

Species of the *Paramecium aurelia* Complex in Italy

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New stands of *Paramecium pentaurelia* were recorded in Valmarana, Veneto region in Italy and one stand of *P. primaurelia* was found at the same locality.

Key words: *Paramecium aurelia* species complex, geographical distribution, frequency of distribution in Europe

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Among 15 species of the *Paramecium aurelia* complex known at present world-wide (SONNEBORN 1975; AUFDERHEIDE *et al.* 1983) the majority have also been found in Europe. These include *P. primaurelia*, *P. biaurelia*, *P. triaurelia*, *P. tetraurelia*, *P. pentaurelia*, *P. sexaurelia*, *P. septaurelia*, *P. octaurelia*, *P. novaurelia*, *P. dodecaurelia*, *P. tredecaurelia* (cf PRZYBOŚ 1991; PRZYBOŚ & FOKIN 2003; PRZYBOŚ *et al.* 2005; PRZYBOŚ *et al.* 2007a; PRZYBOŚ *et al.* 2007/2008; PRZYBOŚ 2008; POTEKHIN *et al.* 2008; PRZYBOŚ *et al.* 2008a,b; PRZYBOŚ *et al.* 2009a,c). The species occur in Europe with different frequency. The number of investigated habitats and the ratio value (r.v.), i.e. the number of habitats for a defined species to the total number of habitats of the area (zone) were taken into consideration when the frequency of species occurrence was estimated. However, different numbers of habitats were studied in particular European regions (PRZYBOŚ 1998, 2005, PRZYBOŚ *et al.* 2008a), influencing the evaluation of species frequency in a region (temperature zone). The most intensive investigations among European countries have been conducted in Poland over many years (since 1959). Some conclusions on the frequency of occurrence of particular species of the complex in Europe, especially in the central part of the continent, can be based on data from Poland where 256 (47.5% of all) habitats were studied (cf PRZYBOŚ

et al. 2011a) among the total number of 531 habitats studied in Europe, and 374 in its central zone (Table 1). The most common species throughout Europe is *P. novaurelia* followed by *P. biaurelia* and *P. primaurelia*. Some species (*P. octaurelia* and *P. tredecaurelia*) were recorded only in single habitats, others are rare (*P. decaurelia*, *P. dodecaurelia*).

Investigations in zones other than the central one, especially in the southern zone in which only 55 habitats were studied in comparison with 374 habitats investigated in the central zone, may bring more interesting data on the occurrence and distribution of the *P. aurelia* spp. complex in Europe. In the southern zone sampling was carried out in Croatia, Greece, Bulgaria, Romania, Spain, and Italy (cf PRZYBOŚ *et al.* 2008a).

In Italy only 13 habitats have been studied. This report presents new data on the *P. aurelia* species in this country. Previous records include: *P. biaurelia* (SONNEBORN 1956) and *P. tetraurelia* (SONNEBORN *et al.* 1959) without information concerning the place of collection; *P. primaurelia* in Naples, Palermo, Syracuse and *P. biaurelia* in Parma (KOMALA & DUBIS 1965), the Island of Giglio (PRZYBOŚ 1998), the Island of Elba (PRZYBOŚ & FOKIN 2001); *P. tetraurelia* and *P. pentaurelia* in Naxos, Sicily as well as *P. dodecaurelia* in Trento, North of Italy ((PRZYBOŚ *et al.* 2005); *P. pentaurelia*

Table 1

Occurrence of species of the *Paramecium aurelia* complex in temperature zones in Europe

Zone	Number of studied habitats of species of the <i>P. aurelia</i> complex*												Total
	<i>P. prim-aurelia</i>	<i>P. bi-aurelia</i>	<i>P. tri-aurelia</i>	<i>P. tetra-aurelia</i>	<i>P. pent-aurelia</i>	<i>P. sex-aurelia</i>	<i>P. sept-aurelia</i>	<i>P. oct-aurelia</i>	<i>P. nov-aurelia</i>	<i>P. dec-aurelia</i>	<i>P. dodec-aurelia</i>	<i>P. tredec-aurelia</i>	
Northern	20	32	9	3	14	4	11	–	16	7	3	–	102
Central	77	97	12	21	3	2	1	1	163	–	3	1	374
Southern	21	18	5	8	5	5	–	–	9	–	2	–	55
Total	118	147	26	32	22	11	12	1	188	7	8	1	531

*Some species appear together in one habitat.

Data from PRZYBOŚ *et al.* 2008a modified by data published later by the authors.

was also found in Naples (PRZYBOŚ *et al.* 2008 a); *P. dodecaurelia* was recorded on the Elbe Island (PRZYBOŚ & FOKIN 2003). DINI *et al.* (1995) in the “Checklist della species della fauna Italiana” indicated the presence of the *P. aurelia* spp. in northern Italy without specific information. The data concerning the occurrence and distribution of the *P. aurelia* species in Italy are summarized in Table 2.

Material and Methods

Material

Water samples with plankton were collected in northern Italy, Veneto region, Valmarana, in June 2008 and July 2009 by Andrea Pereswiet-Soltan. Paramecia were isolated and strains of the *P. aurelia* spp. established (Table 3).

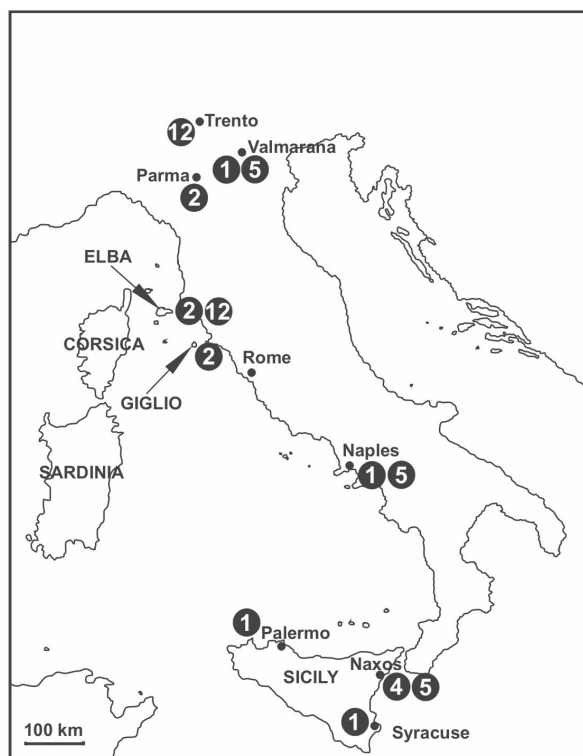


Fig. 1. Occurrence of species of the *Paramecium aurelia* complex in Italy. Numbers refer to the particular species; 1 – *P. primaurelia*, 2 – *P. biaurelia*, 4 – *P. tetraurelia*, 5 – *P. pentaurelia*, 12 – *P. dodecaurelia*.

Table 2

Occurrence and distribution of the *Paramecium aurelia* species in Italy (data from literature)

Species	Origin of strain	References
<i>P. primaurelia</i>	Naples	KOMALA & DUBIS 1965
	Palermo	
	Syracuse	
<i>P. biaurelia</i>	Parma	PRZYBOŚ 1998
	Island of Giglio	
	Island of Elba, Seccheto	PRZYBOŚ & FOKIN 2001
	No data	SONNEBORN 1956
<i>P. tetraurelia</i>	No data	SONNEBORN <i>et al.</i> 1959
	Naxos, Sicily	PRZYBOŚ <i>et al.</i> 2005
<i>P. pentaurelia</i>	Naxos, Sicily	PRZYBOŚ <i>et al.</i> 2005
	Naples	PRZYBOŚ <i>et al.</i> 2008a
<i>P. dodecaurelia</i>	Island of Elba, Azurro	PRZYBOŚ & FOKIN 2003
	Trento, North of Italy	PRZYBOŚ <i>et al.</i> 2005

Table 3

Data on *P. aurelia* spp. collected in 2008 and 2009

Region	Collecting place	Kind of water habitat	Date of sampling	Species of <i>P. aurelia</i> complex
Veneto	Valmarana	Small pond	2008 June	<i>P. pentaurelia</i>
		Small pond		<i>P. pentaurelia</i>
		Channel		<i>P. primaurelia</i>
		Small pond (sampling points: I,II,III)	2009 July	<i>P. pentaurelia</i>

Methods

The paramecia were cultivated on a lettuce medium inoculated with *Enterobacter aerogenes*. Species of the *Paramecium aurelia* were identified by mating the investigated clones with the mating types of standard strains of known species (according to the methods of SONNEBORN 1970). The following standard strains were used: strain 90 of *P. primaurelia*, strain 87 of *P. pentaurelia*.

Results and Discussion

P. pentaurelia was identified in Valmarana (Veneto region) in the samples collected in 2008 and 2009 from 3 habitats (small ponds), in one of them in 3 different sampling points. *P. primaurelia* was recorded in a channel in the same locality (Table 3), the latter species is considered a cosmopolitan one (SONNEBORN 1975), known from North, Central, and South America, Hawaii, Asia, and Europe (PRZYBOŚ & FOKIN 2000).

P. pentaurelia is a species of the *P. aurelia* complex which appears in Italy in its southern (Sicily), middle (Naples) and northern parts (Valmarana). In Europe, it was also found in Spain, Romania, Hungary, Poland, and Russia (PRZYBOŚ *et al.* 2008a). It seemed to be limited to the warm zone of Europe but the finding of this species in Poland (PRZYBOŚ *et al.* 2008 a; PRZYBOŚ *et al.* 2009b) and also in northern Russia (POTEKHIN *et al.* 2010) enlarged its range. Beside Europe, the species is also recorded from North America and Australia (SONNEBORN 1975).

PCR based analyses (RAPD, ARDRA, RFLP) showed no intraspecific differentiation of known strains of *P. pentaurelia* in comparison with other species of the *P. aurelia* complex (cf STOECK *et al.* 2000; PRZYBOŚ *et al.* 2005; PRZYBOŚ *et al.* 2007/2008; PRZYBOŚ *et al.* 2007b), whereas exceptional polymorphism was found in *P. tetraurelia*, *P. octaurelia*, and *P. dodecaurelia* which also con-

firmed later by sequencing rDNA fragments and COI mtDNA (PRZYBOŚ *et al.* 2008b, 2009a). However, sequencing of other DNA fragments (cytb mtDNA and LSUrDNA) revealed intra-specific polymorphism within *P. pentaurelia* (PRZYBOŚ *et al.* 2009b, 2011b) showing that this species is characterized by inbreeding as other species of the *P. aurelia* complex.

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References

AUFDERHEIDE K. J., DAGGETT P.-M., NERAD T. A. 1983. *Paramecium sonneborni* n. sp., a new member of the *Paramecium aurelia* species-complex. *J. Protozool.* **30**: 128-131.

DINI F., LUCCHESI P., MACCHIONI G. 1995. Checklist della fauna Italiana. Protozoa. Edizioni Calderini, Bologna, pp. 92.

KOMALA Z., DUBIS K. 1965. Contribution to the observations on the occurrence of *Paramecium aurelia* syngens in Italy. *Folia biol. (Kraków)* **13**: 265-267.

POTEKHIN A., PRZYBOŚ E., NEKRASOVA I., YASHCHENKO V., RAUTIAN M. 2010. Species of the *Paramecium aurelia* complex in Russia: new stands and overall distribution. *Folia biol. (Kraków)* **58**: 73-78.

POTEKHIN A., PRZYBOŚ E., RAUTIAN M. 2008. *Paramecium* species of the Upper and Lower Volga River Basin. *Folia biol. (Kraków)* **56**: 203-207.

PRZYBOŚ E. 1991. Studies on the *Paramecium aurelia* species complex in Spain (Ciliophora). *Arch. Protistenk.* **140**: 151-156.

PRZYBOŚ E. 1998. New habitats of *Paramecium biaurelia* in Italy. *Folia biol. Kraków* **46**: 87-89.

PRZYBOŚ E. 2005. Recent data on the distribution of species of the *Paramecium aurelia* complex in Europe. *Folia biol. (Kraków)* **53**: 61-63.

- PRZYBÓŚ E. 2008. New stands of *Paramecium tetraurelia* (Ciliophora, Protozoa). In Australia and Europe. *Folia biol. (Kraków)* **56**: 111-113.
- PRZYBÓŚ E., BARTH D., BERENDONK T. U. 2008a. The *Paramecium aurelia* species complex, frequency and co-occurrence across Europe. *Folia biol. (Kraków)* **56**: 77-81.
- PRZYBÓŚ E., FOKIN S. 2000. Data on the occurrence of species of the *Paramecium aurelia* complex world-wide. *Protistology* **1**: 179-180.
- PRZYBÓŚ E., FOKIN S. 2001. Habitat of *Paramecium biaurelia* in Italy, the Island of Elba. *Folia biol. (Kraków)* **49**: 103-104.
- PRZYBÓŚ E., FOKIN S. I. 2003. Finding of *Paramecium dodecaurelia* in Europe. *Protistology* **3**: 136-137.
- PRZYBÓŚ E., GRECZEK-STACHURA M., POTEKHIN A., RAUTIAN M. 2007a. Strains of *Paramecium decaurelia* (Ciliophora, Protozoa) from Russia with molecular characteristics of other known strains of the species. *Folia biol. (Kraków)* **55**: 127-132.
- PRZYBÓŚ E., GRECZEK-STACHURA M., PRAJER M., POTEKHIN A., COTSINIAN A. 2007/ 2008. Two species of the *Paramecium aurelia* complex (Ciliophora, Protista) from the Black Sea, Russia with their RAPD-PCR fingerprints characteristics. *Protistology* **5**: 207-212.
- PRZYBÓŚ E., PRAJER M., GRECZEK-STACHURA M., FOKIN S. I., RAUTIAN M., POTEKHIN A. 2005. New European stands of *Paramecium pentaurelia*, *Paramecium septaurelia*, and *Paramecium dodecaurelia*, genetic and molecular studies. *Folia biol. (Kraków)* **53**: 123-128.
- PRZYBÓŚ E., PRAJER M., GRECZEK-STACHURA M., SKO-TARCZAK B., MACIEJEWSKA A., TARCZ S. 2007b. Genetic analysis of the *Paramecium aurelia* complex by classical and molecular methods. *Systematics and Biodiversity* **5**: 417-434.
- PRZYBÓŚ E., SURMACZ M., GRECZEK-STACHURA M., TARCZ S. 2011a. Seasonal and spatial variability of species occurrence of the *Paramecium aurelia* complex in a single natural pond. In press.
- PRZYBÓŚ E., TARCZ S., FOKIN S. 2009a. Molecular polymorphism of *Paramecium tetraurelia* (Ciliophora, Protozoa) in strains originating from different continents. *Folia biol. (Kraków)* **57**: 57-63.
- PRZYBÓŚ E., TARCZ S., GRECZEK-STACHURA M., SURMACZ M., POTEKHIN A., RAUTIAN M. 2008b. Molecular studies on intra-specific differentiation of *Paramecium dodecaurelia*, with description of new stands of the species (Protozoa, Ciliophora). *Folia biol. (Kraków)* **56**: 249-262.
- PRZYBÓŚ E., TARCZ S., GRECZEK-STACHURA M., SURMACZ M. 2009b. Diversity of *Paramecium pentaurelia* strains. Fifth Meeting of the GDRE "Paramecium Genomics", December 5-8, 2009, Kraków, Poland. Abstracts: 25.
- PRZYBÓŚ E., TARCZ S., GRECZEK-STACHURA M., SURMACZ M. 2011b. Polymorphism of *Paramecium pentaurelia* strains revealed by rDNA and mtDNA sequences. Submitted to publication.
- PRZYBÓŚ E., TARCZ S., SCHMIDT H., CZUBATINSKI L. 2009c. First stand of *Paramecium octaurelia* in Europe and molecular characteristics of other known strains of this species. *Folia biol. (Kraków)* **57**: 65-70.
- SONNEBORN T. M. 1956. The distribution of *Paramecium aurelia* varieties. *Anat. Rec.* **125**: 567.
- SONNEBORN T. M. 1970. Methods in *Paramecium* Research. (In: *Methods in Cell Physiology*, Prescott D. M. ed., vol. 4. Academic Press, New York, London): 241-339.
- SONNEBORN T. M. 1975. The *Paramecium aurelia* complex of fourteen sibling species. *Trans. Amer. Microsc. Soc.* **94**: 155-178.
- SONNEBORN T. M., SCHNELLER M. V., MULLER J. A., HOLZMAN H. E. 1959. Extension of the range of certain syngens of *Paramecium aurelia*. *J. Protozool.* **6**(suppl): 31-32.
- STOECK T., PRZYBÓŚ E., KUSCH J., SCHMIDT H. J. 2000. Intra-species differentiation and level of inbreeding of different sibling species of the *Paramecium aurelia* complex. *Acta Protozool.* **39**: 15-22.