates (ind/mL)	<i>Bodo</i> sp.	0,181	0,026
	<i>Peranema</i> sp.	0,143	0,079
	<i>Trepomonas</i> sp.	-0,346	0,000
Testate amoebae (ind/mL)	<i>Arcella</i> sp.	0,667	0,000
	<i>Euglypha</i> sp.	0,370	0,000
	<i>Pyxidicula</i> sp.	0,350	0,000
Metazoa (ind/mL)	<i>Philodina</i> sp. (Rotifera)	0,468	0,000
	Nematodes	-0,122	0,000
Filamentous bacteria (m/mL)	Type 0092	0,502	0,000
	<i>Monilobacter batavus</i>	0,453	0,000
	<i>Microthrix parvicella</i>	-0,228	0,005
	GALO	-0,284	0,001
	Type 0675	-0,455	0,000
<i>Beggiatoa</i> sp.	-0,652	0,000	

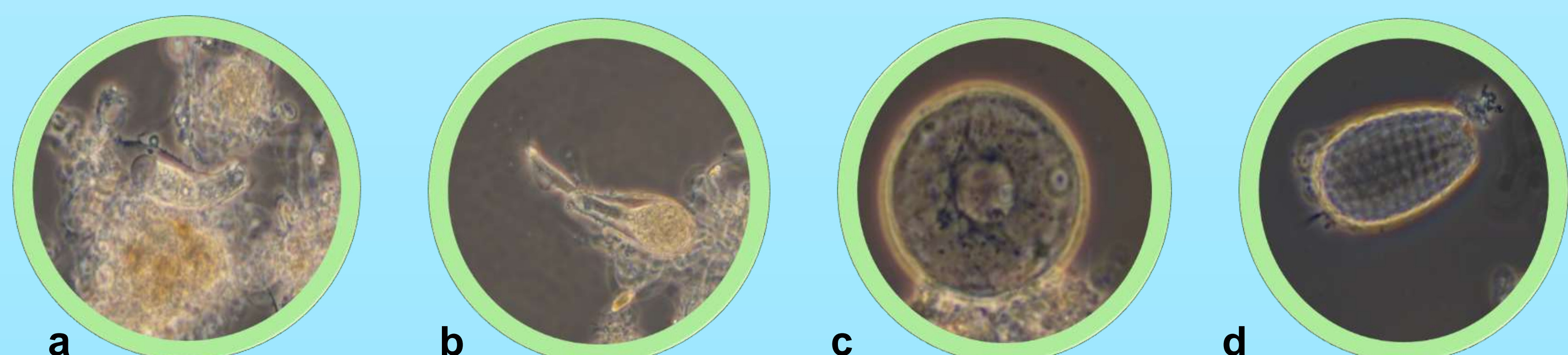


Fig. 1. a) *Metacystis* sp. b) *Chaetospora* sp. c) *Arcella* sp. d) *Euglypha* sp.

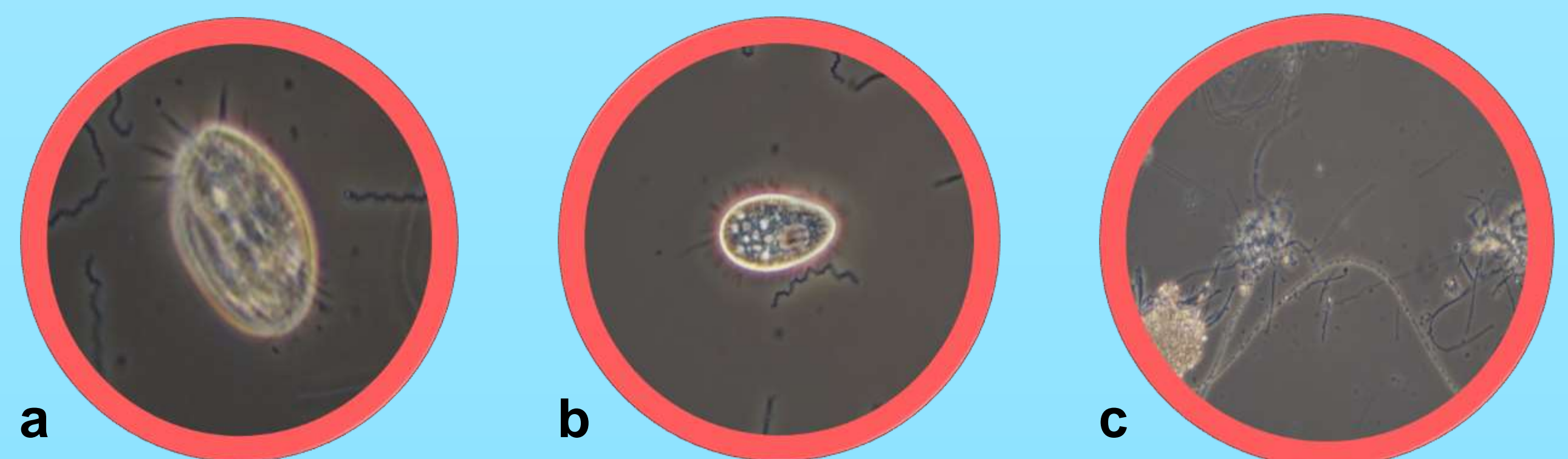


Fig. 2. a) *Euplotes* sp. b) *Uronema nigricans* c) *Beggiatoa* sp.

DISCUSSION AND CONCLUSIONS

An effort to reach an accurate taxonomic identification is essential to obtain reliable results of N-removal performance. In this sense the main groups of taxa do not provide relevant information regarding this parameter as total ciliates, flagellates or filamentous microorganisms. Even within the same group there are taxa that do not provide information, is the case of the common ciliates as *Aspidisca cicada* or *Acineria uncinata*. Despite this, statistical analyses showed two well defined groups of microorganisms according the N-removal efficiency:

- A first group, table 2 (in green), formed by the ciliates *Calyptotricha lanuginosa*, *Metacystis* sp. and *Chaetospora* sp.; the testate amoebae *Arcella* sp., *Euglypha* sp. and *Pyxidicula* sp.; the metazoan *Philodina* sp. and the filamentous bacteria Type 0092 and *Monilobacter batavus*; all of them exhibited a high N-removal efficiency. Most of them related to high sludge age^{1,2,3}.

- A second group, table 2 (in red), was formed by the ciliates *Opercularia* sp., *Euplotes* sp. and *Uronema nigricans*, the flagellate *Trepomonas* sp., and the filamentous bacteria *Beggiatoa* sp. and Type 0675.; which showed low N-removal efficiency.

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