THE CHIRONOMIDAE DIVERSITY IN LENTHIC AND LOTHIC ECOSYSTEMS FROM NORTH DOBROUDJA, ROMANIA

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Abstract. *The Chironomidae taxonomic diversity from nine different aquatic ecosystems in Northern Dobroudja is analyzed comparatively. The stations were: Smârdan Arm, Sulucului Valley, Pojărâta Brook, Luncaviţa Pond, Telincea Lake, Alba River, Babadag Lake, Taiţa Dam Lake and Sărat Lake. The presented results were obtained processing the 36 samples collected in 2005 and 2006. 22 macrotaxa of aquatic invertebrates were identified. For each station the relative abundances were calculated; the amphipods and chironomids proving to be the dominant groups. The taxonomic diversity of the chironomids was established by the 125 identified taxa: 4 families, 2 tribes, 39 genera, 19 subgenera and 61 species; among them the representatives of the Chironominae subfamily are clearly dominant. The taxonomic structure is thoroughly analyzed, emphasizing the similarities and differences among stations and in the same time establishing the structural configuration in relation to the ecological characteristics. The diversity of the Chironomidae fauna was estimated by calculating the Shannon-Wiener (H) diversity and Lloyd-Gheraldi (E) equitability indices.*

Keywords: *Chironomidae, aquatic invertebrates, taxonomic research, Northern Dobroudja.*

Rezumat. Diversitatea chironomidelor în ecosisteme lentice şi lotice din Dobrogea de Nord, România. *Este analizată comparativ diversitatea taxonomică a chironomidofaunei în nouă ecosisteme acvatice de tip diferit din Dobrogea de Nord, şi anume: braţul Smârdan, Valea Sulucului, pârâul Pojărâta, balta Luncaviţa, lacul Telincea, râul Alba, lacul Babadag, lacul de acumulare Taiţa şi lacul Sărat. Rezultatele au fost obţinute prin prelucrarea unui număr de 36 de probe, prelevate în anii 2005 şi 2006. S-au identificat 22 de macrotaxoni de nevertebrate acvatice. Pentru fiecare staţie sunt calculate abundenţele relative, evidenţiindu-se crustaceele-amfipode şi dipterele-chironomide, ca macrotaxoni dominanţi. Diversitatea taxonomică a chironomidelor este definită prin cei 125 de taxoni, reprezentaţi prin 4 subfamilii, 2 triburi, 39 de genuri, 19 subgenuri şi 61 de specii, între care domină net reprezentanţii subfamiliei Chironominae. Este analizată în detaliu structura taxonomică, evidenţiindu-se asemănările şi deosebirile pe staţii şi totodată stabilită configuraţia structurii chironomidofaunei în funcţie de caracteristicile ecologice. S-a calculat diversitatea chironomidofaunei cu ajutorul indicelui de diversitate, Shannon-Wiener (H) şi echitabilitatea Lloyd-Gheraldi (E).*

Cuvinte cheie: *Chironomidae, nevertebrate acvatice, cercetări taxonomice, Dobrogea de Nord.*

INTRODUCTION

The data were collected in the frame of the project "*Assessment of aquatic, terrestrial and ecotonal fauna from Northern Dobroudja"*. The project, part of the thematic plan of the "Grigore Antipa" National Museum of Natural History", aims to update and complete the existing taxonomical information, thus creating a base for the protection, monitoring and sustainable management of the area.

A short history of the area reveals that intensive studies took place in Crapina-Jijila, the Danube flooding zone, in the '60 by a research team coordinated by Acad. N. Botnariuc. The research comprised also the study of chironomids, larvae and adults, the obtained data being published in a significant number of papers, among which the following worth mentioning: ALBU, 1964; ALBU, 1980; TATOLE, 2003.

MATERIAL AND METHODS

Three field trips were made in May and September 2005 and July 2006, the following nine ecosystems in Northern Dobroudja being investigated (Fig. 1):

1. **Smârdan Arm** – component of the Old Danube; the station was placed halfway between Smârdan and Măcin. Riverbed about 40 m wide, bordered by willows and poplars; shallow water; rich organic detritus; aquatic vegetation represented mainly by *Nephrodium thelypteris*, *Lemna minor*, *Ceratophilum demersum*.
2. **Sulucului Valley** – looking like a brook; narrow valley, about 0.50-0.70 m; relatively low flow, with drained sectors; alternating stony sandy-muddy riverbed; completely transparent water.
3. **Pojărâta Brook** – station in a forested area, about 1.5 km away from the Forestry Office; about 1-1.5 m wide; pond-like; low flow; muddy water, no transparency; compact riverbed, sparsely with small stones. Amphipods visibly dominant.
4. **Luncaviţa Pond** – covered by vegetation; 10-20 cm deep; substratum formed by coarse sand, small stones.
5. **Telincea Lake** – placed between Isaccea and Tulcea, is part of Niculiţel-Parcheş lacustrine complex (GÂŞTESCU, 1971); it is a puddle with a surface of about 140 ha, linked to other similar water bodies; significantly covered by floating reeds; used for fishing and tourism.
6. **Alba River** – the station was located upstream of Alba village; variable width, with sectors of about 0.80-1.5 m and others of 3-5 m wide; steep banks, covered in grass, bushes; relative rapid flow; substratum variable: pebbles, clay, mud; low water temperature. Amphipods visibly dominant.

7. **Babadag Lake** – open areas alternating with reeds (excessively developed at the end of the lakes); shallow waters, about 0.60-0.80 m; sandy-muddy substratum; law transparency, high level of suspensions and detritus.

8. **Taița Lake** – dam lake on the Taița River; shallow littoral water, about 0.40 m; covered by vegetation: *Potamogeton crispus*, *P. pusillus*, *Ceratophyllum demersum*, etc.; sandy-muddy substratum, relatively hard.

9. **Sărat Lake** – placed between Greci and Măcin localities, it is a permanent lake, the same type as Greci and Murighiol lakes, but with a lower chloride-sodium-magnesium salinity, comparing to the other elements of the complex (GÂȘTESCU, 1971), it is considered today a recreation lake; salt marsh vegetation present, *Salicornia herbacea*; the samples were collected near the shore, towards Măcin; shallow water.

A number of 36 samples were collected. The sampling was done using a Haveneau type hydrobiologic net with a surface of 0.500 m^2.

The relative abundances were calculated both for all the aquatic invertebrates identified in each of the nine stations, and for the chironomid fauna.

The Shannon-Wiener (H') diversity was calculated, using the formula:

$$H= - \sum p_i \ln (p_i),$$

where: H= the Shannon-Wiener Index
p_i= the relative abundance of the species
(TATOLE, 2004).

Because the variation domain of the SHANNON-WIENER (H') index is between [0, +∞), for standardization the use of the LLOYD-GHERALDI (E) equitability index is recommended, its variation domain being [0, - 1]. The calculation formula is:

$$E= H/InS,$$

where: E= the index of evernness (equitability)
H= the Shannon-Wiener Index
S= total number of identified species
(TATOLE, 2004).

The Fam. Chironomidae taxa (larvae) was identified using the following references: ASHE & CRANSTON, 1990; BOTNARIUC & CURE, 1999; CHERRNOVSKIJ, 1949; PANKRATOVA, 1970, 1977, 1983; WIEDERHOLM, 1983; SAETHER & SPIES, 2004.

RESULTS AND DISCUSSIONS

The taxonomic structure of invertebrate fauna

In the nine studied aquatic ecosystems from Northern Dobroudja the following groups were identified: Turbelaria; Nematoidea; Oligochaeta; Hirudinea; Mollusca; Crustacea: Mysidacea, Amphipoda, Copepoda, Ostracoda; Insecta: Heteroptera, Odonata, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera and from Diptera: Ceratopogonidae, Liriopidae, Simuliidae, Chironomidae and Tabanidae (Table 1; Fig. 2).

Table 1. The relative abundance of the invertebrate taxa.
Tabel 1. Abundența relativă a macrotaxonilor de nevertebrate.

Taxa	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
Turbellaria	2.75	2.95	4.46	2.88	0	7.45	0	0	0
Nematoidea	0	0	0	0	6.17	0	0	0	0
Oligochaeta	10.44	0	7.59	0	33.33	0	6.6	0	6
Hirudinea	1.09	0	0	0	0	0	0	0	0
Mollusca	10.99	0	3.57	3.85	29.63	2.39	0	2.67	0
Mysidacea	0	0	0	0	0	0	3.29	19.46	0
Amphipoda	0	67.65	62.5	0	0	51.66	10.99	0	0
Copepoda	1.65	0	0	0	0	0	0	0	0
Cladocera	34.06	0	0	0	0	0	0	4.22	0
Ostracoda	0	0	0	0	14.82	2.08	0	0	36
Heteroptera	0	0	0	17.31	0	0	24.18	20.99	0
Odonata	0	0	0	2.88	0	0	0	1.91	0
Ephemeroptera	12.64	0	10.27	0	0	21.33	0	0	0
Plecoptera	0	20.57	2.23	0	0	3.32	0	0	0
Coleoptera	0	0	2.23	6.73	0	0	3.29	7.63	0
Trichoptera	0	0	1.79	0	0	3.88	0	0	0
Ceratopogonidae	0	0	0	0	3.7	0	0	1.14	0
Liriopidae	0	0	1.34	0	0	0	0	0	0
Simuliidae	0	0		0	0	2.49	0	0	10
Chironomidae	26.38	8.83	2.68	66.35	12.35	5.4	51.65	41.98	48
Tabanidae	0	0	1.34	0	0	0	0	0	0

The number of macrotaxa per station, in a descending order is: 11 in Pojârâta Brook, 9 in the Alba River, 8 in Smârdan Arm and Taiţa Lake, 6 in Luncavița Pond and Babadag Lake, 5 in Telincea Lake, and 4 in Sulucului Valley and Sărat Lake.

Considering the relative abundances presented in Table 1, the representation level of the different aquatic invertebrate groups identified in the studied ecosystems differentiate itself in three categories, as follows:

- **Dominant** are the amphipods in Sulucului Valley (67.65%), Pojârâta Brook (62.5%), the Alba River (51.66%) and the chironomids in Luncavița Pond (66.35%), Babadag Lake (51.65%), Sărat Lake (48%) and Taiţa Lake (41.98%);
- **Intermediate values** comprised between 36.0% and 10.0% were registered for the following groups: oligochets and mollusks in Telincea Lake and Smârdan Arm; mysids in Taiţa Lake; amphipods in Babadag Lake, cladocerans in Smârdan Arm; ostracods in Sărat and Telincea lakes; heteropterans in Babadag and Taiţa lakes and in Luncavița Pond; ephemeropterans in Alba River, Pojârâta Brook and Smârdan Arm; plecopterans in Sulucului Valley; simulids in Sărat Lake; chironomids in Smârdan Arm and Telincea Lake;
- **Low values**, below 10%, have registered the turbelarians, nematods, hirudineans, copepods, odonates, coleopterans, trichopterans, ceratopogonids, simulids and tabanids in all the stations where they were identified, and all the other groups in the stations not mentioned above.

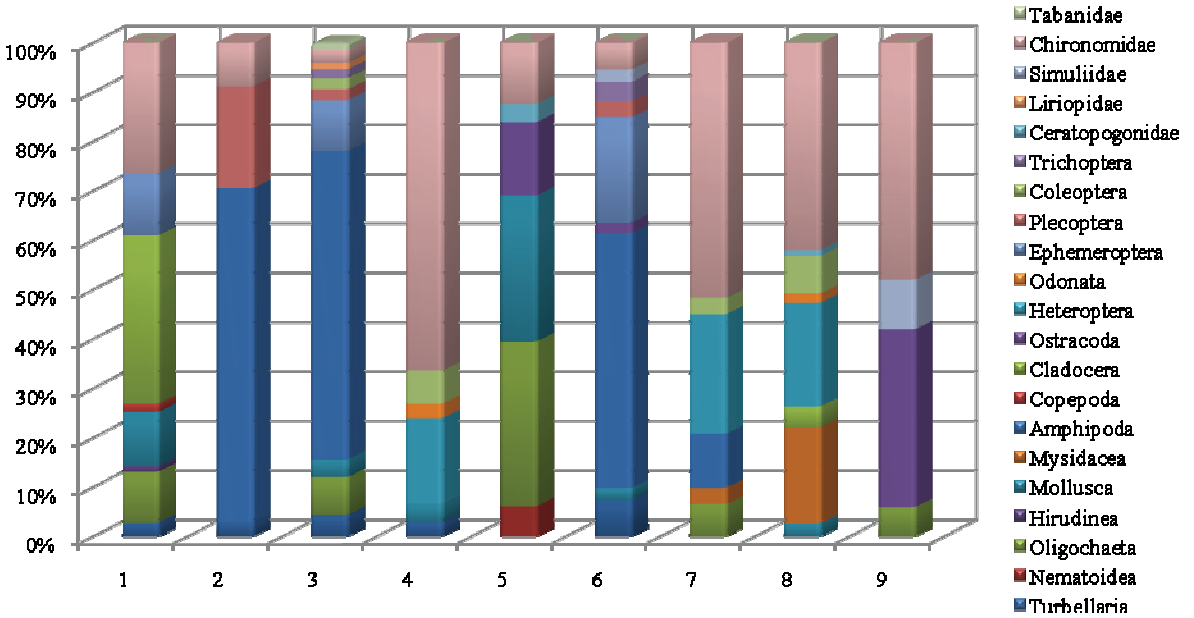


Figure 2. The relative abundance of the identified aquatic invertebrate groups.
Figura 2. Abundența relativă a grupelor de nevertebrate acvatice identificate.

Characterization of the Chironomidae fauna

Fam. Chironomidae exhibits a high taxonomic diversity (REISS, 1977). In larval stages, the chironomids are characterized by a high ecological plasticity, being able to inhabit any type of aquatic ecosystem, and face even strongly anthropized environmental conditions. Thus, they are widely distributed and in the same time dominant in most ecosystems, representing over 50% of the benthic macroinvertebrates. The chironomids communities are used as indicators of the biocoenotic succession, classification of lakes trophicity, water quality etc. (COFFMAN et al., 1966; KRUGLOVA, 1977; SAETHER, 1979).

As already mentioned, chironomids were identified in all the nine studied ecosystems, being one of the dominant groups, along with the amphipods.

In the nine aquatic ecosystems from Northern Dobroudja, the taxonomic diversity is represented by 125 taxa: 4 subfamilies, 2 tribes, 39 genera, 19 subgenera and 61 de species (Table 2).

Table 2. The list of the Chironomidae taxa identified and their relative abundances.
Tabel 2. Lista taxonilor aparținând fam. Chironomidae identificați şi abundențele lor relative.

Station / Taxa	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
SUFAM. PRODIAMESINAE									
Prodiamesa olivacea (MEIGEN. 1818)	2.08								
SUBFAM. TANYPODINAE									
Ablabesmyia (Ablabesmyia) longistyla FITTKAU 1962		11.1				12.82			
Ablabesmyia (Ablabesmyia) phatta (EGGER 1863)		11.1							
Anatopynia plumipes (FRIES. 1823)			16.67						
Clinotanypus nervosus (MEIGEN. 1818)	6.25								
Clinotanypus pinguis (LOEW. 1861)						17.95			

Station / Taxa	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
Labrundinia longipalpis (GOETGHEBUER. 1921)	4.17					7.69			
Monopelopia tenuicalcar (KIEFFER. 1918)		22.2							
Procladius (Holotanypus) choreus (MEIGEN 1804)		11.1	16.67	11.59	20	10.26	6.38	4.50	
Tanypus (Tanypus) kraatzi (KIEFFER 1912)				7.25					
Tanypus (Tanypus) punctipennis MEIGEN 1818							6.38		
Tanypus (Tanypus) vilipennis (KIEFFER 1918							6.38		
Thienemannimyia lentiginosa (FRIES. 1823)						15.38			
SUBFAM. ORTHOCLADIINAE									
Corynoneura celeripes WINNERTZ 1852	12.5								
Corynoneura scutellata WIENNERTZ. 1846	6.25								
Cricotopus (Cricotopus) algarum (KIEFFER 1911)								1.80	
Cricotopus (Cricotopus) bicinctus (MEIGEN 1818)								7.21	
Cricotopus (Cricotopus) flavocinctus (KIEFFER 1924)					10		8.51		
Cricotopus (Cricotopus) fuscus (KIEFFER 1909								0.90	
Cricotopus (Cricotopus) tibialis (MEIGEN 1804)	4.17								
Cricotopus (Isocladius) sylvestris (FABRICIUS 1794)									16.67
Limnophyes minimus (MEIGEN 1818)								7.21	
Metriocnemus (Metriocnemus) eurynotus (HOLMGREN 1883)						17.95			
Metriocnemus scirpi (KIEFFER. 1899)	6.25				30				
Nanocladius (Nanocladius) dichromus (KIEFFER 1906)								2.70	
Orthocladius (Orthocladius) rubicundus (MEIGEN 1818)	2.08	22.2							
Psectrocladius (Psectrocladius) psilopterus (KIEFFER 1906)								5.40	
SUBFAM. CHIONOMINAE									
TRIBE CHIRONOMINI									
Chironomus (Camptochironomus) pallidivittatus EDWARDS 1929				21.74			10.64		8.33
Chironomus (Chironomus) plumosus (LINNAEUS 1758)								6.31	
Chironomus (Chironomus) annularius MEIGEN 1818							6.38	1.80	
Chironomus (Chironomus) anthracinus ZETTERSTEDT 1860									12.5
Chironomus (Chironomus) riparius MEIGEN 1804				10.15			8.51		8.33
Chironomus (Lobochironomus) dorsalis MEIGEN 1818	8.33							12	
Cryptochironomus albofasciatus (STAEGER. 1839)							6.38	7.21	
Cryptochironomus defectus (KIEFFER 1913)							8.51		
Demicryptochironomus (Demicryptochironomus) vulneratus (ZETTERSTEDT 1838)			16.67					2.70	
Dicrotendipes nervosus (STAEGER. 1939)				5.80					
Dicrotendipes tritomus (KIEFFER. 1916)	8.33		16.67	34.78				4.50	
Einfeldia pagana (MEIGEN 1838)					10				
Endochironomus tendens (FABRICIUS. 1775)									4.17
Glyptotendipes (Glyptotendipes) barbipes (STÆGER 1839)									29.17
Glyptotendipes (Glyptotendipes) cauliginellus (KIEFFER 1913)				8.69					
Harnischia curtilamellata (MALOCH. 1915)							2.13		
Harnischia fuscimana KIEFFER 1921								1.80	
Kiefferulus (Kiefferulus) tendipediformis (GOETGHEBUER 1921)							4.25	3.60	
Lauterborniella agrayloides (KIEFFER. 1911)			33.33						
Microchironomus tener (KIEFFER. 1918)							2.13	0.90	
Parachironomus arcuatus (GOETGHEBUER. 1919)	4.17							6.31	
Parachironomus vitiosus (GOETGHEBUER 1921)	2.08						4.25	2.70	
Paracladopelma camptolabis (KIEFFER 1913)							2.13	2.70	
Paratendipes albimanus (MEIGEN 1818)							4.25	1.80	
Polypedilum (Pentapedilum) exsectum (KIEFFER 1916)	4.17							3.60	
Polypedilum (Pentapedilum) sordens (VAN DE WULP. 1874)								8.11	
Polypedilum (Polypedilum) nubeculosum (MEIGEN. 1804)									8.33
Polypedilum (Polypedilum) pedestre (MEIGEN 1830)	8.33						4.25	1.80	
Polypedilum (Uresipedilum) convictum (WALKER 1856)							2.13		
Polypedilum (Tripodura) scalaenum (SCHRANK. 1803)							6.38		
Pseudochironomus prasinatus (STÆGER 1839)									12.5
TRIBE TANITARSINI									
Cladotanytarsus mancus (WALKER 1856)						10.26			
Micropsectra radialis GOETGHEBUER. 1939	20.83							3.60	
Stempellina almi BRUNDIN 1947		22.2							
Paratanytarsus sp.					30				
Tanytarsus sp.						7.70			

The chironomids fauna structure in the nine studied ecosystems comprises representatives of the subfamilies Prodiamesinae, Tanypodinae, Orthocladiinae and Chironominae (Table 3, Fig. 3.). It is obvious that every station is defined by a unique configuration, but similarities do exist. Thus, a first cluster is formed by Pojărâta Brook, Luncavița Pond and Babadag Lake, the second by the Taița and Sărat lakes communities, and the third by Sulucului Valley and the Alba River. The clustering follows the ecosystem types, conditions and specific resources similarities.

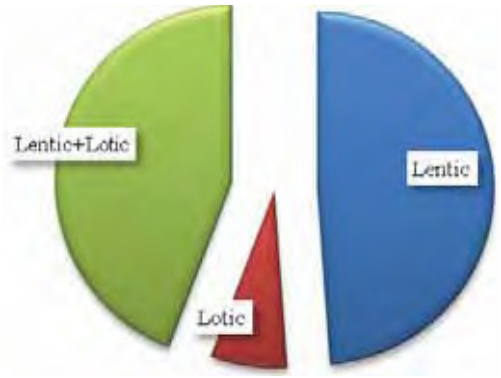
Table 3. The chironomid fauna numeric taxonomic structure.
Tabel 3. Structura numerică taxonomică a chironomifaunei.

Station / Subfamily	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
Prodiamesinae	1	0	0	0	0	0	0	0	0
Tanypodinae	2	4	2	2	1	5	3	1	0
Orhocladiinae	5	1	0	0	2	1	1	6	1
Chironominae	7	1	3	5	2	2	14	17	7

Clearly dominant are the Chironominae species-58, followed by Tanypodine-20, Orthocladiinae-17, the Prodiamesinae being represented by only one species.

The highest number of species was recorded in Taiţa Lake, followed by Babadag Lake and Smîrdan Arm, in all the other stations the number is fairly modest, the lowest being recorded in Pojârâta Brook and Telincea lake-5 species.

Regarding the ecological characteristic, the identified species exhibit certain preferences for ecosystem types (lentic, lotic and lentic+lotic) (Fig. 4.) and/or the existence of certain resources and conditions (pelophilous, psamophilous, pelo-psamophilous, phytophilous, pelophytophilous, detritophilous, oxyphilous, hypo-oxyphilous, distrophilous, euribionts, stenothermophilous) (Fig. 5.).



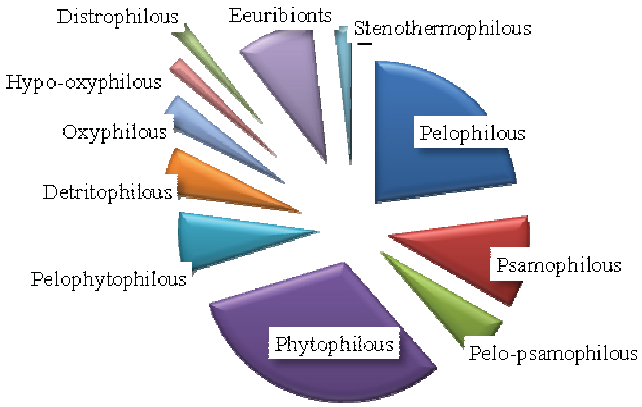


Figure 4. The chironomid fauna structure in relation to the ecosystem type.
Figura 4. Structura chironomidofaunei după tipul de ecosistem.

Figure 5. The chironomid fauna structure in relation to the diverse environmental factors.
Figura 5. Structura chironomidofaunei după diferiţi factori de mediu.

As one can notice, the lentic and lentic+lotic species are codominant, followed by the lotic ones.

Regarding the ecological characteristic, clearly dominant are the phytophilous and pelophilous species, followed by the psamophilous, euribiontas, pelo-phytophilous, detritophilous, oxyphilous and with the same value by the hypo-oxyphilous, distrophilous and stenothermophilous ones.

To emphasize the potential structural differences among the nine studied ecosystems, the diversity of the chironomidae fauna was considered. Starting from the empirical data (species number and relative abundances), relevant for the chironomid fauna structure in each of the studied ecosystems, the SHANNON-WIENER (H') diversity index was considered, starting from the premise that the empirical data was gathered by analyzing a sample randomly extracted from a given ecosystem. Thus, the value of the diversity index (H') will give an estimate of the real diversity of the chironomids fauna. Table 4 lists the values calculated for each ecosystem. As one can observe, the values are high, being comprised between 1.505 in Telincea Lake and 3.008 in Taiţa Lake.

Table 4. The Values of the Shannon-Wiener (H') and Lloyd-Gheraldi (E) indexes, calculated for the chironomid fauna of the studied ecosystems from Northern Dobroudja.
Tabel 4. Valorile indicilor de diversitate, Shannon-Wiener (H') şi de echitabilitate Lloyd-Gheraldi (E), calculate pentru chironomidofauna ecosistemelor studiate din Dobrogea de Nord.

Station / Index	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
H	2.499	1.734	1.561	1.749	1.505	2.030	2.786	3.008	1.931
E	0.923	0.968	0.970	0.899	0.935	0.976	0.964	0.947	0.929

Because the variation domain of the Shannon-Wiener (H') index is between [0, +∞), for standardization the use of the Lloyd-Gheraldi (E) equitability index is recommended. The calculated values are presented also in Table 4. The values are high, close to 1, in all the nine studied ecosystems, a fact that indicates a high diversity in all of them.

CONCLUSIONS

1. In the nine studied aquatic ecosystems from Northern Dobroudja the following groups were identified: Turbelaria; Nematoidea; Oligochaeta; Hirudinea; Mollusca; Crustacea: Mysidacea, Amphipoda, Copepoda, Ostracoda; Insecta: Heteroptera, Odonata, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera, Diptera: Ceratopogonidae, Liriopidae, Simuliidae, Chironomidae and Tabanidae. The amphipods (Crustacea) and the chironomids (Diptera) were dominant.
2. The taxonomic diversity of the chironomid fauna is represented by 125 taxa: 4 subfamilies, 2 tribes, 39 genera, 19 subgenera and 61 species. Clearly dominant are the representatives of the Chironominae Subfamily.
3. From the type of ecosystem point of view, the lentic and lentic+lotic species are codominant, followed by the lotic ones.
4. Regarding the ecological characteristic, clearly dominant are the phytophilous and pelophilous species, followed by the psamophilous, euribionts, pelo-phytophilous, detritophilous, oxyphilous and with the same value by the hypo-oxyphilous, distrophilous and stenothermophilous ones.
5. The Shannon-Wiener diversity index (H') values, calculated for the chironomid species, is very high in all analyzed ecosystems.
6. The Lloyd-Gheraldi equitability index (E) has similar high values in all the nine studied ecosystems.

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Received: June 8, 2009
Accepted: July 9, 2009

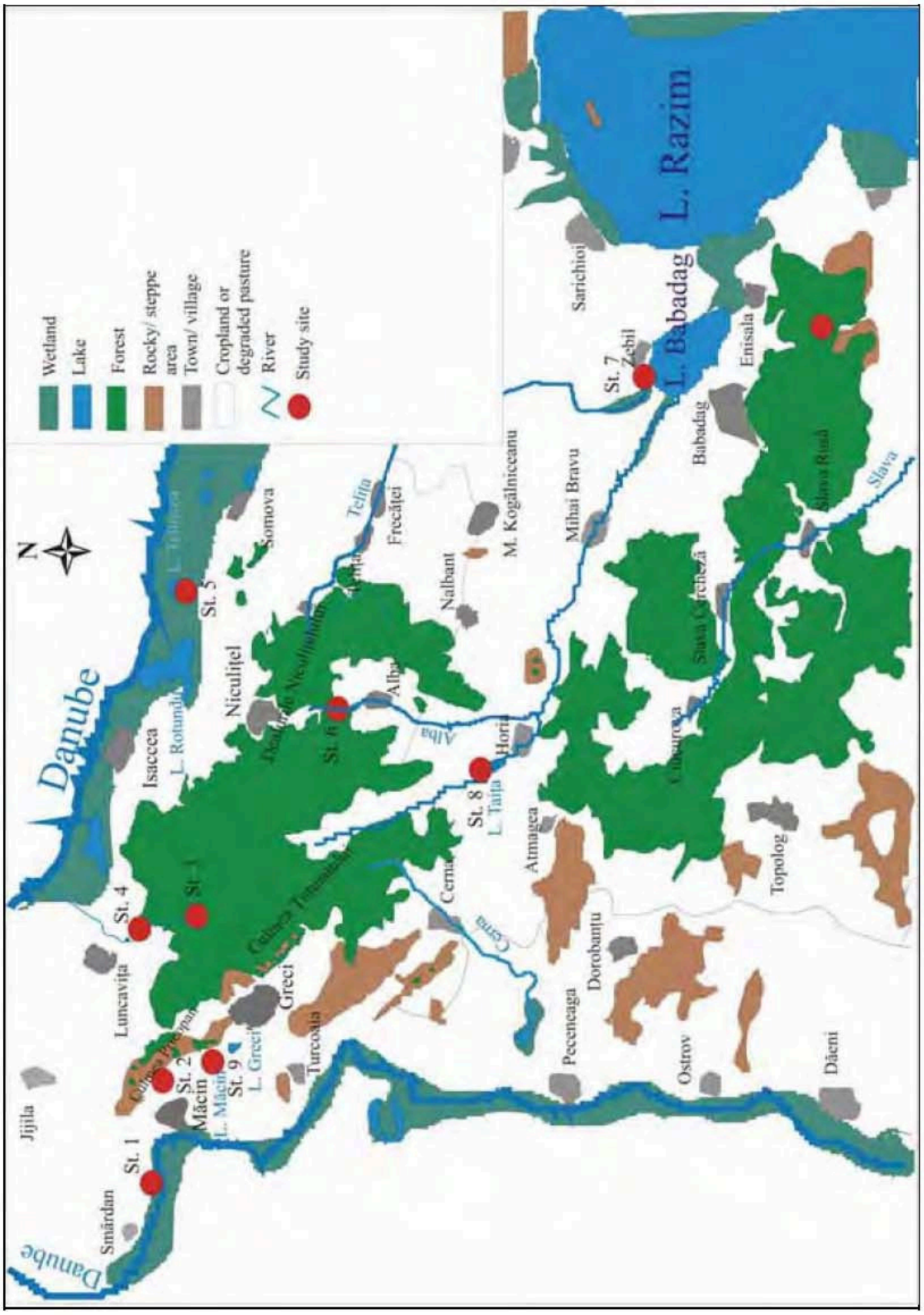

Figure 1. The map of the aquatic invertebrates (and implicitly chironomids-larvae) sampling stations.
Figura 1. Harta staţiilor de prelevare a probelor de nevertebrate acvatice şi implicit de chironomide (larve).

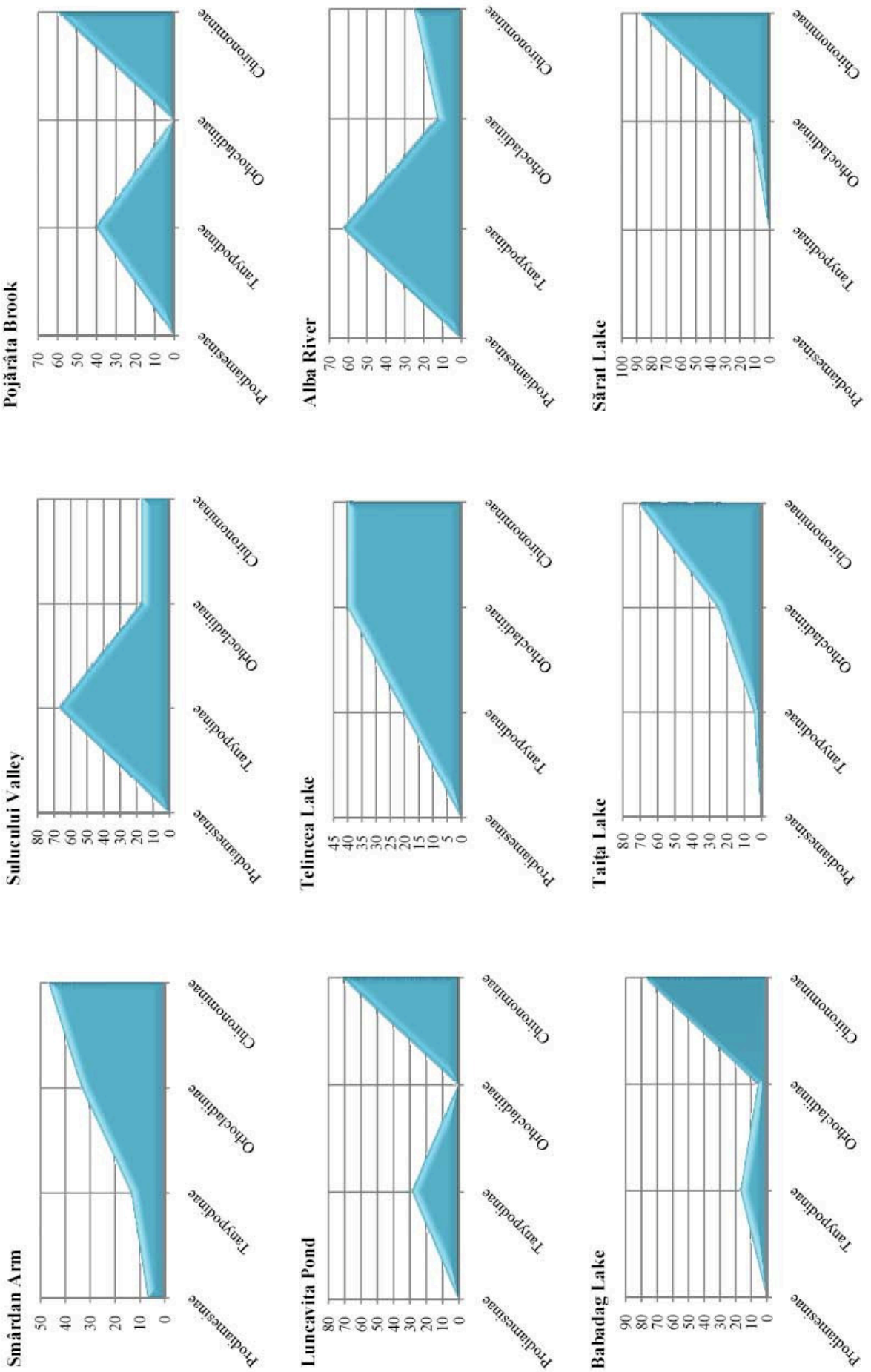

Figure 3. The structure of the chironomid fauna subfamilies.
Figura 3. Aspectul structural al chironomidofaunei, pe subfamilii.