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THE DIVERSITY OF CADDISFLIES (INSECTA, TRICHOPTERA) SPECIES IN TIMIŞ RIVER CATCHMENT AREA (WESTERN ROMANIA)

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ABSTRACT

In order to determine the benthic macro invertebrates communities role as bioindicators, researchers worldwide carried out analyses into the structure, dynamics and diversity of the different groups as well as into the physical-chemical factors. A total of twenty one species of caddisfly larvae were identified in the study. Numerical abundance, frequency and diversity values recorded for the caddisfly species varied according to the physical-chemical conditions specific to each sample collecting station. The physical and chemical parameters monitored in Timiş River water catchment basin have corresponded with the limits of the Ministry of Environment and Water Management (MEWA) Order 161/2006, which states the ecological status of surface bodies of water with, few exceptions being identified.

RĖSUMĖ: La diversité des trichoptères dans le bassin hydrographique de la rivière de Timiș.

Dans le but d’établir le rôle de bioindicateur des communautés de macro-invertébrés benthiques, les chercheurs du monde entier ont effectué des études d’analyse de la structure, de la dynamique et de la diversité des différents groupes, en relation avec l’étude des agents physico-chimiques. Dans la présente étude, 21 espéces de trichoptères au stade larvaire ont été identifiés. Les valeurs d’abondance en pourcentage, de la fréquence et de la diversité biologique relative aux larves de trichoptéres identifiées, ont varié par rapport aux modifications des paramétres physico-chimiques spécifiques à chaque station de collecte d’échantillons. Les valeurs des paramètres physico-chimiques relevées dans le bassin hydrographique de Timiș sont conforment aux normes établies par le Ministère des Eaux et de la Protection de l’Environnement 161/2006, qui prévoit un bon état écologique des cours d’eau; quelques exceptions sont tout de même à noter.

REZUMAT: Diversitatea speciilor de trichoptere în zona bazinului hidrografic al râului Timiş.

În vederea determinării rolului de bioindicatori al comunităților de macronevertebrate bentonice, cercetători din întreaga lume au desfășurat studii de analiză a structurii, dinamicii și diversității diferitelor grupe, alături de cele privind factorii fizico-chimici. În prezentul studiu, au fost identificate 21 specii de trichoptere în stadiul larvar. Valorile abundenței numerice procentuale, ale frecvenței și diversității biologice privind larvele de trichoptere identificate au variat în raport cu modificările parametrilor fizico-chimici specifici fiecărei stații de colectare a probelor. Valorile parametrilor fizico-chimici monitorizați în bazinul hidrografic al Timișului au corespuns limitelor Ordinului Ministrului Apelor și Protecției Mediului 161/2006, care prevede starea ecologică a corpurilor de apă, fiind identificate câteva excepții.

INTRODUCTION

The ecological monitoring of the quality of the water supposes the use of multiple methods of chemical, physical and biological analysis, its importance being given by the specific adaptations to the specific habitat conditions (Ouyang, 2005; Guilpart et al., 2012). The higher the interest, the more the anthropic influences become stronger with direct influence upon the natural ecosystems of aquatic types (Böhmer et al., 2004; Van Hoey et al., 2010). The monitoring programs for water quality has become a major concern in most of European countries, and each country using their own or borrowed system. The joint element being represented by the macro fauna that are frequently used as an indicator (Böhmer et al., 2004; Borja et al., 2007).

The studies carried out presently place caddisflies as an instrumental group of biological indicators, due to their sensitive to alteration of water quality (Azrina et al., 2006; Li et al., 2010; Wesolek et al., 2010). The spread of the different species of caddisflies through the aquatic systems is given by a series of key factors, one of which is the critical role played by the anthropic impact (Englund et al., 1997; Fernández-Aláez et al., 2002; Roy et al., 2003; Kail et al., 2012; Almeida et al., 2013) and ecologic and habitat preferences of each and every species (Hildrew and Edington, 1979; Boyero and Barnard, 2004; Hughes, 1978).

Timiş drainage area (TDA) (5.673 km^2) represents, together with Bega drainage area, (BDA) (2.362 km^2) approximately 43% of the surface of Banat hydrographic space located in the western part of the country (Ilie, 2007).

The main purpose of this study is to analyse the diversity and the structure of the Trichoptera community in the target area for the purpose of establishing a natural and/or anthropic impact, either present or potential.

MATERIAL AND METHODS

Benthos samples collection

In the summer of 2009 a field investigation was conducted in Timiş River water catchment area, western Romania. A total of 19 semi-quantitative samples (1 sample/station) were processed using a hand net (meshes of 250 µm), each of the sites investigated were approximately 200 m in length. In the laboratory, the identification of the organisms was conducted on a species level (Waringer and Graf, 1997; Wallace et al., 2003). Organisms were not identified in the first stages of existence at a species level, they did not feature fully developed morphological traits to allow a proper analysis. 349 individuals were processed.

Localizing the sampling stations and processing the data

The localization of sampling stations according to the code number is as follows:

S1, Moraviţa (45°21’25” N, 21°45’51” E, altitude - alt. 240 m); S2, Străjești (45°23’08” N, 22°02’43” E, alt. 280 m); S3, Valea Runc (45°22’46” N, 22°07’47” E, alt. 320 m); S4, Grădişte (45°13’13” N, 22°06’42” E, alt. 820); S5, Brebu (45°14’03” N, 22°08’47” E, alt. 860 m); S6, Cernei (45°12’39” N, 22°15’53” E, 270 m); S7, Armeniş (45°14’21” N, 22°21’25” E, alt. 440 m); S8, Valea Petroșniței (45°19’14” N, 22°14’14” E, alt. 300 m); S9, Bolnișoara (45°19’07” N, 22°21’31” E, alt. 400 m); S10, Slătinioara (45°21’38” N, 22°22’01” E, alt. 395 m); S11, Valea Vidra (45°25’05” N, 22°31’25” E, alt. 620 m); S12, Mânzul (45°29’56” N, 22°31’14” E, alt. 490 m); S13, Stârna Mare (45°31’33” N, 22°31’10” E, 390 m); S14, Valea Micota (45°32’16” N, 22°33’28” E, alt. 460 m); S15, Loznișoara (45°34’28” N, 22°29’35” E, 415 m alt.); S16, Glimboca (45°31’19” N, 22°19’16” E, alt. 295 m); S17, Macioava (45°31’59” N, 22°11’53” E, alt. 235 m); S18, Padeșu (45°39’30” N, 22°11’59” E, alt. 300 m); S19, Hăuzeasca (45°42’24” N, 22°09’40” E, alt. 260 m).

In each of the sampling sectors, the water temperature (°C), average river width, depth (m) and percentage of riparian tree coverage (%) were estimated. Along with several physico-chemical parameters: pH, dissolved oxygen (mg l^{-1}), conductivity (µS cm^{-1}), water hardness (°dH), dissolved calcium and magnesium ions (mg l^{-1}), dissolved inorganic nitrogen forms (N-nitrate, N-nitrite and N-ammonia) (mg l^{-1}) and soluble reactive phosphorus (SRP) (mg l^{-1}). These indicators were recorded with HACH-Lange (Düsseldorf, Germany) multi-parameter and spectrophotometer field equipment following the standard procedure for each parameter. Each parameter was analysed using one subsample in each sampling sector.

The abundance $A = (n_i N^{-1})*100$ and frequency $F = (N_i*100) N_p^{-1}$ were further calculated, where n_i represents the total number of individuals for the i species, S_p the total researched area, N the total number of individuals belonging to all species (from the sample or samples studied), N_i the number of stations where i species were identifies, N_p total number of stations (Stan, 1995). The Shannon-Wiener (SW-DI) diversity index, $H' = -\Sigma p_i \log_2 p_i$ and the Pielou equitability index (PEI) $E = H'/H_{max}$, where p_i represents species abundance calculated according to $p_i = n_i N^{-1}$, $H_{max} = \log S$, S the total number of species (Sîrbu and Benedek, 2004) were also determined.

RESULTS

The mean values of the maximum river bed stretch and water depth for the 19 stations were 2.71±0.49 m and 0.43±0.10 m. The mean values of the minimum river bed stretch and water depth for the 19 stations were 1.04±0.32 m and 0.08±0.02 m. The mean values of the coverage degree of the river bed was 57.95±13.62% and the sub-layer analyzed was mostly made up of stones, boulders and gravel.

After processing the samples, 21 species included in 12 genera and 7 families were identified as follows: Fam. Glossosomatidae: genus *Glossosoma* (*G. conformis* Neboiss, 1963), Fam. Hydropsychidae: genus *Hydropsyche* (*H. angustipennis* Curtis, 1834; *H. fulvipes* Curtis, 1834; *H. incognita* Pitsch, 1993; *H. instabilis* Curtis, 1834; *H. pellucidula* Curtis, 1834), Fam. Limnephilidae: genus *Chaetopterygopsis* (*C. maclachlani* Stein, 1874), genus *Halesus* (*H. digitatus* von Paula Schrank, 1781; *H. rubricollis* Pictet, 1834), genus *Micropterna* (*M. lateralis* Stephens, 1837), genus *Potamophylax* (*P. latipennis* Curtis, 1834; *P. nigricornis* Pictet, 1834; *P. luctuosus* Piller and Mitterpacher, 1783), Fam. Philopotamidae: genus *Philopotamus* (*P. montanus* Donovan, 1813), Fam. Psychomyiidae: genus *Lype* (*L. phaeopa* Stephens, 1836), genus *Psychomyia* (*P. pusilla* Fabricius, 1781), Fam. Rhyacophilidae: genus *Rhyacophila* (*R. dorsalis* Curtis, 1834; *R. obliterata* McLachlan, 1863; *R. tristis* Pictet, 1834), Fam. Sericostomatidae: genus *Sericostoma* (*S. personatum* Kirby and Spence, 1826), genus *Oecismus* (*O. monedula* Hagen, 1859).

The *Hydropsyche* genus featured the highest number of species (5), followed by the rest, with three species for *Potamophylax* sp. and *Rhyacophila* sp. respectively, and with one species for each of the rest. Their distribution according to the sample collection stations is shown in table 1.

The analysis of the percentage numerical abundance showed a high value for the *H. incognita* species (94.74%), followed by the other two species, but at a great distance from the point of view of value identified, with 31.58% each (Fig. 1). The lowest values were established for 7 of the 21 species of caddisflies identified in total, with values of 5.26% each. In terms of frequency, the highest values were established for two species of the genus *Hydropsyche*, *H. pellucidula* and *H. incognita* with 23.21% and respectively 22.64% (Fig. 2). The lowest frequency was set for *H. digitatus* (0.29%).

After calculating the SW-DI index, a maximum value of diversity for S14 (0.76) and S1 (0.70) were established, the lowest value of 0.15 being set for 5 sampling stations (S2, S5, S13, S15, S17) (Fig. 3). These low values were also established by calculating the PEI index for the same sampling stations, the maximum being identified for S8 and S16 with 1.04 and respectively 1.03 (Fig. 4).

Table 1: Caddisflies species distribution in Timiş River water catchment area, 2009.

	H. angustipennis	*H. fulvipes*	*H. instabilis*	*H. incognita*	*H. pellucidula*	*Pt. latipennis*	*Pt. nigricornis*	*Pt. luctuosus*	*R. dorsalis*	*R. obliterata*	*R. tristis*	*H. digitatus*	*H. rubricolis*	*S. personatum*	*O. monedula*	*L. phaeopa*	*P. montanus*	*M. lateralis*	*P. pusilla*	*G. conformis*	*C. maclachlani*
S1		x	x	x						x	x	x									
S2				x																	
S3				x	x		x				x										
S4	x			x																	
S5				x															x		
S6				x																	
S7				x	x	x	x		x		x			x	x		x	x			
S8				x		x		x	x						x		x	x			
S9	x			x						x				x							
S10			x	x	x					x	x		x								x
S11				x		x		x	x												
S12				x	x																
S13				x		x			x												
S14			x	x		x			x					x	x	x				x	
S15				x																	
S16				x																	
S17				x	x																
S18				x	x																
S19				x		x			x					x							

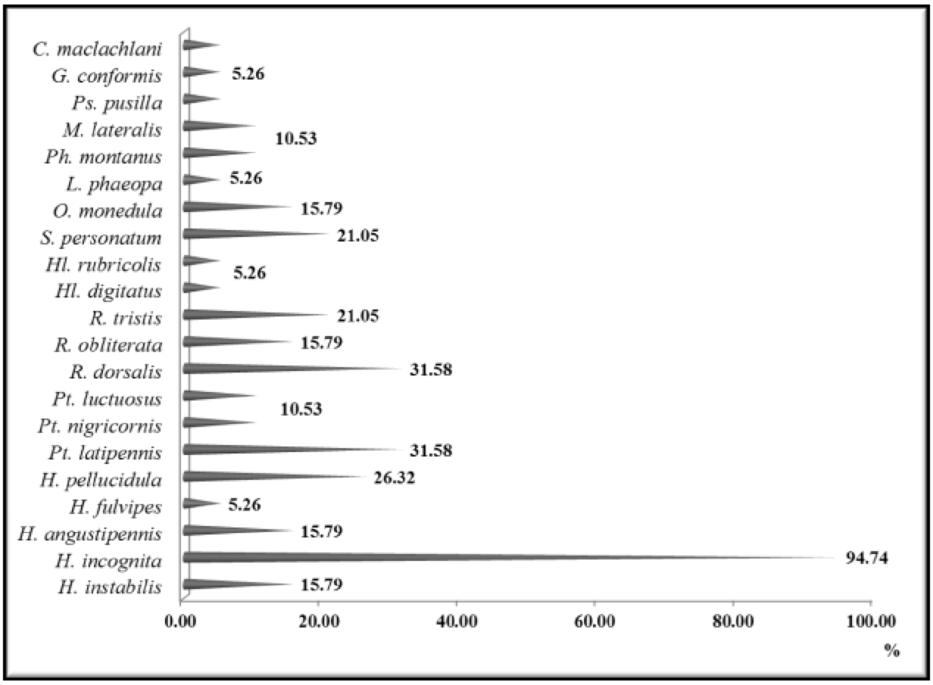

Figure 1: Percentage numerical abundance (%) of caddisflies species in Timiș River water catchment area, 2009.

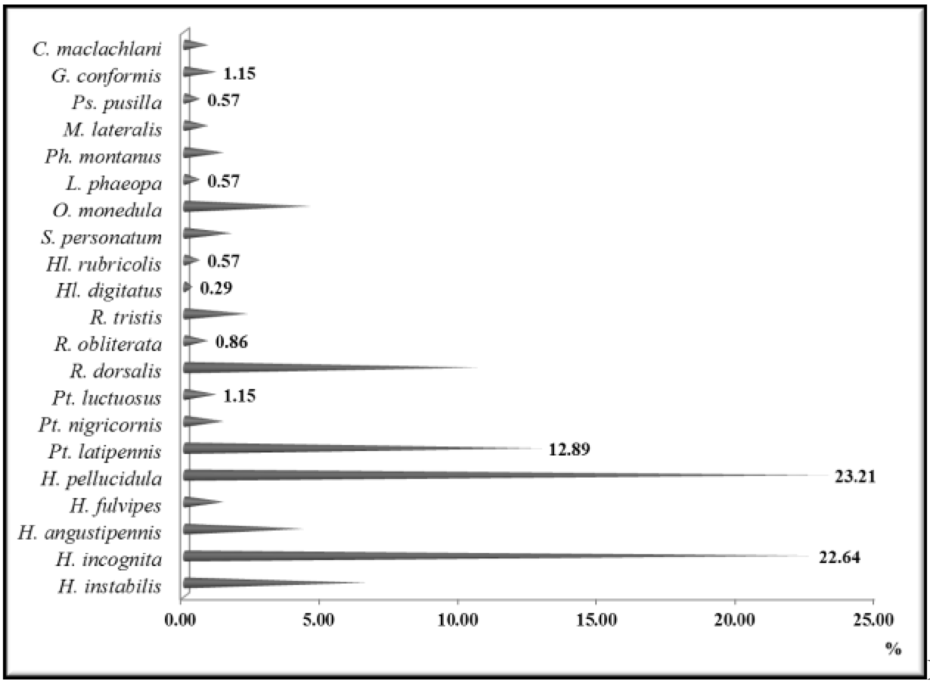

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Figure 2: Frequency (%) of caddisflies species in Timiș River water catchment area, 2009.

The SW index and PEI values corresponding to the 19 sampling stations for the summer of 2009 in Timiș River water catchment basin were presented in figure 3.

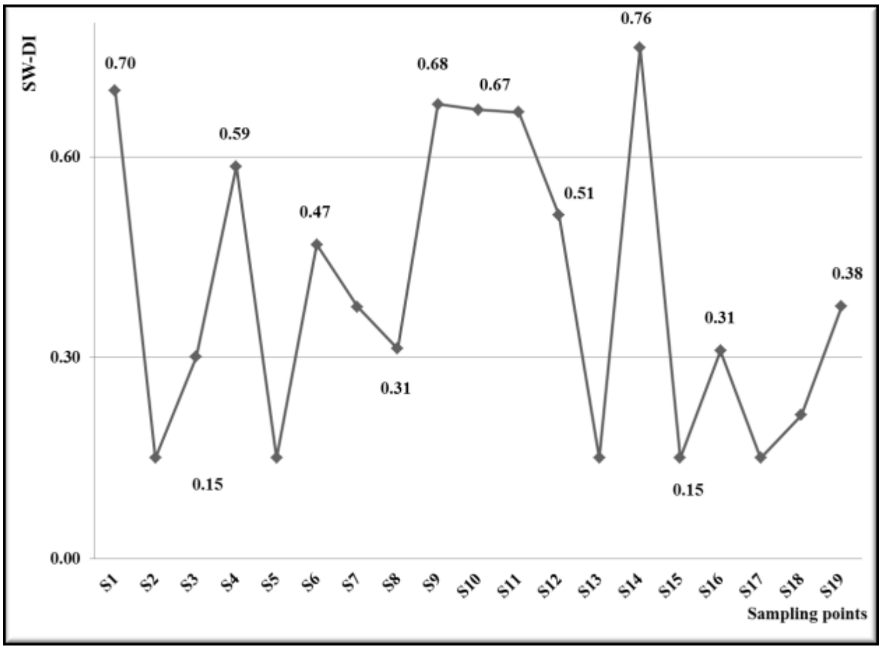

Figure 3: SW-DI values in Timiș River water catchment area, 2009.

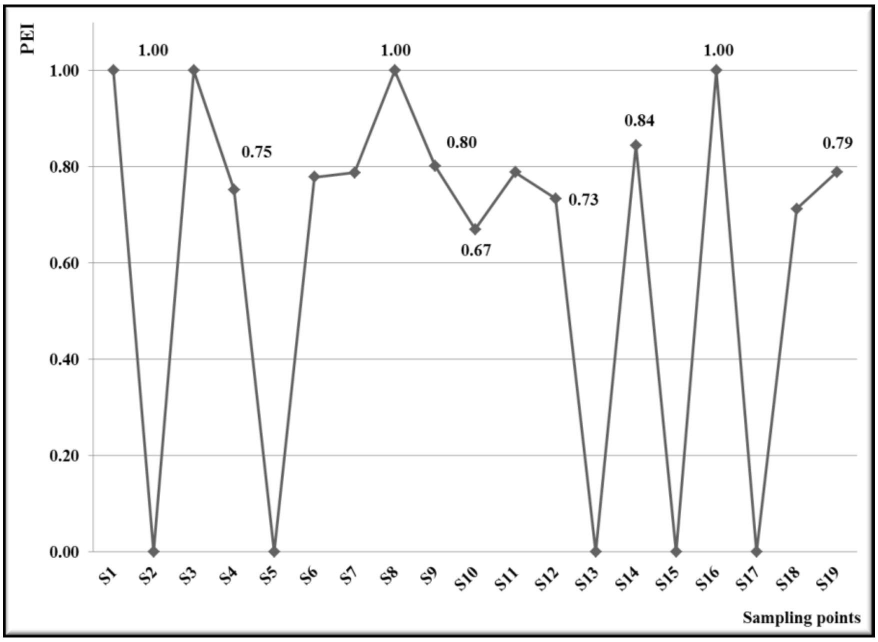

Figure 4: PEI values in Timiș River water catchment area, 2009.

In table 2, the water quality of the monitored stations in this study is presented based on the values of chemical parameters measured in accordance with the Ministry of Environment and Water Management (MEWA) Order 161/2006, reflecting not only the quality of the water, but also the structure of benthic fauna in the area. For table 2, the following abbreviations have been used in determining the appropriate water quality class: field marked white - class I, field marked light gray - class II, field marked dark gray - class III, field marked dark gray and bold values - class IV and field marked white and bold values - class V. pH values were not marked in the table, its values being in accordance with the required normal limits.

Table 2: Assigning the appropriate water quality classes for the sampling stations and the study interval in accordance with Order 161/2006.

Sampling stations	**Dissolved oxygen**	**Ca**	**Mg**	**N-nitrate**	**N-nitrite**	**SRP**	**N-ammonia**	**pH**
S1	8.78	22.50	9.650	0.30	0.06	0.07	0.04	7.08
S2	8.69	11.90	7.610	0.40	0.03	0.14	0.04	7.01
S3	9.00	11.10	3.740	0.20	0.001	0.11	0.08	7.44
S4	9.22	23.50	0.860	0.80	0.002	**1.07**	0.03	7.87
S5	9.01	4.42	16.300	1.10	0.01	**0.78**	0.04	7.74
S6	8.75	6.53	2.240	0.90	0.01	0.17	0.03	8.26
S7	8.73	9.86	4.870	0.40	0.01	0.17	0.04	7.18
S8	8.65	98.50	4.300	1.10	0.002	**0.94**	0.02	7.58
S9	8.93	23.10	2.500	0.70	0.003	0.07	0.02	8.02
S10	9.59	25.70	4.570	0.40	0.003	**0.42**	0.21	7.82
S11	9.03	12.40	7.300	0.10	0.01	0.27	0.07	7.55
S12	9.63	23.60	2.830	0.50	0.01	0.21	0.02	8.15
S13	8.16	18.30	2.000	0.70	0.01	0.21	0.02	6.89
S14	8.88	18.50	2.900	0.40	0.002	**0.80**	0.01	7.90
S15	8.30	19.90	1.540	0.40	0.002	**0.61**	0.01	7.52
S16	8.99	27.10	0.262	0.20	0.002	**0.61**	0.06	8.13
S17	8.20	23.70	1.680	0.30	0.003	**0.49**	0.03	7.60
S18	8.20	61.90	4.430	0.10	0.003	0.05	0.03	8.12
S19	9.04	72.40	26.500	0.20	0.01	0.30	0.01	8.22

Table 3: The values of the physical-chemical parameters calculated at the 19 sites in Timiş River water catchment area, 2009.

Sampling stations	Water temperatur	pH	Dissolved oxygen	Conductivity	Water hardness	Dissolved calcium and magnesium ions		Dissolved inorganic nitrogen forms			SRP
						Ca	Mg	N- nitr	N- nitr	N- am	
S1	15.90	7.08	8.78	32.20	3.16	22.50	9.65	0.30	0.06	0.04	0.07
S2	15.90	7.01	8.69	26.70	1.67	11.90	7.61	0.40	0.03	0.04	0.14
S3	19.10	7.44	9.00	66.00	1.55	11.10	3.74	0.20	0.001	0.08	0.11
S4	18.00	7.87	9.22	161.70	3.29	23.50	0.86	0.80	0.001	0.03	1.07
S5	18.70	7.74	9.01	141.10	3.76	4.42	16.30	1.10	0.01	0.04	0.78
S6	24.20	8.26	8.75	151.30	0.92	6.53	2.24	0.90	0.01	0.03	0.17
S7	19.00	7.18	8.73	60.40	1.38	9.86	4.87	0.40	0.01	0.04	0.17
S8	19.50	7.58	8.65	70.70	1.38	98.50	4.30	1.10	0.001	0.02	0.94
S9	17.30	8.02	8.93	131.70	3.24	23.10	2.50	0.70	0.002	0.02	0.07
S10	14.50	7.82	9.59	79.60	3.61	25.70	4.57	0.40	0.002	0.21	0.42
S11	17.00	7.55	9.03	55.40	1.73	12.40	7.30	0.10	0.01	0.07	0.27
S12	16.30	8.15	9.63	125.20	3.32	23.60	2.83	0.50	0.01	0.02	0.21
S13	17.00	6.89	8.16	141.50	2.57	18.30	2.00	0.70	0.01	0.02	0.21
S14	18.20	7.90	8.88	98.40	2.59	18.50	2.90	0.40	0.002	0.01	0.80
S15	19.50	7.52	8.30	116.60	2.79	19.90	1.54	0.40	0.002	0.01	0.61
S16	27.40	8.13	8.99	178.10	3.86	27.10	0.26	0.20	0.002	0.06	0.61
S17	21.10	7.60	8.20	136.40	3.33	23.70	1.68	0.30	0.001	0.03	0.49
S18	20.80	8.12	8.20	342.00	9.71	61.90	4.43	0.10	0.001	0.03	0.05
S19	15.80	8.22	9.04	601.00	16.30	72.40	26.50	0.20	0.01	0.01	0.30

DISCUSSIONS

The interest in studying caddisfly larvae is sustained by their contribution to turning the allochtone material into biomass, which is then spread across upper trophic levels (Burd et al., 2008). Scientific literature sustains the role caddisflies occupy in evaluating water quality also, as well as the various degrees of tolerance to changes in qualitative parameters of water bodies (Solà and Prat, 2006; Arimoro and Ikomi, 2009; Rizo-Patrón et al., 2013).

Based on the Order 161/2006, it was established that the majority of the physico-chemical parameters studied indicated a high quality of the water, belonging to class I. There were exceptions such as the concentration of the dissolved oxygen (S1, S2, S6-S9, S13-S19 - class II), dissolved calcium (S8, S18, S19 - class II), dissolved magnesium (S5, S19 - class II), nitrate (S5, S8 - class II), nitrite (S1 - class III; S2 - class II) and SRP (S2, S3, S6, S7 - class II; S11-S13, S19 - class III; S5, S10, S13-S17 - class IV; S4, S8 - class V) (Tabs. 2 and 3).

However, these exceptions have not changed the diversity of caddisflies in monitored sampling stations, SW-DI index values and those of the PEI index still being relatively high compared with other stations (Figs. 3 and 4). We believe that this is due to large numbers of individuals belonging to the tolerant species such as the representatives of the *Hydropsyche*, *Rhyacophila* and the *Potamophylax* genus (Tab. 1) (Graf et al., 2008).

Potamophlylax genus preference for altitudes of 150-3100 m and below 150 m, with substrate composed of stones, gravel and boulders and also its tolerance to organic material was demonstrated in the literature (Graf et al., 2008). Lukáš and Krno (2003) for example, the species identified at the altitude of 200-450 m and over 450 m. In this study, three species belonging to this genus were identified at an altitude between 240 and 490 m (Tab. 1). A similar pattern was set for *Rhyacophila* species. The literature has associated the species with pH values ranging from acid to alkaline and considered them tolerant (Fjellheim and Raddum, 1990; Bonada et al., 2005). High altitude dependence of these species was also demonstrated (Urbanič and Toman, 2007) signaling the presence of this species at an altitude over 500 m. In our study, the three species were reported between 270 and 820 m (Tab. 1).

Also, the presence of species tolerant to changing water quality parameters as those belonging to the *Hydropsyche* genus may suggest that an imbalance exists, these species being generally considered to be less sensitive than other species of the order (Bonada et al., 2005; Philipson and Moorhouse, 2006). Given the presence in certain areas of some sensitive caddisfly species and that the species of the *Hydropsyche* genus are predatory by building a special net-spinning trap (Fuller and Mackay, 1980; Poepperl, 2000), we consider that their high number compared to the rest of the species is due to their preference for fast flowing waters such as those analyzed in the present study and by being more tolerant. Moreover, these results are suggested by low values of SW-DI and PEI diversity in 5 of the 19 stations surveyed, in all five locations only one species was identified, *H. incognita* (Tab. 1; Figs. 3 and B). In fact, the highest values of numerical abundance were identified for *H. incognita* with 94.74%, this situation being similar for frequency in which case the maximum values were set for two species of the genus, *H. incognita* and *H. pellucidula* (Figs. 1 and 2). In general the two species replace one other in terms of altitude, but there were noted situations of coexistence (Hildrew and Edington, 1979; Miklós and Ujvárosi, 2009).

Taking into account the results of this study and those reported by the literature, we believe that the caddisfly larvae can be successfully used as biological indicators in determining the water quality. However, future detailed studies are needed.

CONCLUSIONS

Were identified 21 species included in 12 genera. The *Hydropsyche* genus featured the highest number of species (5), followed by the rest of the types, with three (*Potamophylax* sp. and *Rhyacophila* sp. respectively) and the rest of the species with one each. *H. incognita* and *H. pellucidula* have been identified with maximum values in terms of percentage numerical abundance and frequency.

As regarding the diversity indices SW-DI and PEI a maximum value was established for the two sampling stations (S14 - 0.76; S1 - 0.70), the lowest value of 0.15 being set for five sampling stations (S2, S5, S13, S15, S17). These low values were established by calculating the PEI index also for the same sampling stations, the maximum being identified for S8 and S16 with 1.04 and 1.03 respectively.

The physical and chemical parameters monitored in Timiș River water catchment basin have corresponded with the limits of the MEWA Order 161/2006, which states the ecological status of surface water bodies, with a few exceptions.

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