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ZOOGEOGRAPHICAL CONSIDERATIONS ON THE ROMANIAN SPECIES OF THE GENUS *ZELOTES* (ARANEA: GNAPHOSIDAE)

CLEOPATRA STERGHIU

The present paper opines on zoogeographical characteristics of *Zelotes* genus representants from Romania. The zoogeographical analysis is made on 33 species. These species can be integrated in the zoogeographical regions as follows: Eurasian (24.24%), European (30.30%), Central-European (21.21%), Central and south-east European (12.12%), transgradient (6.06%), Ponto-Mediterranean (3.03%), and Mediterranean (3.03%).

It is well known that the evolution of living organisms is a very long lasting process that cannot be simplified. Similarly, the present day distribution of animal species and lineages is the result of such a process, depending as well on ecological and historical factors that are completing and conditioning its expression. The intensive development of faunistic and phyletic studies during the last few decades led to the accumulation of much information on the distribution and presumed dispersal histories of various species. Therefore, we consider useful to give an overview on the Romanian distribution of the spider genus *Zelotes*, as well as on the particularities of its distribution in the world.

Established by Gistel in 1848, the genus comprises according to Bonnet (1) 286 species, and according to Roewer 300 species; it is world wide distributed and includes a number of species much higher than any other gnaphosid genera, its structural characters being well delimited. Because of the sharp delimitation of this genus no author did try to undertake its revision, but some recent studies deal with certain of its species.

Data on the presence of this genus species in Romania are given by Roșca (1930–1968), by Chyzer and Kulczynski (3), and more recently by Bahrin(2), Dumitrescu et al. (4) and above all by Weiss (13, 14).

According to the above mentioned papers and to the author's investigations, the spider fauna of Romania includes 33 species (and one undescribed) of the 300 species of the world (Table 1). The comprehensive catalogues of Bonnet (1) and Roewer (8) mention the occurrence of 156 species in the Palearctic Region, among which: *Zelotes agilis* (Bavaria), *Z. antiope* (Southern France), *Z. atlanticus* (Marrocco), *Z. calladius* (shores of the Caspian Sea), *Z. erebeus* (France, Central and south-eastern Europe, Caucasus), *Z. glossus* (Palestine), *Z. piceus*, *Z. sindi* (Karakorum) and *Z. tarsalis* (northern Sahara); three species are shared by Palearctic and Nearctic Regions. 62 species are present in the Afrotropical, southern Africa and Madagassy areas, e.g.: *Zelotes aculeatus* (southern Africa), *Z. andreinii* (Erythrea), *Z. cordigerus* (Etiopia), *Z. madagascariensis* (Madagascar Island).

Eight species are distributed in the Oriental Region, south and east to Borneo Islands, among which: *Z. hospitus* (India), *Z. pavanus* (Djawa).

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Table 1

Zoogeographical characterization of genus Zelotes Romanian representants

No.	Genus / Species	Eurasian	European	Central-European	Central & SE European	Transgradient	Ponto-Mediterranean	Mediterranean
	1	2	3	4	5	6	7	8
1.	*Zelotes apricorum*	+						
2.	*Zelotes ater*					+		
3.	*Zelotes aurantiacus*		+					
4.	*Zelotes atrocaeruleus*	+						
5.	*Zelotes barbatus*							+
6.	*Zelotes caucasius*	+						
7.	*Zelotes clivicola*		+					
8.	*Zelotes electus*		+					
9.	*Zelotes erebeus*				+			
10.	*Zelotes exiguus*				+			
11.	*Zelotes femmelus*						+	
12.	*Zelotes fulvopilosus*		+					
13.	*Zelotes fuscomicans*			+				
14.	*Zelotes gracilis*		+					
15.	*Zelotes hermani*		+					
16.	*Zelotes kulczynskii*			+				
17.	*Zelotes latreillei*		+					
18.	*Zelotes longipes*	+						
19.	*Zelotes lutetianus*	+						
20.	*Zelotes mundus*			+				
21.	*Zelotes mutabilis*		+					
22.	*Zelotes nanus*			+				
23.	*Zelotes oblongus*			+				
24.	*Zelotes pedestris*		+					

	1	2	3	4	5	6	7	8
25.	*Zelotes petrensis*	+						
26.	*Zelotes praeficus*	+						
27.	*Zelotes pumilis*				+			
28.	*Zelotes pusillus*		+					
29.	*Zelotes rusticus*					+		
30.	*Zelotes seidlitzi*				+			
31.	*Zelotes serotinus*	+						
32.	*Zelotes similis*			+				
33.	*Zelotes villicus*			+				

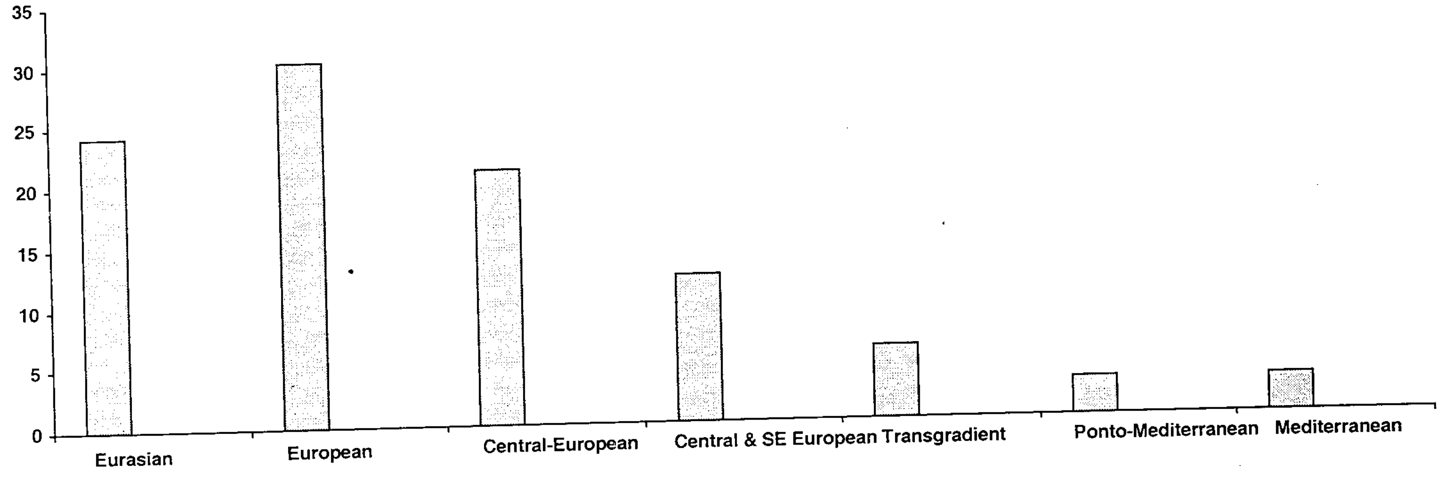

Fig.1. – Percent representation of Zelotes genus species in the world zoogeographical context.

Only three species have been found in Australia recific islands, e.g.: *Z.. pacificus* (Hawai), *Z. samoensis* (Samoa).

In the Neotropical Region (limited by Patagonia and Chile in the south) there are known 41 species, e.g.: *Z. ernsti* (Venezuela), *Z. indecisus* (Mexico), *Z. lutens* (Guatemala), *Z. lividus* (Argentina), *Z. porteri* (Chile).

The Nearctic Region is inhabited by some 21 species, e.g.: *Z. discens* (California), *Z. pseustes* (Texas).

The wide range of the genus can be explained through its age, past geological events, ecological ability, therefore, the possibility of active and passive dispersal. The interrelation between environmental factors and animal life results in a pemanent phenomenon of speciation and range changing.

The distribution pattern of the 33 *Zelotes* species present in Romania (Table 1) makes possible some preliminary conclusions. The occurrence of species having various general ranges (Central-European, Ponto-Mediterranean, etc.) is explained through the geographic position of the country and especially by the environmental conditions. In spite of the high number of species inhabiting the Holarctic Region none of them is present in Romania. The Eurasian species (e.g.: Palearctic species) represent 24% and strictly European species are the most numerous (more than half of the entire number: 63.63%). Among them, the Central-European species represent 21.21%, while the Central and south-eastern European species are less numerous (some 12.12%); quite few species are Ponto-Mediterranean (3.03%) and Mediterranean (3.03%). (Fig. 1).

The Romanian *Zelotes* genus representants are estimated at more than 10% of the world fauna, most species belonging not to a wide or limited distribution but to an intermediate one.

The existent data based on the origin of *Zelotes* permit the integration of this genus to the forest category, typical for Mediterranean zoogeographical elements. Almost all species are holo-Mediterranean species in the expansion phase (inhabiting Central-Europe), a single one being Ponto-Mediterranean (*Z. femellus* – recorded only from Orşova) and another one holo-Mediterranean in a stationary phase (*Z.. barbatus* – also recorded only from Orşova).

The absence of *Zelotes* genus species from coniferous forests attests that these species are not ussuric elements.

Several ecological categories have been distinguished among the Romanian *Zelotes* species: to lowlands, hills, plateaux; all categories consist of species with a Mediterranean origin, mainly in the Central-Europe.

It is worth mentioning that only two of the 31 species of the genus distributed in both the Palearctic and Nearctic areas are present in Romania: *Z. ater* and *Z. rusticus*.

The entire *Zelotes* fauna of Romania has undoubtedly a Central-European character. The few species with a recent southern or sub-Mediterranean range have a restricted distribution in different areas of the country. These are: *Z. barbatus* and *Z. femellus* – recorded only from Orşova, *Z. fuscomarginatus* – recorded in Slatioara in the north-east of Romania, *Z. mundus* – recently found at Hanu Conachi (south-eastern Romania) previously recorded only from Hungary and Macedonia, *Z. seidlitzi* – found only at Iaşi, *Z. similis* – recorded at Băile Herculane (near Orsova), *Z. oblongus* – from Baziaş, *Z. capaulezynski* – from Dobrogea and Iaşi (Birnova Forest) and *Z. rusticus* – recorded near Bucharest.

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TAXONOMICAL CONSIDERATIONS CONCERNING THE SCARABEIDAE FAMILY (COLEOPTERA) FROM ROMANIA

SANDA MAICAN

The paper presents a critical short revision of the family's systematics, also insisting on the most important workpapers in the world concerning the scarabeids and on the original contributions realised in Romania.

The Scarabeidae family is one of the largest beetle families in the world, including, after some authors 17 000 species and after others 20 000 species, some of the most numerous genera being *Anomala* Sam. and *Onthophagus* Latr. with over 1 000 species.

The literature on this group's systematics and biology is vast – fact explained both by their important taxonomic interest and by the large number of agricultural, fruit tree and forest pests contained. During the time there have been done many classification tries for gaining a natural point of view. The most important workpapers belong to Mulsant (21), Burmeister (3), Erichson (4), Balthasar (2). A general systematic revision on this family was made by Reitter (25, 26, 27, 28) and a new classification of Scarabeidae by Medvedev (17, 18, 19). On this group's biology the most well known are Faber's workpapers (5), which described some coprophagous species. There are known as much Jeannel (15) and Arrows' (1) biological researches.

Seidlitz (35) and Petri (24) studied the Scarabeidae fauna from Transilvania. In 1904, Fleck published a catalogue of Romanian Scarabeidae fauna known at that moment. Knechtel and Panin (16) realised an ecological and geographical study on *Anisoplia* Serv. species. Data on this family's spreading in Romania are given by Montandon (20), Jacquet (14), Ienistea (7, 8, 9, 10, 11, 12, 13), Săvulescu (33, 34), Panin (22, 23), Ruicanescu (30, 31, 32), etc. There are Scarabeidae collections in the Natural History Museum "Grigore Antipa" of Bucharest, in Bruckenthal Museum of Sibiu, and in Agronomic Research Institute of Bucharest. Also, there are personal collections belonging to M. Ienistea, Popescu-Gorj, N. Săvulescu, E. Worell.

Starting with the first half of the XIX-th century many authors elaborated different classification systems; in 1929 Winkler (36) realised a masterpiece in this field, paper considered the most complex. By his point of view, the palearctic scarabs are classified in 21 subfamilies. Beginning with Medvedev (1949) there are introduced new systematic conceptions on scarabs. Medvedev proposed a natural classification of this family's groups based on larval characters.

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ECOLOGICAL CONSIDERATIONS

The known 17 000 scarabeid species are adapted to very different ecological conditions. All species are termophilous (they miss completely in the extreme north and south, occurring in the subtropical and tropical areas). The most of these insects are mesophilous and approximately connected to arborescent vegetation (Melolonthinae, Rutelinae, Dynastinae, Valginae, Cetoniinae). There are large steppe groups, more or less xerophylous sometimes even desert, but there are no hygrophilous. Among steppe scarabs the coprins are characteristic. Many of these coprophagous insects are living in dry and warm areas where grasses persist only a few weeks. Some scarabs occurr on coastal areas (*Scarabeus affinis*, *Anoxia* Cast. sp.), others on alpine areas, being found at considerable heights (Melolonthinae and Rutelinae). Besides temperature and humidity, food has a limitative importance in scarabs' life. The adults of Melolonthini and some Rutelini and Dynastinae species feed with leaves, those of some Cetoniini and other Rutelini species with ripe fruit, those of Trichiini and other Cetoniini species with trees fermented leakings and other species exclusively with aerial parts of grasses. There are also species whose adults do not feed at all (many Melolonthinae and some Rutelinae). A large group of scarabs is saprophagous, coprophagous (Coprinae, Aphodiinae, Geotrupinae). Some coprophagous scarabs are very specialised, e.g.: some forest Aphodiinae feed with deer excrements, others (*Bodilus piceus*) with human excrements, and some *Onthophagus* Latr. species with tiger excrements.

In Romania, N. Săvulescu observed in the caterpillar colonies (*Cnetocampa processionea*) that occur tree trunks that *Potosia* Muls. sp. which lives under caterpillar web is feed with its host when it can't find other food. Some species of *Onthophagus* Latr. and *Aphodius porcus* F. have been observed feeding with supplies accumulated in *Scarabeus* L. and *Geotrupes* Latr. galleries; *Onthophagus ovatus* enters into hares galleries where it can find these rodent excrements; some Cetoniinae (*Potosia cuprea*) from our fauna live in *Formica rufa, F. pratensis* ant eaters.

Local spreading of our scarabeid fauna is subordinated to the vegetation distribution areas, so it is in relation with climatic complexes.

From a zoogeographic point of view we can consider that the Romanian scarabs are elements that come mainly from the Oriental-Mediterranean province. Some species probably came from the former Angarian continent (e.g.: *Melolontha hippocastani*) and some Romanian species are spread on the whole Palearctic region.

The necessity of continuation and profound studying on Scarabeidae family in Romania is done both by its representants weight in our entomofauna, and by the fact that the taxons are an important link in the zoophags trophic web, having a determinant role in nature economics.

This beetle family is so vast that making a critical study for the entire family is very hard to do. Most authors restricted their activity in elaborating checklists of the species present in certain areas or belonging to taxonomic units (genera or suprageneral groups). It seems not possible, in the present day status of knowledge, to try to establish a phyletic classification for the whole family. All supraspecific taxa now in use may be susceptible to different interpretations. Doubts have been raised even upon the family's shearing in pleurosticts and laparosticts (Ritcher, 29).

Another difficulty is raised in Romania by the lack of data on larval stadia. It is presently impossible to suggest a general classification of the family based also on the larval characters, because of the limited knowledge of the larvae of most species and of the large variability of the larval characters. So a parallel relationship is induced between the two life stadia (larvae-adult).

The data included in both issues of the "Fauna of Romania" dealing with Scarabeidae family published by Panin among 1955 and 1957 (22; 23) need completions and modifications. Panin adopted the classification proposed in the Catalogue of Winkler (36) which was then considered to be the complete one. According to the most recent information on the phylogeny of the family, this classification needs a fundamental revision.

Recent taxonomic studies put emphasis on the importance of the males genitalia in rightly delimiting the species. Both issues published by Panin do not describe or illustrate the genitalia. Therefore we consider that it is necessary, first of all, to complete the Romanian scarabs diagnosis by adding the aedeagus description and above all the one of *Aphodius* sp. This genus raises many difficulties because of the amount of species and the large variability of the most taxonomic characters used until now.

Studies on the taxonomy of scarabs in the Animal Taxonomy Laboratory (Institute of Biology Bucharest) started in 1994. The available bibliography, consisting mainly in books and magazines, comes from the Natural History Museum "Grigore Antipa" library. Rich and valuable Romanian scarabs collections exist at this museum and at Bruckenthal Museum in Sibiu.

The comparative studies made possible the identification of the taxons collected in the following areas of Romania: Insula Mică a Brăilei, the drainage area of Argeș River, Azuga Valley, south-Banat.

We have analysed in the first line species of the genera: *Sisyphus* (*S. schaefferi*), *Copris* (*C. lunaris*), *Oniticellus* (*O. fulvus*), *Caccobius* (*C. schreberi*), *Onthophagus* (*O. amyntas, O. ovatus, O. vacca, O. nuchichornis, O. vitulus, O. taurus, O. verticicornis, O. lemur, O. fracticornis*), *Odontaeus* (*O. armiger*), *Geotrupes* (*G. stercorarius, G. stercorosus, G. vernalis*), *Aphodius* (*A. erraticus, A. subterraneus, A. fassor, A. haemorrhoidalis, A. hydrochoeris, A. luridus, A. rufipes, A. depressus, A. quadriguttatus, A. melanostictus, A. prodromus, A. sphacelatus, A. obscurus, A.fimetarius, A. aestivalis*), *Serica* (*S. brunnea*), *Homaloplia* (*H. marginata*), *Melolontha* (*M. melolontha, M. melolontha redtembacheri*), *Rhizotrogus* (*R. aequinoctialis*), *Anomala* (*A. dubia, A. solida*), *Anisoplia* (*A. segetum*), *Oryctes* (*O. nasicornis*), *Valgus* (*V. hemipterus*), *Trichius*

(*T. sexualis*), *Oxythyrea* (*O. funesta*), *Cetonia* (*C. aurata aurata*), *Potosia* (*P. cuprea metallica metallica*) etc.

The work-collection that has been initiated at the Animal Taxonomy Laboratory also includes species not yet analysed, species belonging to the following genera: *Aphodius*, *Anomala*, *Anisoplia*, *Trichius*, *Oxythyrea*, *Melolontha*. Our aim is to determine all the members of these genera to the species level (Sanda Maican – "Contribuții la cunoașterea faunei de Scarabeidae (Ord. Coleoptera) din Romania", 1996 and unpublished data).

We intend to pay attention, in the next future, mainly to the species of the genus *Aphodius*, which is widely distributed and abundant in Romania; it is possible to collect large numbers of specimens and to undertake their taxonomic, zoogeographical and ecological study.

The study of the aedeagus has presently been started. This study will make possible the completion of the species diagnosis within the scarabs genera.

The study of representative series of specimens from as many areas of Romania as possible may clarify important aspects of the ecology and general biology of the respective species. The diagnosis of the scarabs species of Romania will be accomplished by ecological and zoogeographical considerations, since the establishment of phyletic relations implies zoogeographic considerations.

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OVERVIEW OF THE STAPHYLINIDS FROM ROMANIA (COLEOPTERA: STAPHYLINIDAE)

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The paper presents a short revision of the systematics of Staphylinidae, insisting also on the most important workpapers in the world concerning the rove beetles and on the original contributions realised in Romania.

This family belongs to the Suborder Polyphaga, Superfamily Staphylinoidea, the latter being characterised by antennae with the last 3 segments rarely forming a compact club; if they do, the first segment is not elongate; exoskeleton rarely very hard and shining, elytra truncate and usually leaving more than 2 abdominal segments exposed (44).

It is a very important family because the number of species included (about 1000 species in Romania), is very homogeneous and is particularly characterised by the very short elytra, hence the older name of Brachielytra for the group. Notwithstanding the small size of these organs, they conceal large well-developed wings, which are complexly folded away beneath them. On the other hand the unfolding of the wings can take place with great rapidity, thus allowing the insect to resort to an almost instantaneous flight. In a few genera (*Olophrum, Lathrimaeum*) the elytra are larger than usual, leaving only the apex of the abdomen uncovered (44).

The determination of rove beetles is especially difficult because of the relative vagueness of the differentiation characters, of the small size of most species and of their great number (40). The majority of species are inconspicuous, only a few are brightly coloured (44).

Among beetles the staphylinids represent a basic link in a trophic chain of zoophagous, playing an important role in the nature economy. There are phytophagous species that feed on vegetal remainders more or less rotten (*Oxytelus* Grav., *Micropeplus* Latr.); mushrooms (*Oxyporus* F.), fragments of wood (*Leptochirus* Germ., *Osorius* Latr. as larvae), the majority of species are carnivorous as for them it is not important if they feed on alive or dead prey; others are strongly specialised (8). Because of their various feeding-habit, they occupy diverse ecological niches.

The staphylinids are important through their wide distribution being present from the equatorial areas to the limit of permanent snow (8). Most taxa are hygrophilous, live near rivers, in swampy areas, forests and among vegetal remainders. Most of them live on the ground, so the nature of ground influences the existence of different species of staphylinids: there are halophilous and petrophilous species. In the Mediterranean areas there are quite abundant species which live in the soil, among the roots of plants, while others are true endogenous, devoid of wings and

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uniform, pale colour (8). In temperate areas, the members of the genera *Stenus* and *Paederus* usually live near rivers while in equatorial zones they live in the leafage of the trees (8). More genera are found in mushrooms (*Bolitobius* Mannh.), others under the rind of trees (*Baptolinus* Kr.), on flowers feeding on pollen (*Eusphalerum* Kraatz.), and others on decaying organic matter, including dead animals and dung (*Philonthus* Curtis). The staphylinids are abundant among the inhabitants of anteaters and termitary, more than 300 species are known to be mirmecofilous (44).

In Romania the scientific research on the Staphylinidae has been occasionally made. Romanian and foreign students contributed to the knowledge of staphylinids fauna from Transilvania, at the end of the XIXth century and at the beginning of the XXth century. For example: E. A. Bielz published in 1887: "Catalogus coleopterorum Transilvaniae", (1); G. Seidlitz published in 1891: "Fauna Transsylvanica. Die Kafer Siebenburgens", (47); among 1925–1926 K. Petri published: "Erganzungen und Berichtigungen zur Kaferfauna Siebenburgens 1912", (41); in 1897 it was published "Fauna Regni Hungariae-Coleoptera" which contains the staphylinids fauna from Maramureș, Ardeal and Banat areas. The Maramureș area has been investigated by Fr. Deubel (3), L. Ganglbauer (7), J. Frivaldszky (6) and E.Csiki who listed numerous staphylinid species. M. Jaquet (16-23), Ed. Fleck (4), A.L. Montandon (35,36), J.Roubal (45) contributed to the knowledge of the staphylinid fauna of the whole Romania. After 1900, several Romanian zoologists contributed to the knowledge of the beetles fauna from several provinces of Romania and the present day Republic of Moldova. These authors published an important faunistic list concerning the distribution of staphylinid species throughout Romania and Moldova, also including data on their habitats and zoogeographic areas (M. A. Ienistea 11, 12, 13; St. Negru 37, 38; C. Ionescu 14, 15; O. Marcu 25–34; C. Hurmuzachi 9, 10).

This group is incompletely studied in Romania except for the faunistic lists and some thorough investigations on the genus *Xantholinus* (2) and the genera *Philonthus*, *Gabrius* (42, 43), there are not complex papers on the other genera.

During the research on the Staphylinidae have been realised many classifications that determined modifications on the number of subfamilies and taxons rank. For example, Ed. Reitter (1908) in his workpaper "Die Kafer des Deutschen Reiches" considered that the Staphylinidae contains 18 subfamilies; P. Kuhnt (1912) also referring to the German rove beetles species divided this family into 12 subfamilies (25). In 1964, G.A. Lohse (5) presented the approximately 2 000 central-European staphilinids species, known at present, as belonging to 22 subfamilies. Some of this include a single genus compressing one or a few species; in this manner a number of genera have been raised to subfamily rank. On the contrary, several other subfamilies are very specious and the study of their aedeagus is obligatory, being the most important character for identification of species.

CONCLUSIONS

Summarising, this family is incompletely known from a taxonomic, zoogeographic and ecological point of view and it is therefore necessary to achieve a complete study of rove beetles in Romania, considering that it is one of the most specious insect families in the country.

Starting from 1995 laboratory and field studies began with the aim to elaborate the issue "Staphylinidae" in the series "Fauna of Romania". Examinations of the staphylinids specimens present in the Natural History Museum of Bucharest and Sibiu ("Gr. Antipa" Museum and "Bruckenthal" Museum) represented the first step favouring the possibility to identify species present in these collections. Field investigations from the Valley of Azuga and neighbouring localities, the Valley of Azuga River (tributary of Argeș River), Colibița area (Bistrița-Năsăud county), specimens were also obtained from other localities: Insula Mică a Brăilei (in the flood plain of the Danube), Voineasa (Lotru River drainage area), Ieud in the Maramureș (north-western Romania). A contribution on the staphylinid fauna of Insula Mică a Brăilei is under press (in which 25 species were recorded for the first time in this area: *Omalium caesum, Arpedium quadrum, Oxytelus piceus, Stenus bipunctatus, S. bimaculatus, S. humilis, S. providus, Euaesthetus bipunctatus, Paederus fuscipes, Astenus gracilis, Hypomedon melanocephalus, Scopaeus laevigatus, Philonthus fuscipennis, Ph. varius, Ph. varians, Ph. salinus, Gabrius vernalis, G. suffragani, Ocypus similis, O. picipennis, Tachyporus abdominalis, T. chrysomelinus, T. hypnorum, Falagria sulcata, Aleochara curtula*) (48).

The study of a high number of specimens from different localities is necessary to achieve a right and complete description of the species, considering that the intraspecific variability is mainly a geographical one.

In the next step of investigation it is planned to pay attention especially to the subfamilies: Staphylininae, Paederinae, Steninae, Omaliinae, Tachyporinae, Aleocharinae from which many not identified individuals become available to be represented and which are believed to be richly represented in the Romanian fauna.

The description of the species will be based exclusively on the specimens present in the country considering their local variability. It is also intended to give detailed data on the distribution (also including maps), on their habitats, on the general distribution, zoogeographical and taxonomic affinity.

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A CONSPECTUS CONCERNING THE ROMANIAN SCATOPHAGIDAE FAMILY SPECIES

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It is presented the taxonomical list of the representants of the Scathophagidae Family in the Romanian fauna. The list includes data on the taxonomical status, synonyms, spreading of the species.

The Scathophagidae, known frequently as Cordyluridae, Scopeumatidae or Scatomyzidae, is a Diptera family distributed in the northern temperate and cold areas. The research workers consider that most species have individual ranges in the boreal zone, their number being smaller in the south of the Palearctic Region.

This flies size range among 3 and 12 mm, rarely up to 15, usually having 6–9 mm. Their body is golden-yellow, pale-yellow, brown or even black, being covered by long, closely set hairs, which sometimes form true furs (e.g.: *Scathophaga stercoraria*). They are usually slender flies, with long and thin legs; only exceptionally, their femurs are thicken and provide excavations and prominences. Their feeding habits differ: some species are zoophagous, others phytophagous, saprophagous, occasionally even coprophagous, thus these flies are feeding on all that can be sucked or ground, but sometimes they show a preference for certain food. The larvae of most species are phytophagous, feeding on wild or cultivated plants or on putrified marine algae. These larvae are not harmful, except for those of *Nanna* species which feed on cereals, and *Cleigastra apicalis* larvae being parasites on other phytophagous larvae.

The Scathophagidae are met in humid and shady places, near rivers, in meadows or marshy places. It is easy to remark their occurrence because of their vivacity. When threatened, they hid under leaves.

The richest fauna of Scathophagidae is that of the far north, near the limit of the forests, in the southern sector of tundras, as well as in the Mountains of Siberia, in the alpine tundra and in the taiga.

By the world, studies on this family's systematics have been undertaken by Fallen, Meigen, Zetterstedt, Macquart, Schiner (23), Loew (18), etc. A comprehensive monograph of this family has been elaborated by Becker (1). The first papers describing members of this family are those of Reamur (1738), Linnaeus (1758) and Fabricius (1763), who mention some scatophagids under the generic name "Musca".

The first records of Scatophagidae in the Romanian fauna were published rather late, in the second half of the XXth century and they refer to Transylvania and Banat: Fridvalssky (1872) lists, among other insects, some scatophagids and Thalhammer (1899) cites about 24 species from the *Cordilura, Parallelomma,* *Phrosia, Cnemopogon, Megaphtalma, Norellisoma, Trichopalpus* and *Scatophaga* genera. The list of Romanian Diptera published by Fleck (1904) mentions a number of species from the Bucegi Mountains (Jepii Mari and Jepii Mici) and *Chylizosoma medium* from Sinaia, which mines *Paris quatrifolia* leaves. The paper of Szilady (1918), dealing with the vertical distribution of Arthropods, with examples from the Retezat Mountains, mentions some species of Scatophaga.

The doctor-thesis of Ecaterina Dobreanu (1937) mentions some miner species of Scatophagidae, while her book (1962) on synanthropic flies includes a description of *S. stercoraria*, a species frequently found in towns and villages.

Miklos' 1952 paper on the Sebeş mountains entomofauna lists some scatophagid species while Sifner (1979) describes the new species *Norellisoma mireki* from the Călimani Mountains.

I began in 1980 the taxonomic study of this family in Romania and published several papers mentioning new data on their distribution and biology.

The list of the family's Romanian members is based on all the published contributions and on the study of the collections existent in the Natural History Museum "Grigore Antipa" from Bucharest, Bruckenthal Museum from Sibiu, "Ţării Crişurilor" Museum from Oradea and at the Institute of Biology of the Romanian Academy from Bucharest.

The synonymies of all genera and species are included. The older classification of the family proposed by Becker in his 1894 monograph, who recognized five subfamilies, has been rejected and the more recent one proposed by Collin in 1958 (also adopted by Gorotkov in 1986) in which only two subfamilies, Scatophaginae and Delininae, have been accepted, since this is considered to be actually phyletic.

CLASA INSECTA

ORD. DIPTERA

Fam. Scatophagidae (Cordyluridae, Scopeumatidae, Scatomyzidae)

Genus *Norellia* Robineau-Desvoidy, 1830
Syn.: 1830 *Norellia* Robineau-Desvoidy: Essai Myod.:673
1856 *Achantolena* Rondani: Dipt. Ital. Prodromus 1:101

1. *Norellia spinipes* (Meigen, 1826):
Syn.: 1826 *Cordilura spinipes* Meigen: Syst. Beschr., 5.237.16.
1835 *Cleigastra spinipes* Macquart: Suit. a Buff. II 386.8.
1864 *Norellia spinipes* Schiner: Fauna Austriaca II, 7:1894 Becker: Berlin. entom. Zeischr. 39. 131. 62t IX f. 5

5.5–8.5 mm	IV–X	Sack
6.5–8.5 mm	–	Seguy
5.5–8.5 mm	–	Gorodkov
6–8 mm	V–IX	Drascovits
6–8 mm	V–VIII	Sifner

World distribution: Romania (Thalhammer, 1899); France, Germany, western and eastern Alps (Seguy, 1934); Central and southern Europe (Sack, 1937); south Moravia (Sifner, 1969), Europe (Drascovits, 1981); France, Poland, Spain, Great Britain, CSI: Russia, Ukraine, Moldavian Republic, north Africa: Algeria (Gorodkov, 1986).

Romanian distribution: Sf. Gheorghe – Danube Delta (Tulcea county); Sinaia, Buşteni, Peştera (Prahova county); Băile Olăneşti (Vâlcea county); Băile Herculane (Caraş-Severin county); Orăştioara (Hunedoara county).

Genus *Norellisoma* Hendel, 1910
Syn.: 1910 *Norellisoma* Hendel: Wien. Ent. Zeitg. 29 (9–10):308

1. *Norellisoma alpestris* Schiner, 1864:
Syn.: 1864 *Norellia alpestre* Schiner: Fauna Austriaca, 2: 6; 1894 Becker: Berlin. entom. Zeitschr. 39. 127. 55.t IX
1866 *Norellia bertei* Rondani: Dipt. Ital. Prodromus., 7: 4.

8.5–9 mm	–	Seguy
7.5–9 mm	VI–IX	Sack
7.5–9 mm	–	Gorodkov
7.5–9 mm	V–IX	Cociu

World distribution: Alps and Carpathians (Schiner, 1864); Alps, Italy, Croatia, Prussia (Becker, 1894); western and eastern Alps 1200–2200 m (Seguy, 1934); Alps (Sack, 1937); Romania (Cociu, 1981, 1993, 1995); Czechoslovakia (Sifner, 1972); France, Sweden, Italy, Austria, Yugoslavia (Gorodkov, 1986).

Romanian distribution: Băile Herculane, Cornereva, Teregova, Semenic, Valiug, Oraviţa (Caraş-Severin county); Câmpulung Moldovenesc – Valea Caselor, Putna Valley, Podul Bucătarului, Seacă Valley, Rarău Mountains peak (Suceava county); surroundings Câmpulung-Muscel, Bughea de Jos, Albeşti, Lereşti, Voina (Argeş county); Baia de Fier, Polovraci (Gorj county); Tuşnad, Miercurea Ciuc (Harghita county).

2. *Norellisoma armipes* (Meigen, 1826):
Syn.: 1826 *Cordilura armipes* Meigen: Syst. Beschr., 5.234.10.
1826 *Cordilura flavicauda* Meigen: Syst. Beschr., 5.235.12; 1835 Macquart: Suit a Buff., II. 384; 1849 Lucas: Explor. sciend de l'Algerie, III. 495. 247; 1894 Becker: Berlin entom. Zeitschr., 39.127.57.
1838 *Cordilura ruficauda* Zetterstedt, Ins.Lapp., 733.35.; 1846, Zett.: Dipt.Scand. V. 2055.49.
1840 *Cordilura flava* Von Roser: Wiurttemb. Corrbl.
1867 *Norellia roserii* Rondani: Dipt. Ital. Prodromus, 7:101.

9–10 mm	V	Seguy
8.5–10 mm	V–IX	Sack

8.5–10 mm	IV–X	Cociu

World distribution: Romania (Strobl, 1987; Thalhammer, 1899); France, Germany, Great Britain, Siberia (Seguy, 1934); Europe, Siberia, Algeria (Sack, 1937); France, Germany (Gorodkov, 1986).

Romanian distribution: Măgura Cisnădiei, Oncești Mountains peak, Gâtul Berbecului – Păltiniș (Sibiu county); Rarău Mountains peak, Valea Caselor, Deia – Câmpulung Moldovenesc (Suceava county); Peștera, Azuga, (Prahova county).

3. *Norellisoma lesgiae* Becker, 1894:

Syn.: 1894 *Norellia lesgiae* Becker: Berlin entom. Zeitschr. 39(1):129

7–8 mm	–	Sack
6–8 mm	–	Gorodkov
6.5–8 mm	V	Cociu

World distribution: Caucasus (Becker, 1894; Sack, 1937); CSI – Russia, Ukraine, Modovian Rep., Georgia, Azerbaidjan, Armenia (Gorodkov, 1986).

Romanian distribution: Călimani Mountains, Crucea – Vatra Dorna (Suceava county); river Dâmbovicioara gorges, Berevoiești, Nucșoara (Argeș county).

4. *Norellisoma liturata* (Meigen, 1826):

Syn.: 1826 *Cordilura liturata* Meigen: Syst. Beschr. V.238.19.
1835 *Cleigastra liturata* Macquart: Suit. a Buff., II.387.12.
1846 *Cordilura liturata* Zetterstedt: Dipt. Scand., V.2056. 49-50; 1864 Schiner: Fauna Austriaca, II.7; 1894 Becker: Berlin entom. Zeitschr., 39.128.58.; 1899 Meade: Entom. Monthly Mag., 173.4.
1864 *Cordilura opaca* Loew: Wien ent. Monatschr., VIII.19.3

5–6 mm	VI–IX	Sack
4.5–6 mm	–	Seguy
4 mm	VI–VII	Hackman
4–6 mm	–	Gorodkov

World distribution: Romania (Strobl, 1897, Thalhammer, 1899; Cociu, 1981, 1993, 1995); France, Great Britain, Germany, eastern Prussia, Austrian, eastern and western Alps, Siberia (Seguy, 1934); Europe, Siberia (Sack, 1937); eastern Fennoscandia and Central Europe (Hackman, 1956); Scotland (Collin, 1958); Europe: Norway, Sewden, Austria, Great Britain, Czechoslovakia, CSI – Russia, Siberia, Asia: Mongolia (Gorodkov, 1986).

Romanian distribution: Postăvaru (Brașov, county), Cibinului Mountains, Păltiniș (Sibiu county); Sinaia, Bușteni, Piatra Arsă, Azuga – Baiului Mountains (Prahova county); Putna Valley, Cârlibaba, Dorna Cândrenilor, Poiana Stampei, Poiana Negri, Vatra Dornei; Brodina, Vicovul de Sus, Rădăuți (Suceava county); Răstolița (Mureș county); Retezat Mountains, Gura Zlata, (Hunedoara county); Polovraci, Baia de Fier, river Oltetului gorges (Gorj county); Semenicului Mountains, Valiug, Nera Valley, Carasova (Caraș-Severin county).

5. *Norellisoma mireki* Sifner, 1979: Acta Universitatis Carolinai Biologica, 397–402. 12.

World distribution: Europe: Romania (Sifner, 1979; Cociu 1993, 1995).

Romanian distribution: Câmpulung Moldovenesc – Putna Valley, Deia, Rarău Mountains peak, Cârlibaba (Suceava county); Bucegi Mountains – Piatra Arsă, Peștera, Bușteni (Prahova county); Baiului Mountains; Păltiniș – Oncești Mountains peak, Gâtul Berbecului (Sibiu county); river Sohodol gorges, Hobita Valley (Gorj county); Tușnad, Miercurea Ciuc (Harghita county).

6. *Norellisoma nervosa* (Meigen, 1826):

Syn.: 1826 *Cordilura nervosa* Meigen: Syst. Beschr., V.234.9.t XLV.f.21.; 1835 Maquart: Suit. a Buff., II.383.12; 1864, Schiner: Fauna Austriaca, II.5.: 1894 Becker: Berlin entom. Zeitschr. 39.126.52.; 1899 Meade: Entom. Monthly Mag. 173.2.
1938 *Clidogastra flaviceps* Wimmer: Ent. Listy. 1(1) (1937):29

7.5–8 mm	–	Seguy
7.5–8.5 mm	V–VIII	Sack
7–12 mm	V–IX	Sifner
7.5–8.5 mm	–	Gorodkov

World distribution: Czechoslovakia (Czizek, 1907); France, Belgium, Germany (Seguy, 1934); Central Europe (Sack, 1937); Central and southern Europe (Sifner, 1972); Romania (Cociu, 1981, 1993); France, Germany, Switzerland, Czechoslovakia (Gorodkov, 1986).

Romanian distribution: Pojorâta, Putna Valley, Valea Caselor, Izvorul Alb, Seacă Valley (Suceava county); Berevoiești, Nucșoara, river Dâmbovicioarei gorges, Câmpulung-Muscel surroundings, Voina (Argeș county); Tușnad, Miercurea-Ciuc (Harghita county); Ghiroda Veche (Timiș county); Răstolița – Galaoaia, Cofu, Mijlocu Cald (Mureș county); Cloșani (county Mehedinți); Sinaia, Bușteni, Peștera, Mountains Baiului – Azuga (Prahova county); Băile Olănești, Cozia Mountains (Vâlcea county).

7. *Norellisoma spinimana* (Fallen, 1819):

Syn.: 1798 *Musca semiflava* Panz: Fauna Germ. LIX. 19
1819 *Cordilura spinimana* Fallen: Dipt. Suec. Scatom. 7.3; 1826 Meigen: Syst. Beschr. V.235.13.; 1835 Maquart: Suit.a Buff., II.383.11; 1846 Zeetterstedt: Dipt. Scand., V.2007.11.; 1864 Schiner: Fauna Austriaca, II.7.; 1866 Rondani: Prodr., VII Scatophag. 17.2.; 1880 Gercke: Verth. d.Vereins. f. Naturw. Unterh. Hamburg, VI.46.t II.20. Metamorph.; 1883 Brauer: Zweifl. d. Kais. Mus. Wien, 93.; 1894 Becker: Berlin entom. Zeitschr. 39.127.56.; 1899 Meade: Entom. Monthly Mag., 173.1.
1930 *Norellisoma septentrionale* Hendel: Ark. Zool., 21A (18)

7–9 mm	V–IX	Sack
7 mm	VI–VIII	Hackman
7–8 mm	VI–IX	Seguy

World distribution: Romania (Thalhammer, 1899; Cociu, 1981, 1995); France, Germany, Arkhangelsk, Prussia, Macedonia, Great Britain (Seguy, 1934); Europe, Siberia (Sack, 1937); Europe (Hackman, 1956); Scotland (Collin, 1958); Europe, North America, Siberia, Asia: Mongolia (Drascovits, 1981); Sweden, Finland, Great Britain, France, Hungary, Russia, Estonia, Latvia, Lithuania, Belorussia, Ukraine and far east, North America (Gorodkov, 1986).

Romanian distribution: Periam (Timiş county), Tasnad, Pir (Satu Mare county), Băile Herculane, Cernei Valley, gorges river Corcoaiei (Caraş-Severin county), Tuşnad (Harghita county), Pistrita Valley, Baia de Aramă (Mehedinţi county), Câmpulung Moldovenesc, Putna Valley, Valea Caselor, Podul Bucătarului, Seacă Valley, Deia (Suceava county), Săftica, Căscioarele, the Dumitrana forest, the Comana forest, Snagov, Crevedia, Tunari, the Cernica forest, Mogoşoaia (Ilfov county), Bran (Braşov county), Sasca Româna, river Nera gorges, Carasova, Naidas (Caraş-Severin county).

8. *Norellisoma striolata* (Meigen, 1826):
Syn.: 1826 *Cordylura striolata* Meigen: Syst. Beschr., V.235.11.
1835 *Cordylura striata* Macquart: Suit.a Buff., II.383.13
1864 *Cordylura striolata* Schiner: Fauna Austriaca II.6; 1866 Rondani: Prodr., VII Scatophag. 16.1; 1894 Becker:Berlin entom. Zeitschr., 39.127.53.

8.5–11 mm	VII–IX	Sack
8.5–9.5 mm	–	Seguy
8.5–11 mm	–	Gorodkov

World distribution: Romania (Strobl, 1897; Thalhammer, 1899; Cociu, 1981, 1995); Czechoslovakia (Thalhammer, 1899; Sifner, 1965); Italy, Great Britain, Germany, eastern Alps - 2200 m (Seguy, 1934); Central and southern Europe (Sack, 1937); Europe: Czechoslovakia, Carpathians (Drascovits, 1981); France, Switzerland, Austria, Czechoslovakia, Russia, Ukraine, Moldovian Rep. (Gorodkov, 1986).

Romanian distribution: Postăvaru (Braşov county); Berzasca (Caraş-Severin county); Cibinului Mountains, Poiana Sibiului, Păltiniş – Onceşti Mountains peak, Gâtul Berbecului (Sibiu county), Câmpulung Moldovenesc – Valea Caselor, Putna Valley, Deia, Pojorâta, Vatra Dornei, Dorna Cândrenilor, Poiana Stampei (Suceava county), Sinaia, Buşteni, Azuga – Baiului Mountains, Piatra Arsă, Peştera (Prahova county), river Dâmbovicioara gorges, Berevoieşti, Câmpulung-Muscel – Flamânda, Bughea de Jos, Voina (Argeş county), Răstoliţa – Galaoaia, Cofu (Mureş county), Bran (Braşov county).

Genus *Cordylura* Fallen, 1810
Syn.: 1758 *Musca* Linnaeus: Sist.Nat.Ed.10.1:598
1810 *Cordilura* Fallen: Nov.Dipt.dispon.Method.,15.45
1830 *Mosina* Robineau Desvoidy: Essai Myot: 670

1. *Cordylura ciliata* (Meigen, 1826):
Syn.: 1826 *Cordylura ciliata* Meigen: Syst.Beschr.,V.231.2.; 1835 Macquart: Suit. a Buff., II.381.3.; 1846 Zett.:Dipt.Scand.; V.4; Schiner: Fauna Austriaca II.3.; 1866 Rondani: Prodr., VII Scatoph. 13.1.; 1894 Becker: Berlin entom. Zeitschr., 39.91.6; 1899 Meade: Entom. Monthly Mag., 172.6.

8–10 mm	V–IX	Seguy
9–12 mm	V–IX	Sack
9–12 mm	VI–VIII	Drascovits
8–12 mm	–	Gorodkov
8–9 mm	–	Collin
9–11 mm	VI, VII	Cociu

World distribution: Romania (Thalhammer, 1899; Cociu, 1995); France, Great Britain, Denmark, Germany, Austria, eastern Alps – 2500 m (Seguy, 1934); Central and northern Europe (Sack, 1937); Central Europe – high Mountains (Hackman, 1956); Europe (Drascovits, 1981); Europe: Sweden, Finland, Great Britain, Czechoslovakia, Russia, Ukraine, Moldovian Rep. (Gorodkov, 1986).

Romanian distribution: Băile Herculane, Cerna Valley, Cornereva, Teregova, Carasova (Caraş-Severin county); Ciolpani, Căscioarele, Budeşti, Crevedia, the Comana forest, the Pasărea forest (Ilfov county); Slatina, Scărişoara, Pleşoiu, Strejeşti, Grădinari (Olt county); Ştefăneşti, Mădulari, Măciuca, Vădeşti, Băile Olăneşti (Vâlcea county); Polovraci, Baia de Fier, Novaci (Gorj county); the Verde forest – Timişoara (Timiş county)

2. *Cordylura picipes* (Meigen, 1826):
Syn.: 1826 *Cordylura picipes* Meigen: Syst. Beschr. V. 232. 4.: 1902 Becker: Zetschr. f. Hymenopt. u. Dipt., II. 213. 4.
1864 *Cordylura biseta* Loew: Wien. entom. Monatschr., VIII. 21. 5.: 1894 Becker: Berlin entom. Zeitschr.; XXXIX. 93. 13; 1899 Meade: Entom. Monthly Mag., 172. 7.

5–6 mm	–	Gorodkov
5–6 mm	IV–VI	Drascovits
5–6 mm	V–IX	Sack
6 mm	–	Collin

World distribution: Czechoslovakia (Kowarz, 1894; Vimmer, 1913); France, eastern Prussia, Germany (Seguy, 1934); Central Europe (Sack, 1937; Hackman, 1956); Central and Northern Europe, Great Britain (Collin, 1958); South Finland, Great Britain, Czechoslovakia, Russia, Esthonia, Lithuania, Latvia, Belorussia, Ukraine, Moldovian Rep., Asia: Mongolia (Gorodkov, 1986).

Romanian distribution: Sâmbata (Braşov county); Podenii Vechi, Gornet, Vălenii de Munte, Slănic (county Prahova); Putineiu (county Teleorman); Scărişoara (Olt county); Comana, Pasărea, the Snagov forest (Ilfov county); Târgu Cărbuneşti, Peştişani, Tismana (Gorj county).

3. *Cordylura pubera* (Linnaeus, 1758):

Syn.: 1758 *Musca pubera* Linnaeus: Syst. Nat. Ed. 10, 1: 598; 1781 Fabricius: Spec. Ins. II. 446. 55; 1788 Gmel.: Syst. Nat. V. 2850. 95.
1805 *Occiptera pubera* Fabricius: Syst. Antl., 315. 10.; 1819 Fallen: Dipt. Suec., Scatomyz., 6. 1.
1826 *Cordylura rufipes* Meigen: Syst. Beschr., V. 232. 5.; 1902 Becker: Zeitschr. f. Hymenopt. u. Dipt. II. 213. 5.
1830 *Mosina pubera* Robineau-Desvoidy: Myod., 671.; 1835 Macquart: Suit. a Buff. II. 381. 1. t XVIII f. 7.; 1838 Zetterstedt: Insecta Lapp. 725. 1 and 1846 Dipt. Scand. V. 1895. 1.; 1864 Schiner: Fauna Austriaca, II. 2.; 1866 Rondani: Prodr., VII. Scatophag. 13. 2.; 1892 Bezzi: Contribuz. alla F. ditt. di Pavia, II, 50, 560; 1894 Becker: Berlin entom. Zeitschr., XXXIX 91. 5. t. IV. f. 1. 6.; 1899 Meade: Entom. Monthly Mag., 171.; 1900 Becker: Acta Soc. scient. fenn., XXVI, 48. 83.

9–12 mm	IV–IX	Sack
8–12 mm	–	Gorodkov
–	V–IX	Sifner
9–12 mm	IV–VIII	Drascovits
8.5–12 mm	V–IX	Cociu

World distribution: Romania (Thalhammer, 1899; Cociu, 1980, 1995); Czechoslovakia (Czizek, 1907; Vimmer, 1913); France (Amiens, Paris, Mendon, Rambouillet, Poissy, Gray, Fontainebleau, Lyon), Great Britain, Germany, Austria, Denmark, Siberia (Seguy, 1934); Europe, Siberia (Sack, 1937); Europe, Siberia (Hackman, 1956); Europe, Siberia (Sifner, 1965); Europe: Sweden, Finland, Great Britain, Hungary, Russia, Ukraine, Moldovian Rep., Far east, Asia: Mongolia (Gorodkov, 1986).

Romanian distribution: Periam, Ghiroda Veche (Timiş county); Semenic Mountains, Valiug (Caraş-Severin county); Tuşnad, Miercurea-Ciuc (Harghita county); Vatra Dornei, Poiana Negri, Dorna Cândrenilor, Poiana Stampei (Suceava county); Răstoliţa (Mureş county); Sinaia – Cota 1400, Azuga (Prahova county).

4. *Cordylura pudica* (Meigen, 1826)

Syn.: 1826 *Cordylura pudica* Meigen: Syst. Beschr. V.S. 231. 3.; 1835 Macquart: Suit., a Buff., II. 382. 5.
1838 *Cordylura geniculata* Zetterstedt: Insecta Lapp. 725. 1.
1864 *Cordylura pudica* Schiner: Fauna Austriaca, II. 2.; 1894 Becker: Berlin entom. Zeitschr., XXXIX. 90. 1.; 1899 Meade: Entom. Monthly Mag., 171. 2.

7–9 mm	IV–IX	Sack
7–9 mm	–	Gorodkov
7–9 mm	–	Drascovits

World distribution: Romania (Thalhammer, 1899; Cociu, 1993); France, Arkhangelsk, Sweden, Germany, Austria, Italy, Great Britain (Seguy, 1934); Europe (Sack, 1937); north Europe, Lapland, Karelia (Hackman, 1956); All Europe, north CSI - Arkhangelsk (Sifner, 1965); Europe: Sweden, Finland, Switzerland, Great Britain, Czechoslovakia, Russia, Esthonia, Latvia, Lithuania, Belorussia, Ukraine; North America: Alasca to Quebec (Gorodkov, 1986).

Romanian distribution: Miercurea-Ciuc, Tuşnad (Harghita county); Răstoliţa (Mureş county); Baiului Mountains (Prahova county); Poiana Sibiului, Cisnădie (Sibiu county); Brodina, Vicovul de Sus, Rădăuţi, Solca (Suceava county).

5. *Cordylura umbrosa* (Loew, 1873):

Syn.: 1875 *Cordylura umbrosa* Loew: Beschr. europ. Dipt., 3. 246. 159.; 1894 Becker: Berlin entom. Zeitschr., XXXIX. 93. 12.; 1899 Meade: Entom. Monthly Mag., 171. 2.

8–10 mm	V–X	Sack
8–9 mm	–	Collin
8-9 mm	–	Gorodkov
8–9 mm	V–VIII	Drascovits

Wordl distribution: Hungary, Czechoslovakia (Loew, 1873); Romania (Thalhammer, 1899); Central Europe (Sack, 1937; Gorodkov, 1971); Europe: France, Czechoslovakia, Hungary, Russia, Ukraine, Moldovian Rep., Kazakstan (Gorodkov, 1986).

Romanian distribution: Periam, Ghiroda Veche (Timiş county); Cornereva, Domasnea, Iablonita, Teregova, Caransebeş, Brebu, Moldova Nouă (Caraş-Severin county).

Genus *Spathephilus* Becker, 1894

Syn.: 1894 *Spathephilus* Becker: Berlin. entom. Zeitschr., 39. (1): 121.
1894 *Monochaeta* Becker: Berl. entom. Zeitschr., 39. (1): 87, 186.

1. *Spathephilus breviventris* (Loew, 1873):

Syn.: 1873 *Cordylura breviventris* Loew: Beschr. europ. Dipt. 3. 250.
1894 *Spathephilus breviventris* Becker: Berlin. entom. Zeitschr., 39. 122. 50. t. V. f. 8.

5 mm	–	Sack
4–5 mm	IV–VII	Sifner
5 mm	IV–VIII	Cociu

World distribution: Sarepta (Sack, 1937); Europe: Czechoslovakia, CSI – Russia, Ukraine, Moldavian Rep. (Gorodkov, 1986).

Romanian Distribution: Băile Herculane, Domogled, Cornereva, Mehadia, Naidas, Carasova, river Caraşului gorges, Semenicului Mountains, Teregova (Caraş-Severin county); Răstoliţa (Mureş county); Colibiţa (Bistriţa Năsăud county); Cozia Mountains, Călimăneşti (Vâlcea county).

Genus *Cleigastra* Macquart, 1835

Syn.: 1835 *Cleigastra* Macquart: Hist. nat. Ins. Dipt., 2: 384.
1856 *Cnemopogon* Rondani: Dipt. Ital. Prodromus 1: 100.

1. *Cleigastra apicalis* (Meigen, 1826):

Syn.: 1826 *Cordylura apicalis* Meigen: Syst. Beschr., 5. 236.
1835 *Cleigastra apicalis* Macquart: Hist. Nat. Ins. Dipt., 2: 384.

4.5–6.5 mm	–	Seguy
5–8 mm	VI–IX	Sack
–	V, VI	Hackman
6–8 mm	V–VII	Sifner
5–8 mm	IV–X	Drascovits

World ditribution: Romania (Thalhammer, 1899); France (Vendrese, Paris, Bambouillet), Germany, eastern Prussia (Seguy, 1934); Central and northern Europe (Sack, 1937); eastern Fenoscandia and central Europe (Hackman, 1956); All Europe (Sifner, 1965); Europe: Sweden, Finland, Great Britain, Hungary, Russia, Esthonia, Latvia, Lithuania, Belorussia, Ukraine (Gorodkov, 1986).

Romanian distribution: Miercurea Ciuc, Tuşnad (Harghita county); Braşov (Braşov county); Păltiniş – Onceşti Mountains peak, Gâtul Berbecului (Sibiu county); Semenicului Mountains, Valiug, Mehadia, Berzasca, Moldova Nouă (Caraş-Severin county); Dragoslavele, Nucşoara, Berevoieşti, river Dâmbovicioara gorges (Argeş county).

Genus *Megaphthalma* Becker, 1894: Berlin. entom. Zeitschr., 39 (1): 105.

1. *Megaphthalma pallida* (Fallen, 1819):

Syn.: *Cordylura palida* Fallen: Dipt. Suec. Scatomyz., 8. 4.; 1826 Meigen: Syst. Beschr., V. 242. 28.; 1838 Zetterstedt: Insecta Lapp. 720. 8.; 1894 Becker: Berlin. entom. Zeitschr., 39. 106. 29 t. VI. f. 3.

4–6 mm	VII, VIII	Seguy
4–5 mm	VI–IX	Sack
4–5 mm	–	Gorodkov
–	VI–VIII	Hackman
4–5 mm	–	Drascovits
6–8 mm	V–VIII	Sifner

World distribution: France (Paris, Rambouillet), Great Britain, North America (Seguy, 1934); Central and northern Europe (Sack, 1937); holarctic distribution (Hackman, 1956); Great Britain (Collin, 1958); Romania (Strobl, 1897; Cociu, 1980, 1993, 1995); Central and northern Europe, North America (Sifner, 1965); Europe: Sweden, Finland, Switzerland, Great Britain, Czechoslovakia, Russia, Esthonia, Lithuania, Latvia, Belorussia, Ukraine (Gorodkov, 1986).

Romanian distribution: Cibin Mountains, Poiana Sibiului, Păltiniş (Sibiu county); Postăvaru Mountains peak (Braşov county); Câmpulung Moldovenesc, Putna Valley, Valea Caselor, Seacă Valley, Rarău Mountains peak (Suceava county); Azuga, Baiului Mountains (Prahova county); Colibiţa (Bistriţa Năsăud county).

Genus *Microprosopa* Becker, 1894: Berlin. entom. Zeitschr., 39 (1): 147.

1. *Microprosopa haemorrhoidalis* (Meigen, 1826):

Syn.: 1826 *Cordylura haemorrhoidalis* Meigen: Syst. Beschr., V. 237. 17.; 1838 Zetterstedt: Insecta Lapp. 732. 27.
1838 *Cordylura melanura* Zett.: Insecta Lapp. 731. 28.
1838 *Cordylura pallipes* Zett.: Insecta Lapp. 732. 29.
1846 *Cordylura lividipes* Zett.: Dipt. Scand. V. 2042. 39.
1894 *Microprosopa haemorrhoidalis* Becker: Berlin. entom. Zeitschr., 39. 149. 76.

5.5–6 mm	–	Seguy
5–6 mm	VI–VIII	Sack
4/6 mm	–	Gorodkov

World distribution: Sweden (Meigen, 1826); Spain, Arkhangelsk, Siberia, Greenland (Seguy, 1934); Central and northern Europe, Greenland (Sack, 1937), Siberia, central Europe and North America (Gorodkov, 1971); Romania (Cociu, 1980, 1993); Europe: Norway, Sweden, Finland, Alps, Russia, Far north, eastern Siberia (Sayan Mts), North America: Alaska to Greenland (Gorodkov, 1986).

Romanian distribution: Rarău Mountains peak (Suceava county); Onceşti Mountains peak, Gâtul Berbecului – Păltiniş (Sibiu county); Baiului Mountains – Azuga, Bucegi Mountains – Postăvaru Mountains peak, Piatra Arsă Mountains peak, Peştera (Prahova county); Colibiţa (Bistriţa Năsăud county); Răstoliţa (Mureş county); Semenic Mountains (Caraş-Severin county).

2. *Microprosopa hoberlandti* Sifner, 1981: Acta Ent. Mus. Nat. Pragae, 40: 95–104.

6–7 mm	VII	Sifner
7 mm	VII	Cociu

World distribution: Asia: Iran (Sifner, 1981); Europe: Romania (Cociu, 1993).

Romanian distribution: Valea Seacă – Câmpulung Moldovenesc (county Suceava).

3. *Microprosopa pallidicauda* (Zeterstedt, 1838):

Syn.: 1838 *Cordylura pallidicauda* Zett.: Insecta Lapp. 733. 36. and Dipt. Scand. V. 2053. 47.
1894 *Microprosopa pallidicauda* Becker: Berlin. entom. Zeitschr., 39. 150. 77. t. 8. f. 9 and 1900 Acta Soc. scient. Fenn. XXVI. 53. 97.

4–6 mm	VI–VIII	Sack
4–6 mm	–	Gorodkov
6–8 mm	V–VIII	Sifner

World distribution: Central and northern Europe, Siberia (Sack, 1937); Romania (Cociu, 1980, 1993); Europe: Norway, Sweden, Finland, Czechoslovakia, Switzerland, Russia, eastern Siberia and westhern Siberia; North America: Alaska (Gorodkov, 1986).

Romanian distribution: Călimani Mountains (Suceava county); Semenic Mountains (Caraş-Severin county); Păltiniş – Onceşti Mountains peak (Sibiu county); Bucegi Mountains – Peştera, Piatra Arsă Mountains peak, Cerbului Valley, Baiului Mountains – Azuga (Prahova county); river Dâmbovicioara gorges (Argeş county).

Genus *Acanthocnema* Becker, 1894

Syn.: 1894 *Acanthocnema* Becker: Berl. entom. Zeitschr., 39 (1): 136.

1917 *Clinoceroides* Hendel: Dt. ent. Z., 1917 (1): 36.

1. *Acanthocnema glaucescens* (Loew, 1864):

Syn.: 1864 *Cordylura glaucescens* Loew: Wien ent. Monatschr., 8 (1): 23; 1873 Wien. ent. Monatschr. 8 (7): 23.

1894 *Acanthocnema glaucescens* Becker: Berlin entom. Zeitschr., 39. 138. 66.

1936 *Acanthocnema nigripes* Ringdahl: Ent. Tidskr., 57 (2–3): 175.

4 mm	–	Seguy
4–5 mm	VI–VIII	Sack
–	IV, V	Collin
4–5 mm	–	Gorodkov
5–6 mm	IV–VII	Sifner

World distribution: Germany (Loew, 1864); Alps (Becker, 1894); Romania (Thalhammer, 1899); France (Rhone), Germany, Alps (Seguy, 1934); Central Europe (Sack, 1937); Great Britain (Collin, 1958); Great Britain, Finland, Sweden (Drascovits, 1981); Europe: Sweden, Finland, germany, Great Britain, Poland, Austria, the Alps (Gorodkov, 1986).

Romanian distribution: Băile Herculane, Cerna Valley, near the river Corcoaiei gorges, Nera Valley nearby Sasca Româna, Bozovici, Teregova (Caraş-Severin county).

Genus *Trichopalpus* Rondani, 1856: Dipt. Ital. Prodromus 1: 100.

1. *Trichopalpus fraterna* (Meigen, 1826):

Syn.: 1826 *Cordylura fraterna* Meigen: Syst. Beschr., 5: 243; 1846 Zett.: Dipt. Scand., V. 2038. 36.

1864 *Hydromyza fraternus* Schiner: Fauna Austriaca, II. 14.

1866 *Trichopalpus fraternus* Rondani: Prodr. I. Scatophag. 22. 2; 1894 Becker: Berlin.entom. Zeitschr., 39. 157. 88: 1899 Meade: Entom. Monthly. Mag., 176. 1.

4–5 mm	–	Seguy
4–5 mm	V–IX	Sack
4–5 mm	–	Gorodkov
–	VII–IX	Hackman
4–6 mm	V–VII	Sifner
4–5 mm	V–IX	Drascovits

World distribution: Romania (Thalhammer, 1899); France, Austria, eastern Prussia, Sweden (Seguy, 1934); Europe (Sack, 1937); Fennoscandia (Hackman, 1956); Czechoslovakia (Sifner, 1969); northern and central Europe (Drascovits, 1981); Europe: Sweden, south Finland, France, Great Britain, Czechoslovakia, Hungary, Russia (Gorodkov, 1986).

Romanian distribution: Valea Caselor, Izvorul Alb – Câmpulung Moldovenesc, Putna Valley, Cârlibaba, Vatra Dornei – Negru Mountains, Poiana Stampei (Suceava county); Nucşoara, Albeşti, Musateşti, Berevoieşti, Bughea de Jos, Lereşti, Voina (Argeş county); Colibiţa (Bistriţa Năsăud county).

Genus *Chaetosa* Coquillett, 1898: Jl. N. Y. ent. Soc., 6: 163.

1. *Chaetosa punctipes* (Meigen, 1826):

Syn.: 1804 *Cleigastra punctipes* Schiner: Fauna Austriaca, II. 10; 1835 Macquart: Suit. a Buff., II, 386. 9; 1894 Becker: Berlin entom. Zeitschr., 39. 158. 89 t. VII; 1899 Meade: Entom. Monthly Mag., 217; 1900 Becker: Acta Soc. scient. Fenn., XXVI. 51. 91.

1826 *Cordylura punctipes* Meigen: Syst. Beschr. V. 239. 20.; 1838 Zett.: Insecta Lapp., 731. 26.

1826 *Cordylura flavipes* Meigen (nec. Fallen): Syst. Beschr. V. 230.

4–4.5 mm	–	Seguy
4-5 mm	V–VIII	Sack
4-5 mm	–	Gorodkov
4–6 mm	V–IX	Sifner
3-4 mm	IV–X	Drascovits
3.5–5 mm	V–X	Cociu

World distribution: Czechoslovakia (Czizek, 1907; Vimmer, 1913; Sifner, 1964, 1967); France, Germany, Austria, eastern Prussia, Arkhangelsk, Siberia (Seguy, 1934) and North America (Seguy, 1952); Europe, Siberia, North America (Hackman, 1956); Europe, Siberia, Labrador (Sack, 1937); Romania (Cociu, 1980); Europe, North America, Asia: Siberia, Mongolia (Drascovits, 1981); Europe, Island, Italy, Great Britain, Hungary, Russia, Ukraine, Moldavian Rep., Far east, Asia: Mongolia, North America: Alaska to Labrador (Gorodkov, 1971, 1986).

Romanian distribution: Valea Caselor, Seacă Valley, Podul Bucătarului, Putna Valley – Câmpulung Moldovenesc, Cârlibaba, Vatra Dornei, Poiana Stampei (Suceava county); Sâmbăta (Braşov county); Mountains Cozia, Băile Olăneşti, Berbeşti (Vâlcea county); river Sohodol gorges, Runcu, Tismana (Gorj county); Caransebeş, Orşova, Ieşelniţa (Caraş-Severin county).

Genus *Spaziphora* Rondani, 1856: Dipt. Ital. Prodromus, 1: 99.

1. *Spaziphora hydromyzina* (Fallen, 1819):

Syn.: 1819 *Cordylura hydromyzina* Fallen: Dipt. Soec. Scatomyz., 7. 2; 1826 Meigen: Syst. Beschr. V. 242. 29; 1846 Zett.: Dipt. Scand., V. 2037.35; 1866 Rondani: Prodr., VII. Scathophag. 21; 1894 Becker: Berlin. entom. Zeitschr., 39. 160. t. VII.
1835 *Cleigastra hydromyzina* Macquart: Suit. a Buff., II. 885. 6.
1864 *Hydromyza fallenii* Schiner: Fauna Austriaca, 2: 14.
1894 *Spatiophora fascipes* Becker: Berlin. entom. Zeitschr., 39 (1): 160.
1899 *Scathophaga hydromyzina* Meade; Entom. Monthly Mag., 223. 12; 1900 Becker: Acta Soc. scient. Fenn. XXVI. 51. 90.

5–6 mm	–	Seguy
5–6 mm	VI–VIII	Sack
5–6 mm	–	Gorodkov
5–6 mm	IV–X	Drascovits
8–10 mm	V–IX	Sifner

World distribution: Romania (Thalhammer, 1899); Germany, eastern Prussia, Central and northern Europe, Arkhangelsk, Siberia (Seguy, 1934); Central and northern Europe, Siberia (Sack, 1937; Hackman, 1956); England in Scotland and Ireland (Collin, 1958); Palearctic – Asia and Europe: Czechoslovakia, Esthonia, Finland, Sweden, european part of the URSS (Drascovits, 1981); Europe: Sweden, Finland, Ireland, Czechoslovakia, Hungary, Russia, Esthonia, Lithuania, Latvia, Belorussia, Ukraine, Georgia, Azerbaidjan, Armenia (Gorodkov, 1986).

Romanian distribution: Băile Herculane, Cerna Valley, Caransebeş (Caraş-Severin county); Ghiroda Veche (Timiş county); Sângiorz Băi (Bistriţa Năsăud county).

Genus *Nanna* Becker, 1894

Syn.: 1894 *Nanna* Becker in Strobl.: Mitt. naturw. Ver. Steierm., 30 (1893).
1894 *Amaurosoma* Becker: Berlin. entom. Zeitschr., 39 (1): 109.
1894 *Pselaphephila* Becker: Berlin. entom. Zeitschr., 39 (1): 122.

1. *Nanna armillata* (Zetterstedt, 1846):

Syn.: 1846 *Cordylura armillatum* Zett.: Dipt. Scand., 5: 2069.
1894 *Nanna armillatum* Becker: Berlin. entom. Zeitschr., 39. 120. 47.

4 mm	–	Seguy
4 mm	VI–VIII	Sack
4–5 mm	–	Drascovits

World distribution: Skane, Sweden and Copenhagen, Denmark (Zetterstedt, 1846); Romania (Fleck, 1904); Sweden, eastern Prussia, Silesia (Seguy, 1934); Central and northern Europe (Sack, 1937); the centre of the Sweden, of the Norway and the Europe (Hackman, 1956); Great Britain and Scotland (Collin, 1958); Europe (Drascovits, 1981); Europe: Norway, Sweden, Finland, Great Britain to Czechoslovakia, Russia, Esthonia, Latvia, Lithuania, Belorussia, Ukraine (Gorodkov, 1986).

Romanian distribution: Valea Caselor, Seacă Valley, Deia – Câmpulung Moldovenesc (Suceava county); Colibiţa (Bistriţa Năsăud county); Răstoliţa (Mureş county); river Dâmbovicioara gorges, Berevoieşti, Nucşoara, Brădet (Argeş county).

2. *Nanna articulata* (Becker, 1894):

Syn.: 1894 *Amaurosoma articulata* Becker: Berlin. entom. Zeitschr., 39 (1): 117.
1894 *Nanna articulata* Becker: Berlin. entom. Zeitschr., 120. 47.

7–9 mm	–	Seguy
7–9 mm	V–IX	Sack
7–9 mm	–	Gorodkov
4–5 mm	V	Drascovits
–	V, VI	Hackman

World distribution: Poland (Becker, 1894); Romania (Fleck, 1904); France, Silesia (Seguy, 1934); Central Europe (Sack, 1937; Sifner, 1972); Scandinavia, Czechoslovakia, Poland, Hungary (Drascovits, 1981); Europe: Sweden, Finland, France to Hungary, Russia (Gorodkov, 1986).

Romanian distribution: Comana, Pasărea, Tunari, Snagov, Buftea forests (Ilfov county); Putineiu (Teleorman county); Orşova, Ieşelniţa (Mehedinţi county); Moldova Nouă, Naidas, Oraviţa, Varadia, Cornereva, Caransebeş (Caraş-Severin county); Timişoara, Ghiroda Veche (Timiş county); gorges river Sohodol, Hobiţa, Baia de Aramă (Gorj county); Băile Olăneşti, Călimăneşti (Vâlcea county).

3. *Nanna fasciata* (Meigen, 1826):

Syn.: 1826 *Cordylura fasciatum* Meigen: Syst. Beschr., V. 238. 18.
1835 *Cleigastra fasciatum* Macquart: Suit.a Buff. II. 387. 11; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 118. 42; 1899 Meade: Entom. Monthly Mag., 217. 1.
1846 *Cordylura cinerella* Zett.: Dipt. Scand. 5: 2070.
1901 *Amaurosoma brevipenne* Curt., Verral: List of Brit. Dipt., 29–36.

4–5.5 mm	–	Seguy
4–4.5 mm	V–IX	Sack
4–5 mm	V	Drascovits

World distribution: Denmark (Zett., 1846); Romania (Fleck, 1904); France, Sweden, eastern Prussia, Great Britain (Seguy, 1934); Central and northern Europe (Sack, 1937); Europe: Esthonia, Silesia, Sweden, Norway (Drascovits, 1981); Europe: Sweden, Finland, Great Britain, Hungary, Russia (Gorodkov, 1986).

Romania distribution: Băile Herculane, Domogled, river Corcoaiei gorges (Caraş-Severin county); Băile Olăneşti, Călimăneşti, Mountains Cozia (Vâlcea county); Vatra Dornei (Suceava county).

4. *Nanna flavipes* (Fallen, 1819):

Syn.: 1819 *Cordylura flavipes* Fallen: Scatomyzides Sveciae: 9; 1826 Meigen: Syst. Beschr., V. 239. 21; 1838 Zett.: Insecta Lapp. 730. 24 and 1846 Dipt. Scand., V. 2059. 52.
1835 *Cleigastra frontalis* Macquart: Hist. nat. Ins. Dipt. 2: 387.
1838 *Cordylura trilineata* Meigen: Syst. Beschr., 7: 341.
1864 *Cleigastra flavipes* Schiner: Fauna Austriaca, II. 11; 1866 Rondani: Prodr., VII Scathophag. 20. 1; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 114. 33 and 1900 Acta Soc. scient. Fenn., XXVI. 48. 86.

4–5 mm	IV, V	Seguy
4–5 mm	IV–IX	Sack
5–6 mm	V–VII	Sifner
5–6 mm	IV–VI	Drascovits

World distribution: Sweden (Fallen, 1819); Romania (Fleck, 1904); Central and northern Europe (Seguy, 1934); Europe, Siberia (Sack, 1937); England (Collin, 1958), Europe, Siberia, Mongolia (Drascovits, 1981); Europe: Sweden, Finland, Great Britain to Hungary, Esthonia, Latvia, Lithuania, Russia, Ukraine, western Siberia, eastern Siberia (Gorodkon, 1986).

Romanian distribution: Bușteni, Mountains Baiului – Azuga, Sinaia – 2000 m, Peștera (Prahova county); Colibița (Bistrița Năsăud county); Tismana, Polovraci, Cărbunești (Gorj county); Mountains Semenic, Valiug (Caraș-Severin county); Gura Zlata (Hunedoara county).

5. *Nanna inermis* (Becker, 1894):

Syn.: 1894 *Amaurosoma inermis* Becker: Berlin. entom. Zeitschr., XXXIX. 119. 45.

3.5–4 mm	–	Seguy
3.5–4 mm	V–VIII	Sack
–	V, VI	Hackman
3.5–4 mm	–	Gorodkov
3–4 mm	IV	Drascovits

World distribution: Romania (Thalhammer, 1899); Great Britain, Silesia (Seguy, 1934); Central Europe (Sack, 1937); Great Britain (Merioneth, Hampshire, Suffolk and Inverness-ghire) (Collin, 1958); Europe: Finland, Great Britain, Hungary, Russia, Esthonia, Latvia, Lithuania, Belorussia, Ukraine (Gorodkov, 1986).

Romanian distribution: Brodina, Vicovul de Sus, Rădăuți, Cârlibaba, Vatra Dornei, Poiana Stampei (Suceava county); Dorohoi, Broscăuți (Botoșani county); Colibița, Sângiorz Băi (Bistrița Năsăud county); Miercurea-Ciuc, Tușnad (Harghita county); Beiuș (Bihor county); river Dâmbovicioara gorges, Nucșoara, Berevoiești, Mușetești, Albești (Argeș county); Răstolița – Gălăoaia, Cofu (Mureș county).

6. *Nanna tibiella* (Zetterstedt, 1838):

Syn.: 1838 *Cordylura tibiella* Zett.: Insecta Lapp., 731. 25; 1894 Becker: Berlin. entom. Zeitschr., 39. 121. 49; 1899 Meade: Entom. Monthly Mag., 218. 2.

4 mm	–	Seguy
3–4 mm	IV–VIII	Sack
–	V, VI	Hackman
4–5 mm	–	Drascovits

World distribution: Sweden, Norway (Zetterstedt, 1838); Romania (Thalhammer, 1899); Hungary (Seguy, 1934); Central and northern Europe (Sack, 1937; Sifner, 1972); Europe, Norway, Sweden, Great Britain to Hungary, Russia, Esthonia, Latvia, Lethonia, Belorussia, Ukraine (Gorodkov, 1986).

Romanian distribution: Vălenii de Munte, Slănic (Prahova county); Berbești, Voineasa (Vâlcea county); Câmpulung Muscel, Bughea de Jos, Dragoslavele, Brădet, Mușetești (Argeș county).

Genus *Scathophaga* Meigen, 1803

Syn.: 1800 *Scopeuma* Meigen: Nouve. Class.: 36.
1803 *Scathophaga* Meigen: Mag. Insectenck., 2: 277.
1807 *Pyropa* Illiger: Fauna Etrvsca, 2: 475.
1810 *Scatomyza* Fallen: Specim. entom. noram. Dipt.: 15.
1830 *Amina* Robineau-Desvoidy: Essai Myod.: 629.
1830 *Satina* Robineau-Desvoidy: Essai Myod.: 629.
1894 *Coniosternum* Becker: Berlin. entom. Zeitschr., 39 (1): 176.
1926 *Scathophagela* Szilady: Annls hist. nat. Mus. natn. hung., 24: 596. Scatophaga: unjustifiend emend.

1. *Scathophaga decipiens* (Haliday in Curtis, 1832):

Syn.: 1832 *Scatophaga decipiens* Haliday in Curtis: Brit. Entom., 9: 405.
1894 *Scatophaga dalmatica* Becker: Berlin. entom. Zeitschr., 39. 176;
1901 Verral: List of Brit. dipt., 29. 36.

5.5–6 mm	–	Seguy
5.5–6 mm	V–IX	Sack
5–6 mm	–	Gorodkov

World distribution: France, England, Algeria – Oran (Seguy, 1934); northern and Central Europe, North Africa (Sack, 1937); Europe: Ireland to Czechoslovakia, Russia, Ukraine, Moldavian Rep., Uzbekistan, Tadjhikistan, Turkmenia, North Africa – ? Algeria (Gorodkov, 1986).

Romanian distribution: Podul Bucătarului, Seacă Valley, Valea Caselor, Deia – Câmpulung Moldovenesc, Rarău Mountains peak (Suceava county); Baiului Mountains – Azuga (Prahova county); Răstolița (Mureș county); Colibița (Bistrița Năsăud county).

2. *Scathophaga furcata* (Say, 1823):

Syn.: 1823 *Pyropa furcata* Say: J. Acad. Nat. Sci. Philad., 3 (1): 98.
1826 *Scatophaga squalida* Meigen: Syst. Beschr., 5: 252; 1835 Macquart: Suit. a Buff., II. 394. 9.
1838 *Scatomyza fuscinervis* Zett.: Insecta Lapp.: 722.
1838 *Cordylura fuscinervis* Zett.: Insecta Lapp.: 733.
1846 *Scatomyza squalida* Zett.: Dipt. Scand., V. 10; 1864 Schiner: Fauna Austriaca, II. 18.
1866 *Scatina squalida* Rondani: Prodr., VII. Scatophag. 29. 1; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 172. 107; 1899 Meade: Entom. Monthly Mag., 223. 14.

4–8 mm	III–IX	Seguy
8–9 mm	III–IX	Sack
5–9 mm	–	Gorodkov
5–9 mm	III–XI	Drascovits
4.5–9 mm	IV–X	Cociu

World distribution: Lapponia, Sweden, Norway (Zetterstedt, 1838); Romania (Thalhammer, 1899; Cociu, 1995); France, Great Britain, Germany, Austria, Italy, Alps 2000 m, eastern Prussia, Sweden, Arkhangelsk, Alaska (Seguy, 1934, 1952); Europe, Greenland, Spitsbergen, Labrador (Sack, 1937); Europe, Siberia, Mongolia (Drascovits, 1981); Europe: Island, Norway (include Spitsbergen) to Italy, Great Britain to Poland, CSI: Russia to Ukraine, Moldavian Rep., Uzbekistan, Tadzhikistan, Kirkizia, Turkmenia, Siberia, Far east (include Commander and Kuril is.), Asia: Mongolia, North America; Alaska to Greenland and Mexico (Gorodkov, 1986).

Romanian distribution: Cibin Mountains, Poiana Sibiului, Păltiniş (Sibiu county); Băile Herculane, river Corcoaiei gorges, Domogled (Caraş-Severin county); Peştera – Bucegi Mountains, Azuga – Baiului Mountains, Sinaia – 2000 m (Prahova county); Cernei de Jos meadow (Hunedoara county); Postăvaru (Braşov county); Rarău Mountains peak, Călimani Mountains, Poiana Stampei (Suceava county); Câmpulung-Muscel – Flamânda, Nucşoara, Berevoieşti, river Dâmbovicioara gorges (county Argeş); river Sohodol gorges, Cloşani – Calului Valley (Gorj county).

3. *Scathophaga incola* (Becker, 1900):

Syn. 1900 *Scatophaga incola* Becker: Acta Soc. scient. Fenn., 24 (9): 54.
1936 *Scopeuma fascifrons* Ringdahl: Ent. Tidskr., 57 (2–3): 174.

6–7.5 mm	VII	Sack
7.5–9 mm	VI–IX	Hackman
7.5–9 mm	–	Gorodkov
7–9 mm	IV–XI	Cociu

World distribution: Siberia (Sack, 1937); Europe, North America, Greenland (Sifner, 1972); Romania (Cociu, 1980, 1994, 1995); Europe: Sweden, Finland, CSI: Russia, western Siberia, eastern Siberia, North America: Alaska to Labrador (Gorodkov, 1986).

Romanian distribution: Valea Caselor, Podul Bucătarului, Deia, Putna Valley, Rarău Mountains peak, Călimani Mountains, Poiana Stampei (Suceava county); Cloşani, Runcu, river Sohodol gorges (Gorj county); Păltiniş, Onceşti Mountains peak, Gâtul Berbecului, Sibiel, Poiana Sibiului (Sibiu county); Semenic Mountains, Valiug, river Caraş gorges, Caraşova, river Nera gorges, Sasca Româna, Naidas, Cornereva, Băile Herculane, Cerna Valley (Caraş-Severin county); Băile Olăneşti, Cozia, Călimăneşti, Căciulata (Vâlcea county); Sf. Gheorghe – Danube Delta, the Letea forest, Sulina (Tulcea county); river Dâmbovicioara gorges, Voina, Vidraru, Berevoieşti, Nucşoara, Muşeteşti, Brădet, Cândeşti (Argeş county); Piatra Arsă, Potoci, Peştera, Buşteni, Azuga, Sinaia – Cota 1400 (Prahova county); Bistriţa Valley, Hobiţa Valley, Cloşani (Gorj county); Gura Zlata (Hunedoara county); Răstoliţa (Mureş county); Sângiorz Băi, Colibiţa (Bistriţa Năsăud county); Slatina, Scărişoara, Strejeşti, Grădinari, Pleşoiu (Olt county); Voiceşti, Drăgăşani, Babeni (Vâlcea county); Crângu, Putineiu (Teleorman county); Săftica, Snagov, Pasărea, Comana, Andronache, Băneasa, the Cernica forest (Ilfov county).

4. *Scathophaga inquinata* (Meigen, 1826):

Syn.: 1826 *Scatophaga inquinata* Meigen: Syst. Beschr., 5: 250.
1846 *Scatomyza inquinata* Zett.: Dipt. Scand., V. 1963. 3; 1864 Schiner: Fauna Austriaca, II. 17; 1866 Rondani: Prodr., VII Scatophag. 26. 4; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 168. 96; 1899 Meade: Entom. Monthly Mag., 222. 8.

6–7.5 mm	III–IX	Seguy
6–7.5 mm	III–IX	Sack
6–7 mm	VI, VII	Hackman
6–7 mm	–	Gorodkov
6–7 mm	III–X	Drascovits
6–7.5 mm	III–XII	Cociu

World distribution: Romania (Thalhammer, 1899; Cociu, 1994, 1995); Corsica, France, Germany, Silesia, Alps (Seguy, 1934, 1952); Europe (Sack, 1937); All Europe except arctic area (Sifner, 1972); Esthonia, Finland, Sweden, Czechoslovakia, Trans-Caucasia (Drascovits, 1981); Europe: Sweden, Finland, Great Britain to Hungary, CSI: Russia, Transcaucazia, Georgia, Azerdaidjan, Armenia (Gorodcov, 1986).

Romanian distribution: Olăneşti Băi, (Vâlcea county); Cloşani (Gorj county); river Dâmbovicioara gorges, Voina, Albeşti, Cândeşti, Nucşoara, Berevoieşti (Argeş county); Gura Zlata (Hunedoara county); Domogled, Cerna Valley, Cornereva, river Nera gorges, river Caraş gorges, Caraşova (Caraş-Severin county); Păltiniş – Onceşti mountain peak, Gâtul Berbecului, Poiana Sibiului, Sibiel (Sibiu county); Peştera – Bucegi Mountains (Prahova county); Răstoliţa (Mureş county);

Periam (Timiș county); Rarău mountain peak, Valea Caselor, Căliman Mountains (Suceava county).

5. *Scathophaga lutaria* (Fabricius, 1794):

Syn.: 1794 *Musca lutaria* Fabricius: Entom. Syst., 4. 344 and 1805 Syst. Antl., 306. 115; 1826 Meigen: Syst. Beschr., V. 249. 4; 1835 Macquart: Suit. a Buff., II. 393. 2.

1838 *Scatomyza lutaria* Zetterstedt: Insecta Lapp., 720. 2. and 1846 Dipt. Scand., 5. 1962. 2; 1852 Walk.: Ins. Brit. Dipt., II. 154. 4; 1864 Schiner: Fauna Austriaca, II. 17; 1866 Rondani: Prodr., VII Scatophag. 26. 3; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 169. 100; 1894 Meade: Entom. Monthly Mag., 222. 7.

6–9 mm	VII–IX	Seguy
7–9 mm	V–X	Sack
7–10 mm	–	Gorodkov
7–9 mm	III–X	Drascovits
7–10 mm	V	Cociu

World distribution: Sweden, Norway (Zetterstedt, 1846); Romania (Strobl, 1897; Thalhammer, 1899; Fleck, 1904; Cociu, 1994); France, Corsica, Great Britain, Germany, Alps 2500 m, Syria, Tunisia, North America (Seguy, 1934); Europe (Sack, 1937); Europe, Syria and North Africa (Hackman, 1956); North Africa, Syria and many countries of the Europe (Drascovits, 1981); Europe: Sweden, France, Corsica, Italy, Great Britain, Hungary, CSI: Russia, Ukraine, Moldavian Rep., western Siberia, Asia: Syria, North Africa; Tunisia (Gorodkov, 1986).

Romanian distribution: Periam (Timiș county); Bucegi Mountains, Peștera, Bușteni - Cerbului Valley, Azuga (Prahova county); Măgura Cisnădiei, Sibiu – Dumbrava, Cibin Mountains (Sibiu county); Postăvaru (Brașov county); Cloșani (Gorj county); river Dâmbovicioara gorges, Voina, Bughea de Jos, Cândești, Berevoiești (Argeș county); Valea Caselor – Câmpulung Moldovenesc, Poiana Stampei (Suceava county); Semenic Mountains, Valiug, Carașova, river Caraș gorges, river Nera gorges, Varadia (Caraș-Severin county).

6. *Scathophaga milani* (Sifner, 1981):

Syn.: 1981 *Coniosternum milani* Sifner: Acta Entom. Musei Nationalis Pragae 40:98.

6 mm	–	Sifner
6.5 mm	VI	Cociu

World distribution: Europe: Albania (Sifner, 1981); Romania (Cociu, 1994).

Romanian distribution: Putna Valley – Câmpulung Moldovenesc (Suceava county).

7. *Scathophaga obscura* (Fallen, 1819):

Syn.: 1819 *Cordylura obscura* Fallen: Scatomyzides Sveciae: 9.

5–6 mm	–	Seguy
4.5–5 mm	VI–IX	Sack
–	VI–IX	Hackman
5–6 mm	V–VIII	Sifner
4–5 mm	–	Drascovits
5.5 mm	VI, VIII	Cociu

World distribution: Sweden (Fallen, 1819); north France, Germany, Austria, Silesia, Scandinavia (Seguy, 1934); north and Central Europe (Sack, 1937); Scotland (Collin, 1958); Europe: Norway to Switzerland, Great Britain to Poland, CSI: Russia, Esthonia, Latvia, Lethonia, Ukraine, Moldavian Rep., western Siberia to Far east include Kuril is., Asia: Mongolia (Gorodkov, 1986): Romania (Cociu, 1994).

Romanian distribution: Câmpulung Moldovenesc – Valea Caselor, Putna Valley, Seacă Valley, Cârlibaba, Poiana Stampei, Dorna Cândrenilor, Brodina, Straja (Suceava county); Câmpulung-Muscel, Bughea de Jos, Brădet, Nucșoara, Berevoiești (Argeș county); Răstolița (Mureș county); Mountains Semenic, Mountains Anina, Bozovici, Sasca Montana (Caraș-Severin county); Baiului Mountains, Bușteni (Prahova county).

8. *Scathophaga scybalaria* (Linnaeus, 1758):

Syn.: 1758 *Musca scybalaria* Linnaeus: Syst. Nat. Ed. 10, 1: 599; 1781 Fabricius: Spec. Ins. II. 449. 72; 1805 Syst. Antl., 307. 118; 1788 Gmel.: Syst. Nat. V. 2853. 104.

1819 *Scatomyza scybalaria* Fallen: Dipt. Suec. Scatomyz., 3. 1; 1809 Latr.: Gen. Crust. IV. 358; 1826 Meigen: Syst. Beschr., V. 247. 1; 1830 Robineau-Desvoidy: Myod., 624. 1. and Dipt. Scand. V. 1960. 1; 1835 Macquart: Suit. a Buff., II. 392. 1; 1838, 1846 Zett.: Insecta Lapp., 720. 1. and Dipt. Scand., V. 1960. 1; 1853 Walk.: Ins. Brit. Dipt., II. 53. 1; 1864 Schiner: Fauna Austriaca, II. 17; 1866 Rondani: Prodr., VII Scatophag. 25. 2; 1894 Becker: Berlin entom. Zeitschr., XXXIX. 166. 92; 1899 Meade: Entom. Monthly Mag., 221. 4.

1958 *Scatophaga anomala* Collin: Trans. Soc. Br. Ent., 13 (3): 51.

7–10 mm	–	Seguy
8–11 mm	VII–IX	Sack
7 mm	VI	Collin
7–12 mm	–	Gorodkov
8–12 mm	VII–IX	Drascovits
12 mm	VI	Cociu

World distribution: Romania (Thalhammer, 1899; Cociu, 1994); north France, Great Britain, Germany, Prussie, Alps, Asia: Mongolia (Seguy, 1934, 1952); Europe, Asia: Mongolia (Sack, 1937); Europe, Asia: Mongolia (Hackman, 1956); Great Britain (Collin, 1958); Asia: north China, Mongolia, Siberia, Europe: Esthonia, Finlanda, Sweden, Czechoslovakia, Hungary (Drascovits, 1981); Europe, Finland to Italy, Great Britain, Hungary, CSI: Russia, Ukraine, Moldavian Rep., western Siberia to Far east, Asia: Mongolia, north China (Gorodkov, 1971, 1986).

Romanian distribution: Bucegi Mountains – Peştera (Prahova county); Grindul Roşu, Crişani, Sf. Gheorghe – Danube Delta, the Letea forest (Tulcea county).

9. *Scathophaga stercoraria* (Linnaeus, 1758):

Syn.: 1758 *Musca stercoraria* Linnaeus: Syst. Nat. Ed. 10. 1: 599; 1776 De Geer: Ins., 6. 88. 17; 1788 Gmel.: Syst. Nat., V. 2853. 105.

1794 *Musca merdaria* Fabricius: Entom. Syst. 4: 433.

1803 *Scatophaga stercoraria* Meigen: Mag. Insektenk., 2: 277.

1819 *Scatomyza stercoraria* Fallen: Dipt. Suec. Scatomyz., 4. 3; 1826 Meigen: Syst. Beschr. V. 248. 2; 1830 Robineau-Desvoidy: Myod., 627. 7; 1835 Macquart: Suit. a Buff., II, 393. 5; 1838 Zetterstedt: Insecta Lapp. 721. 3 and 1846 Dipt. Scand., 5. 1968. 7; 1853 Walk.: Ins. Brit. Dipt., II, 153. 2; 1864 Schiner: Fauna Austriaca, II. 18; 1866 Rondani: Prodr. VII Scatophag., 25. 1; 1880 Holmgr.: Entom. Tidskr., 173. 351; 1894 Becker: Berlin. entom. Zeitschr. XXIX. 169. 100; 1899 Meade: Entom. Monthly Mag., 220. 1; 1900 Becker: Acta Soc. scient. Fenn., XXVII. 53. 102.

1926 *Scatophaga asticha* Szilady: Annls hist. nat. Mus. natn hung., 24: 594.

1926 *Scatophaga nigricans* Szilady: Annls hist. nat. Mus. natn. hung. 24: 595.

1937 *Scopeuma alpestre* Sack: 62 a. Fliegen pal. Reg., 7: 58.

9–11 mm	IV	Seguy
5–10 mm	IV–X	Sack
5–10 mm	–	Hackman
5–10 mm	–	Gorodkov
6–12 mm	IV–X	Sifner
7–12 mm	III–XI	Cociu
5–10 mm	III–XI	Drascovits

World distribution: Romania (Strobl, 1897; Thalhammer, 1899; Szilady, 1926; Worell, 1945; Hannenheim, 1935; Dobreanu, 1962; Cociu, 1980, 1994, 1995); Hungary, Tunisia, Kaukasus (Szilady, 1926); Norway, Lapland, Island (Gaimard, 1837), North America (Seguy, 1937); Africa, Asia, Europe, North America (Drascovits, 1981); Afghanistan (Sifner, 1969); Europe, Asia, Africa, North America includes Mexico (Gorodkov, 1986).

Romanian distribution: Câmpulung Moldovenesc, Rarău Mountains peak, Călimani Mountains, Solca, Rădăuţi, Brodina, Vicovul de Sus, Dorna Cândrenilor, Vatra Dornei, Sarul Dornei, Poiana Stampei, Cârlibaba, Iacobeni, Crucea, the Adâncata forest, Dragomirna, Giumalău Mountains (Suceava county); Mangalia, the Hagieni forest (Constanţa county); Babadag, Letea, Sf. Gheorghe, Sulina, Casimcea forests (Tulcea county); Peştera, Potoci, Sinaia, Buşteni, Azuga, Breaza (Prahova county), Predeal, Bran, Postăvaru (Braşov county); Albeşti, Nucşoara, Berevoieşti, Cândeşti, Vidraru, Brădet, Brădulet, Muşeteşti, Voina, Goleşti (Argeş county); Beiuş (Bihor county); Băile Olăneşti, Horezu, Călimăneşti (Vâlcea county); river Sohodol gorges, Tismana, Hobiţa Valley, Cloşani (Gorj county); Baia de Aramă, Orşova (Mehedinţi county); Băile Herculane, river Corcoaiei gorges, Sirina Valley, Ieşelniţa, Mehadia, Berzasca, Moldova Nouă, Naidas, Varadia, Valiug, Semenic Mountains, Caraşova, river Caraş gorges, river Nera gorges, Sasca Română, Sasca Montana (Caraş-Severin county); Ghiroda Veche (Timiş county); Gura Zlata, Gemenele (Hunedoara county); Orlat, Dumbrava, Trei Stejari (Sibiu county); Răstoliţa (Mureş county), Sângiorz Băi, Măgura Ilvei, Maieru (Bistriţa Năsăud county); Tuşnad, Miercurea-Ciuc, Sf. Ana Lake (Harghita county); Zalău, Jibou, Şimleul Silvaniei (Sălaj county); Dorohoi, the Dorobanţi forest (Botoşani county); Bicaz (Neamţ county); Trotuş Valley, Slănic Moldova, Târgu Ocna (Bacău county); Nehoiu (Buzău county); the Râioasa forest, Oinacu (Giurgiu county); the Ciolăneasa forest, Nanov, Drăgăneşti, Purani (Teleorman county); Budeşti, Comana, Pasărea, Cernica, Băneasa, Crevedia, Mogoşoaia, Căldăruşani, Andronache, Chitila, Periş, Dragomireşti, Baloteşti, Snagov, Săftica, the Tunari forest (Ilfov county); Bucureşti; Căscioarele (Călăraşi county); Drăgăneşti, Scorniceşti (Olt county); Dealul Clujului (Cluj county).

10. *Scathophaga suilla* (Fabricius, 1794):

Syn.: 1794 *Musca suilla* Fabricius: Entom. Syst., 4. 343. 129.

1819 *Scatomyza suilla* Fallen: Dipt. Suec. Scatomyz., 3. 2.

1826 *Scatomyza spurca* Meigen: Syst. Beschr., 5: 250.

1835 *Scatomyza incisa* Macquart: Suit. a Buff., II. 394. 10.

1838 *Scatomyza glabrata* Zett.: Insecta Lapp., 721. 5.

1838 *Cordylura scatomyzoides* Zett.: Insecta Lapp., 727.

1839 *Scatophaga serotina* Perris: Annls Soc. Ent. Fr., 8: 48.

1848 *Scatomyza suilla* Zett.: Dipt. Scand., V; 1965. 5; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 169. 94 and 1900 Acta Soc. scient. Fenn., XXVI. 53. 103.

5–11 mm	VI–VIII	Seguy
7 mm	IV–IX	Sack
4.5–5 mm	–	Hackman
4.5–7 mm	–	Gorodkov

6–8 mm	–	Drascovits
4.5–7 mm	V–XI	Cociu

World distribution: Norway, Sweden (Zetterstedt, 1838); Romania (Thalhammer, 1899; Worell, 1953; Cociu, 1980, 1995); France, Alps 2100 m, Arkhangelsk, Siberia, Lapland, Alaska, North America, Great Britain (Seguy, 1934); Central and northern Europe, Siberia (Sack, 1937); Scotland (Collin, 1958); North America, Asia, Europe (Drascovits, 1981); Syria (Sifner, 1981); Europe: Sweden, Finland, Great Britain to Czechoslovakia, Alps, CSI: Russia, Ukraine, Moldavian Rep., Kazakstan and Uzbekistan, Tadzhikistan, Kirchizia, Turkmenia (mountains), western Siberia to eastern Siberia, Asia: Mongolia, North America: Alaska to Quebec (Gorodkov, 1986).

Romanian distribution: Turnişor – Cibin, Dumbrava – Sibiu (Sibiu county); Valea Caselor, Podul Bucătarului, Seacă Valley – Câmpulung Moldovenesc, Putna Valley, Cârlibaba, Vatra Dornei, Dorna Cândrenilor (Suceava county); Matiţa, Merhei, Sf. Gheorghe (Tulcea county); Cloşani (Gorj county); Ieşelniţa, Orşova, Isverna, Baia de Aramă (Mehedinţi county); Braşov (Braşov county); Sasca Montană, Nera Valley, Bozovici, river Caraş gorges (Caraş-Severin county); river Dâmbovicioara gorges, Berevoieşti, Cândeşti, Albeşti (Argeş county); Gura Zlata (Hunedoara county); Buşteni, Sinaia – Cota 2000, Azuga, Peştera (Prahova county).

11. *Scathophaga taeniopa* (Rondani, 1867):

Syn.: 1867 *Scatophaga taeniopa* Rondani: Dipt. Prodromus, 7: 111.
1894 *Scatophaga ordinata* Becker: Berlin. Entom. Zeitschr., 39 (1): 178.

7 mm	–	Seguy
7–8 mm	VI–VIII	Sack

World distribution: Romania (Fleck, 1904); Italy, Switzerland, Great Britain, Alps (Seguy, 1934); Central and south Europe (Sack, 1937); Europe: Apls, Austria, Switzerland, Italy, Czechoslovakia, CSI: Russia, Ukraine, Moldavian Rep., Kazacstan, eastern Siberia, Fae east, Asia: Mongolia, China (Gorodkov, 1986).

Romanian distribution: Podul Bucătarului, Valea Caselor, Poiana Stampei, Dorna Cândrenilor, Cârlibaba (Suceava county); Câmpulung Muscel, river Dâmbovicioara gorges, Berevoieşti, Nucşoara, Brădet, Muşeteşti (Argeş county); Buşteni, Azuga – Baiului Mountains (Prahova county); Răstoliţa – Gălăoaia, Cofu (Mureş county); Păltiniş, Onceşti mountain peak, Gâtul Berbecului, Poiana Sibiului (Sibiu county); Colibiţa (Bistriţa Năsăud county); Semenic Mountains, Valiug, Carasova, Sasca Montană, Bozovici (Caraş-Severin county).

Genus *Hydromyza* Fallen, 1823

Syn.: 1823 *Hydromyza* Fallen: Dipt. Suec. Hydromyz., 1. 1.
1830 *Nupharia* Robineau-Desvoidy: Myod., 78. 5. 1.

1. *Hydromyza livens* (Fabricius, 1794):

Syn.: 1794 *Musca livens* Fabricius: Entom. Syst., 4: 345. 135.
1823 *Hydromyza livens* Fallen: Dipt. Suec. Hydromyz., 1. 1; 1826 Meigen: Syst. Beschr., V. 243. 31; 1835 Macquart: Suit. a Buff., II. 386. 7.
1830 *Nupharia rivularis* Robineau-Desvoidy: Essai Myod.: 785.
1846 *Cordylura livens* Zett.: Dipt. Scand., V. 2035. 34; 1864 Schiner: Fauna Austriaca, II. 14; 1878 Gercke: Verf. d. Vereins f. nat. Unterh. Hamburg, V. 229; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 135. 63. t VI. 7-8; 1899 Meade: Entom. Monthly Mag., 175. 1.

6–8 mm	–	Seguy
9 mm	V–VIII	Sack
8–10 mm	VI, VII	Sifner
6–9 mm	–	Drascovits

World distribution: France, Prussia, Germany, Austria, Sweden, Great Britain (Seguy, 1934); Central Europe (Hackman, 1956); north and south Bohemia, Moravia (Sifner, 1969); north Europe, Czechoslovakia and the European part of the URSS (Drascovits, 1981); Central and north Europe, Siberia (Sack, 1937); Europe: Sweden to Austria, Great Britain, Poland, CSI: Russia to Ukraine, Moldavian Rep. (Gorodkov, 1986).

Romanian distribution: Sahalin, Sf. Gheorghe (Tulcea county).

Subfam. Delininae

Genus *Parallelomma* Becker, 1894

Syn.: 1894 *Parallelomma* Becker: Berlin. entom. Zeitschr., XXXIX. 94. 11.
1830 *Mosina* Robineau-Desvoidy: Myod., 673. 7.

1. *Parallelomma albipes* Fallen, 1819:

Syn.: 1819 *Cordylura albipes* Fallen: Dipt. Suec. Scatomyz., 9. 8; 1826 Meigen: Syst. Beschr., V. 255. 8; 1835 Macquart: Suit. a Buff., II. 383. 10; 1838 Zett.: Insecta Lapp., 726. 5; 1853 Walk.: Ins. Brit. II. 150. 2; 1864 Schiner: Fauna Austr., II. 4; 1866 Rondani: Prodr., VII Scatophag. 4. 4; 1872 Kaltenb.: Pflanzenf., 714. 1; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 95. 16; 1899 Meade: Entom. Monthly Mag., 172. 8.
1830 *Mosina filipes* Robineau-Desvoidy: Myod., 673. 7.
1838 *Cordylura bilineata* Meigen: Syst. Beschr., 7. 340; 1902 Becker: Zeischr. f. Hymenopt. n. Dipt., II. 216. 38.

5–7 mm	IV–X	Seguy
5–7 mm	IV–X	Sack
5–7 mm	–	Gorodkov
6–9 mm	V–IX	Sifner

5–7 mm	V–VII	Drascovits
5–7 mm	V–IX	Cociu

World distribution: Romania (Thalhammer, 1899; Cociu, 1995); France, Corsica, Prussia, Sweden, Austria, Italy, Germany, Great Britain (Seguy, 1934); Europe, Siberia (Sack, 1937); Europe and Siberia (Hackman, 1956); England, Scotland (Collin, 1958); Bohemia, Moravia (Sifner, 1965); Europe, Siberia, Asia: Mongolia (Drascovits, 1981).

Romanian distribution: Băile Herculane, Domogled, river Corcoaiei gorges, Nera Valley, Cârpa (Caraş-Severin county); Buşteni, Azuga (Prahova county); Câmpulung-Muscel – Flamânda, Bughea de Jos, Berevoieşti, Nucşoara, Brădet (Argeş county); Păltiniş, Onceşti Mountain peak, Gâtul Berbecului (Sibiu county).

Genus *Phrosia* Robineau-Desvoidy, 1830

Syn.: 1805 *Ocyptera p.p.,* Fabricius: Syst. Antl., 315. 11.
1830 *Phrosia* Robineau-Desvoidy: Essai Myod.: 668.

1. *Phrosia albilabris* (Fabricius, 1805):

Syn.: 1805 *Ocyptera albilabris* Fabricius: Syst. Antl., 315. 11.
1826 *Cordylura albilabris* Meigen: Syst. Beschr., V. 233. 7; 1835 Macquart: Suit. a Buff., II. 282. 8; 1846 Zett.: Dipt. Scand., V. 2003. 8; 1864 Schiner: Fauna Austr., II. 4; 1866 Rondani: Prodr., VII Scatophag., 14. 5; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 97. 20. t IV. f. 4. 5.
1830 *Phrosia scirpi* Robineau-Desvoidy: Essai Myod.: 669. 1.

7–8 mm	V–X	Sack
6–8 mm	V–X	Seguy
–	VI–VII	Hackman
6–8 mm	V–IX	Drascovits
6–8 mm	V–VIII	Cociu

World distribution: Romania (Thalhammer, 1899; Cociu, 1995); France, Germany, Prussia, Algeria (Seguy, 1934); Central and south Europe (Sack, 1937); Central and southern Europe (Hackman, 1956); Europe (Drascovits, 1981); Europe: Sweden, Finland to Austria, France to Hungary, CSI: Russia, Ukraine, Moldavian Rep. (Gorodkov, 1986).

Romanian distribution: Jibou, Uliacul Şimlăului (Sălaj county), Taşnad (Satu Mare county); Băile Herculane, Domogled, Nera Valley, Cerna Valley, Semenic Mountains, the Cârpa river (Caraş-Severin county); Buşteni – Cerbului Valley, Azuga – Baiului Mountains, Sinaia – Cota 2000, Peştera (Prahova county); Gura Zlata (Hunedoara county); Cloşani, Tismana (Gorj county); Baia de Aramă (Mehedinţi county); Câmpulung-Muscel, Bughea de Jos, Albeşti, Cândeşti, Lereşti, Voina, Nucşoara, Brăduleţ, Berevoieşti (Argeş county).

Genus *Delina* Robineau-Desvoidy, 1830

Syn.: 1830 *Delina* Robineau-Desvoidy: Essai Myod.: 669.

1835 *Cleigastra* Macquart: Suit. a Buff., II. 384. 6.

1. *Delina antrax* (Schiner, 1864):

Syn.: 1864 *Cleigastra antrax* Schiner: Fauna Austr., 2: 11; 1894 Becker: Berlin. entom. Zeitschr., XXXIX. 181. 118.

7.5–8 mm	–	Seguy
7–8 mm	VI–VIII	Sack
6–8 mm	V–VII	Sifner

World distribution: Romania (Thalhammer, 1899; Fleck, 1904); Central Alps (Seguy, 1934); Alps (Sack, 1937); Europe: Alps (Gorodkov, 1986).

Romanian distribution: Cibin Mountains, Păltiniş – Onceşti mountain peak, Gâtul Berbecului (Sibiu county); Câmpulung-Muscel – Flămânda, Bughea de Jos, Cândeşti, Albeşti, Voina, river Dâmbovicioara gorges, Nucşoara, Berevoieşti (Argeş county); Peştera (Prahova county); Călimani Mountains, Vatra Dornei, Dorna Cândrenilor (Suceava county).

2. *Delina veratri* (Hendel, 1925):

Syn.: 1925 *Clidogastra veratri* Hendel: Konowia, 4 (5): 301.

5–6 mm	–	Seguy
5–6 mm	V–IX	Sack
5.5–6.5 mm	VI–VIII	Cociu

World distribution: Romania (Fleck, 1904; Dobreanu, 1937; Cociu, 1975); Central Europe (Sack, 1937); Europe, Austria (Gorodkov, 1986).

Romanian distribution: Bucegi Mountains – Jepii Mari, Jepii Mici, Baiului Mountains – Azuga, Peştera, Piatra Arsă (Prahova county); Păltiniş – Onceşti mountain peak, Gâtul Berbecului (Sibiu county); Călimani Mountains (Suceava county).

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TAXONOMICAL RESEARCH ON ROMANIAN CHIRONOMID FAUNA

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This paper presents the imago taxonomical descriptions of the following species: *Cricotopus (Cricotopus) caducus* Hirvenoja, 1973, *Cricotopus (Cricotopus) septentrionalis* Hirvenoja, 1973, *Limnophyes prolongatus* (Kieffer in Thienemann, 1921). These descriptions are made on individuals sampled from Romania.

The Orthocladiinae subfamily (Diptera: Chironomidae) comprises some species rich genera among which *Cricotopus* and *Limnophyes*. These genera are speciouse too in the Romanian chironomid fauna. The taxonomical research, realized on imago samples, has been started by Paula Albu (1, 2, 3, 4) and continued by us (11, 12).

The aim of this paper is to complete the existent information by presenting the diagnosis of other three species. Simultaneously, we like to notice that *Cricotopus (Cricotopus) septentrionalis* is cited for the first time in our fauna.

CRICOTOPUS (CRICOTOPUS) CADUCUS HIRVENOJA, 1973

Male. Head: black, especially posterior; eyes: blackish, big; palp: black; palp length (μ): 36; 72; 88; 110. Antennae: brownish black; scapus: black. AR = = 0.59–0.62.

Thorax: generaly light; mesonotal stripes, postnotum and a very little part of ventral sternal pleura: brownish; scutelum and metathorax pleural sclerite: lighter. Chaetotaxy: Dm: 8; Dl: 6; Sc: 12.

Wing: 1.46 mm (squama included); 1.24 mm (till the arculus); C more than R_{4+5} as long as r-m; A straight, almost near fCu; $VR_{Cu} = 1.04$; squama with 6 hairs; anal lobe slightly undeveloped; halteres light brown.

Legs: light yellow or light brown; all tibia with one well defined spur; the second spur on PII and PIII tibia very small, almost invisible; pulvilli absent; length and proportions of legs (μ):

	fe	t	ta_1	ta_2	ta_3	ta_4	ta_5	LR
PI	517	602	320	179	132	85	85	0.53
PII	404	508	179	94	71	47	66	0.35
PIII	517	555	235	141	113	56	66	0.42

Abdomen: light brown; tergites with a light margin; anterior sternites with dark spots, the last ones sometimes completely dark; abdominal median bristles generally absent, the lateral ones well represented.

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Hypopygium (Fig. 1) brown; anal point absent; tergum IX with about 20 hairs; basal lobe distal rounded; styls short; crista dorsalis rounded.

Geographical spreading: Palearctic Region (Finland, Greece, Yugoslavia).

In Romania: Portița; Chirnogi.

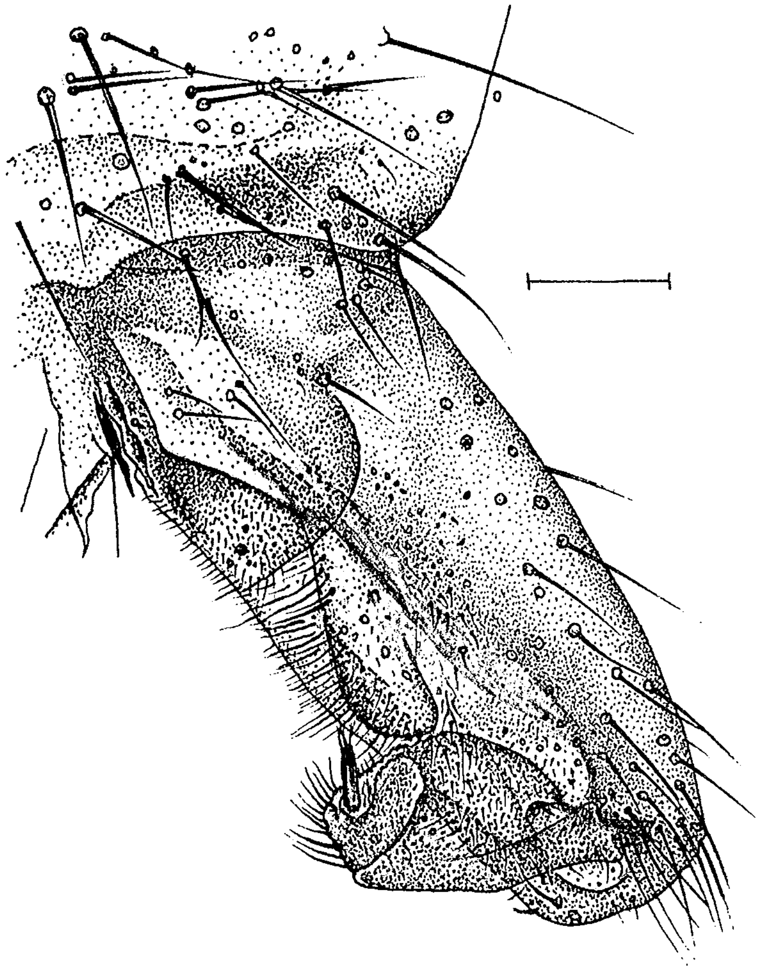

Fig. 1. – Hypopygium of *Cricotopus (Cricotopus) caducus* Hirvenoja, 1973 (scale line = 50 μ).

CRICOTOPUS (CRICOTOPUS) SEPTENTRIONALIS HIRVENOJA, 1973

Male. Head: brown; eyes: black, especialy anterior, relatively small, hairy; palp: light brown; palp length (μ): 55; 101; 120; 182. Antennae: brown; scapus: dark brown; antennal plume undeveloped, formed with very thin hairs; AR = 1.47.

Thorax: yellow; mesonotal strips, scutelum, postnotum: dark brown. Chaetotaxy: Dm 20–22; Sc over 20.

Wing: 2.95 mm (squama included); 2.55 mm (till the arculus); anal lobe well developed, rounded. R_{4+5} exceeds C, more than r-m; An over fCu; VR = 1.12; squama with 14–16 hairs; halteres light.

Legs: brown; proximal femura yellow; tibia with light rings on PI; PI tarsal articles 4 and 3/4 of 3 dark brown; on PII and PIII the rings are yellowish; sensitive hairs on proximal 1/4 of tarsal articles 1 on PIII; pulvilli absent; legs articles length (μ):

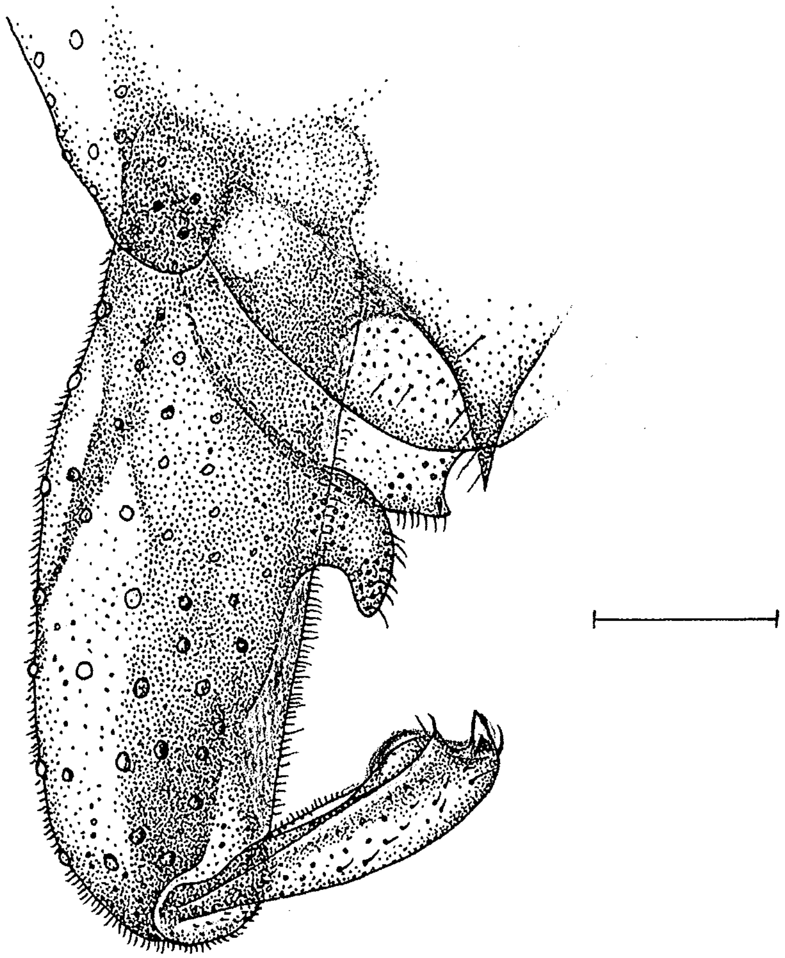

Fig. 2. – Hypopygium of *Cricotopus* (*Cricotopus*) *septentrionalis* Hirvenoja, 1973 (scale line = 50 μ).

	fe	t	ta_1	ta_2	ta_3	ta_4	ta_5	LR
PI	874	1090	771	432	301	225	141	0.68
PII	940	968	470	291	207	160	147	0.48
PIII	921	1175	649	357	373	179	141	0.57

Abdomen: yellow greenish; anterior tergites dark.

Hypopygium (Fig. 2): distal light, with anal point short, but strong; tergum IX with about 15 hairs; basistyle as broad as long; basal lobe of the basistyle slightly curved; crista dorsalis straight, with spurs.

Geographical spreading: Palearctic Region (Finland, Norway).

In Romania imago Sinaia. Larval and pupae stadies unknown. The species is cited for the first time in Romania.

Biology: cold running waters.

Fly period: May – September.

LIMNOPHYES PROLONGATUS (KIEFFER IN THIENEMANN, 1921)

Male. Head: dark brown, almost black; eyes: black, relatively small, unhairy, omatid diametre 10 μ. Palp: with macrotrichs, brown; palp articles length (μ): 34; 85; 72; 119. Antennae: 13 articles, the last one slightly broad; flagelum: dark brown; antennal plum: dark brown; scapus: black; AR = 0.62.

Thorax: brown; humeral pit: small; mesonotum: with many spreaded hairs; prescutelar and humeral area with spread hairs.

Wing: 1.67–1.90 mm; with distinct microtrichia; 6–8 macrotrichs present on R; R_1 unhairy; C more than fCu; R_{4+5} exceeds Cu_1; Cu_2 slightly curved, sinuous; An near fCu; squama with 4–6 hairs; anal lobe undeveloped, very bevelled, rounded.

Legs: brown; on PI the tarsal 4th article longer than tarsal 5th one; on PII and PIII the tarsal 4th articles shorter; length and proportions of the legs (μ).

	fe	t	ta_1	ta_2	ta_3	ta_4	ta_5	LR
PI	542	603	339	184	158	86	76	0.54–0.55
PII	545	564	247	136	105	67	72	0.40–0.49
PIII	507	668	320	193	146	79	79	0.43–0.47

Abdomen: brown.

Hypopygium: (Fig. 3) with macrotrichs; inner lobe small, fingered, with 2–3 strong hairs; terminal article: proximal globular, with long thin peak; anal tergum with anal point almost invisible.

Geographical spreading: Palearctic Region (Austria, Belgium, Germany, Great Britain, Ireland, I.S.C. – Central European territory); Asian Region (Japan, Madeira).

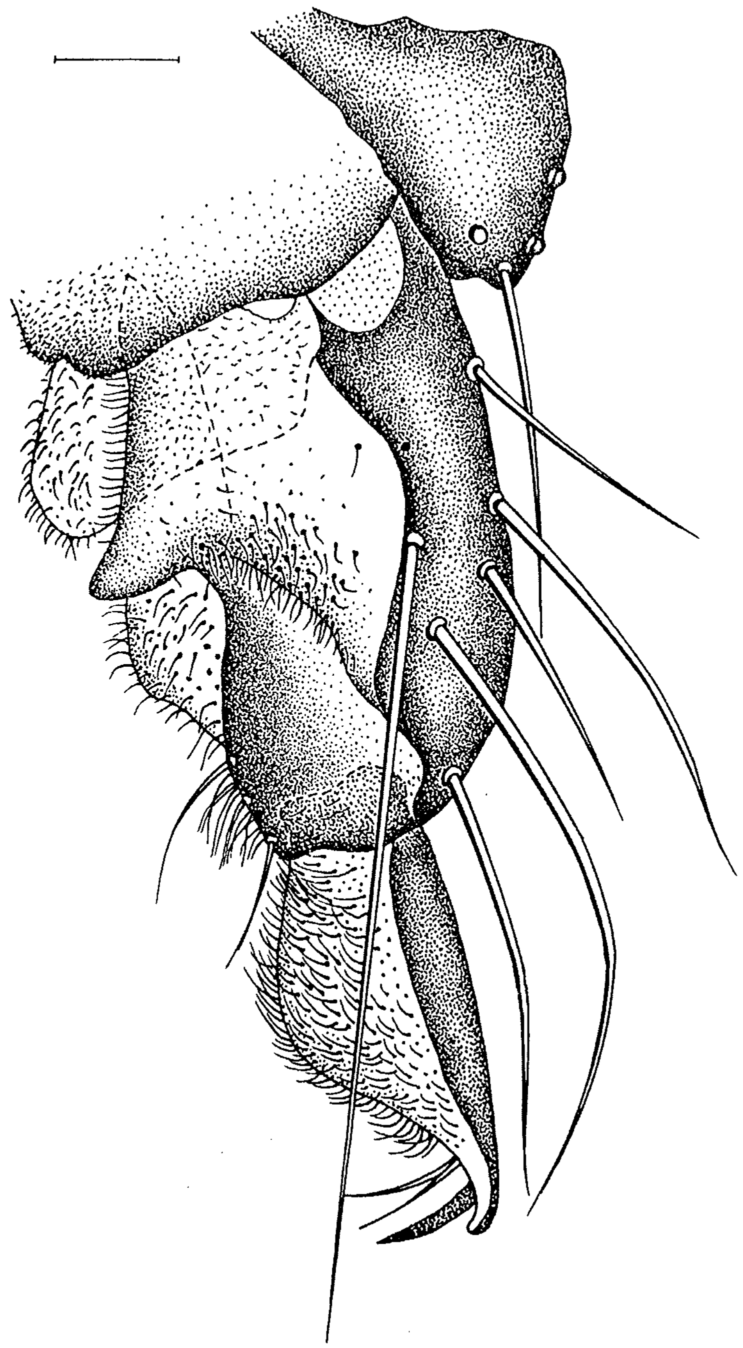

Fig. 3. – Hypopygium of *Limnophyes prolongatus* (Kieffer in Thienemann, 1921) (scale line = 25 μ).

In Romania: imago (Bucura, Gura Zlata – Retezat); larval (Iron Gates, Danube Delta, Jiu, Olt, Prahova).

Biology: Larva phytophilous.

Fly period: June, July, September.

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COBITIS ELONGATA HECKEL AND KNER, 1858 (PISCES: OSTARIOPHYSI: COBITIDAE): DISTRIBUTION, RELATIONSHIPS, GEOGRAPHICAL VARIATION AND PROTECTION STATUS

PETRU M. BĂNĂRESCU, TEODOR T. NALBANT

The loach *Cobitis elongata* has been described by Heckel and Kner (11) after specimens believed to have been collected in the river Sala, a tributary of Soca (Isonzo) on the Adriatic Sea watershed, present in Slovenia and Croatia. This nominal species was believed, during almost a century, to be a synonym of the central European species *Cobitis taenia* Linnaeus. S. Karaman (12) was the first to assert 94 years after the description of *elongata*, that this is a distinct species from *taenia*. He collected specimens of *elongata* in the upper part of river Sava (Danube catchment area) and in its tributary, the river Kupa. He mentioned some distinctive characters (large size,small suborbital spine, well-developed mental lobes, disposition of spots on the body, but neither biometric values nor illustrations).

The first scientific revalidation of *elongata* was made by Bănărescu and Nalbant (7) based on 33 specimens collected in the river Nera, a northern tributary of the middle Danube, in the southern Banat, Romania. Their study comprises biometric tables illustrations of good quality and comparison with presumed related species. Supplementary data were furnished by Bănărescu (2).

The species was later recorded in Bulgaria by Marinov (16) from the river Rossitza, in the basin of Iantra (lower Danube catchment) and in Jugoslavia by Sorić (19) from the whole basin of Morava, also a southern tributary of the middle Danube. The latter contribution also comprises morphological and biological data, biometric tables and illustrations.

Cobitis elongata is presently unanimously recognized as valid species being listed in catalogs and books, both scientific and popular (see 5, 6, 13) and in the list of threatened fishes of Europe (14) and Romania (3).

The main aim of present contribution is to establish:

1. the general range of *Cobitis elongata*;
2. its systematic position within the genus;
3. its geographic variation;
4. its protection status, mainly in Romania.

MATERIAL

The specimens examined for the present study belong to the following institutions and collections: Institute of Biology, Bucureşti (ISBB), Natural History Museum, Wien (NMW), Natural History Museum Hamburg (HZM), American

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Museum of Natural History, New York (AMNH), Natural History Museum, Torino (MSNT), The Ichthyological Collection of the Department of Zoology, Hacettepe University, Ankara (HUA), Field Museum of Natural History, Chicago (FMNH) and Natural History Museum, Geneve (MHNG).

Cobitis elongata Heckel and Kner, 1858. ISBB 1618, 1948, 2529, 2860, 3613, 4021, more than 60 specimens 63–144 mm SL, Romania, river Nera, Sasca Montana. ISBB 3614 one specimen 97 mm SL river Jiu, Pestcana de Jiu. NMW 48610, two syntypes of the species, see discussion below for the type locality.

Cobitis bilseli Battalgil, 1942. All specimens came from Turkey: Central Anatolia, Beyshehir Lake. MSNT 3948, one 195 mm SL. HZM 1929, one 174 mm SL. ISBB uncat., one 155 mm SL. HUA uncat., four 169–182 mm SL.

Cobitis macrostigma Dabry de Thiersant, 1872. All specimens come from China: Hupeh Prov., Chanjiang (Yangtsekiang) catchment. AMNH five specimens 75–146 mm SL. ISBB uncat., two 131–137 mm SL. FMNH 14807, three specimens, 78–97 mm SL.

Cobitis calderoni Băcescu, 1961. All specimens examined come from Spain: Zamora Prov., Lago de Sandin de Carbaleda. MHNG 1247, six 40–59 mm SL. ISBB 2774, two 54 and 63 mm SL.

GENERAL RANGE OF *COBITIS ELONGATA*

The species was described on the basis of specimens believed to have been collected from Sala river, a tributary of river Soca (Isonzo) on the Adriatic watershed of Istria (11). All later records of this species are from rivers belonging to the drainage area of the Danube (see 7, 8, 17, 19). These data suggested that the range of *elongata* comprises the basins of two rivers, i. e. Soca and Danube, whose fish faunas are in general unsimilar S. Karaman (12) explained that this distribution has resulted from subterranean connections between both riverine drainages. Later he thought that the specimens of Heckel and Kner have been collected in the upper reach of river Sava, a tributary of the Danube and were mislabelled (in litt., January 9, 1957). Unfortunately, Karaman never published this opinion, which has been briefly mentioned by Bănărescu and Nalbant (7) in a footnote, p. 290.

The senior author of this paper has examined in Vienna, together with late Dr. W. Hacker, the former curator of fishes of the museum, the two syntypes of *elongata*, both females (the three other specimens in the same jar proved to be from *taenia* group of species): the largest speciemn of *elongata* (NMW 48610-1), 135,5 mm SL, is here declared as lectotype. The original label in the jar bears the mention: "Save, Krain" (Save being the German name of the river Sava, and Krain, the name of a county which is extended in the drainage area of both Sava and Isonzo (Soca) rivers. This original mention was cut through a line and then replaced by the mention "Sale in Krain bei Istria". However, in the register of the collection it is mentioned that these speciemens have been acquired together with specimens

of other three typical Danubian species which are absent in the Adriatic watershed (i. e. Sala river, Soca drainage): *Gobio uranoscopus, Salmo hucho (=Hucho hucho)* and *Aspro vulgaris (= Zingel streber)*. This fact definitively proves that both syntypes of *elongata* were collected in the river Sava, whose upper reach flows, similarly to that of Sala river, through the Krain county. What Stanko Karaman supposed is proved.

Hence *elongata* is endemic to the Danube river basin, having even a relatively large distribution. However, in Romania the range of this species is restricted to the river Nera, in Banat and the river Jiu in its upper most part, in Oltenia (western Vallachia). Unfortunately, in the latter point, *elongata* became extinct. The species is present in several southern tributaries of the Danube: river Sava in Slovenia and Croatia (and perhaps in Serbia too), basin of Morava in Serbia (19), river Vit (specimens in the collection of the zoological Institute of Bulgarian Academy of Sciences, collected in August 22, 1926) and in the Rossita river, Iantra drainage, lower Danube basin. Both Vit and Iantra are in Bulgaria. The junior author thinks that *Cobitis elongata* could be present also in the middle Danube tributaries, such as Drava, Una, Vrbas, Dvina and Bosna but it is confounded with *Cobitis "taenia"* (i. e. *danubialis* Băcescu, 1992).

PHYLOGENETIC RELATIONSHIPS OF *COBITIS ELONGATA*

In the original description of *Cobitis elongata* (9) and in the further contributions (2, 7, 8, 10) to this species, there are mentioned a number of differences between it and *"taenia"* (i. e. *danubialis*) such as larger size or more elongate body, small suborbitar spine, oblique position of the black spot at the caudal base, long mental lobes on the lower lip, less developed intermediary pigmentation between the dorsal and lateral spots (i. e. the Gambetta's pigmentary zones I, II, and III) and above all, absence of the *Canestrini's scale* or *lamina circularis* at the level of second pectoral ray in male specimens. The latter character justifies the establishment by Băcescu (1) of the subgenus *Acanestrinia* for *elongata*.

Bănărescu and Nalbant (7) suggested that *elongata*, on the basis of the above mentioned characters, may be related to three loaches present in the Asian areas, very distant from the Danube basin: *biseli* from Turkey, Central Anatolia in the lake Beyshehir, *macrostigma* from China, in Chanjiang (Yangtse) drainage and so-called "*Cobitis taenia sibirica* var. *elongata*" briefly recorded by Berg (9, p. 894) in the lake Kossogol (Hubsugul) Mongolia. We have concluded that *macrostigma, bilseli* and Mongolian var. *elongata* from Hubsugul, are subspecies of European *elongata*. Having later the opportunity to study more specimens from the three presumed relatives of *elongata*, we arrived at a different conclusion.

The so-called *Cobitis taenia sibirica* var. *elongata*, known from a single specimen in the collection of the Zoological Institute of the Russian Academy of Sciences, in Sankt Petersburg (ZIAN) from Hubsugul, examined by the senior author, actually belongs to *Cobitis granoei* Rendahl, 1935, in fact to *Cobitis melanoleuca* Nichols, 1925 (see Nalbant, 18).

Cobitis biseli bears much similarity with *elongata*, having a large size, even much larger than *elongata*, up to 200 mm SL, and therefore an elongate and stout

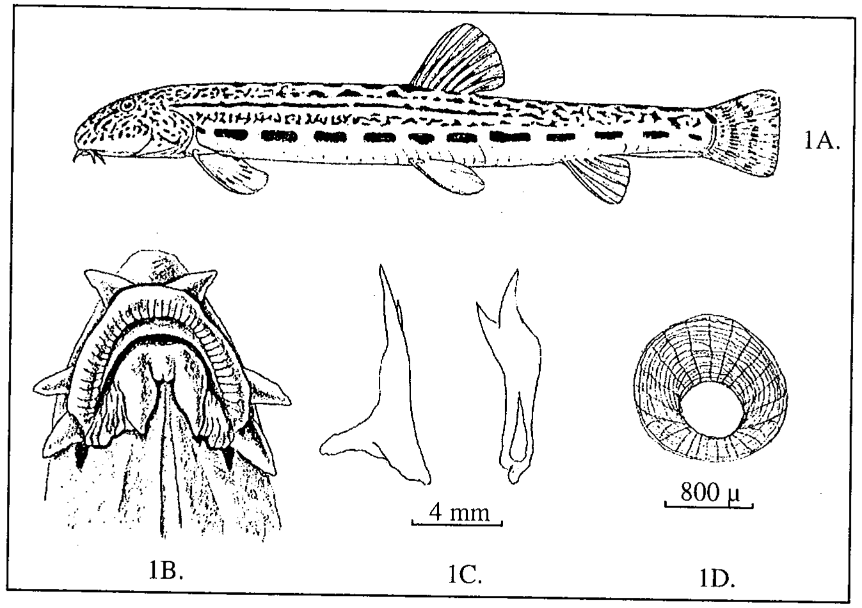

Fig. 1

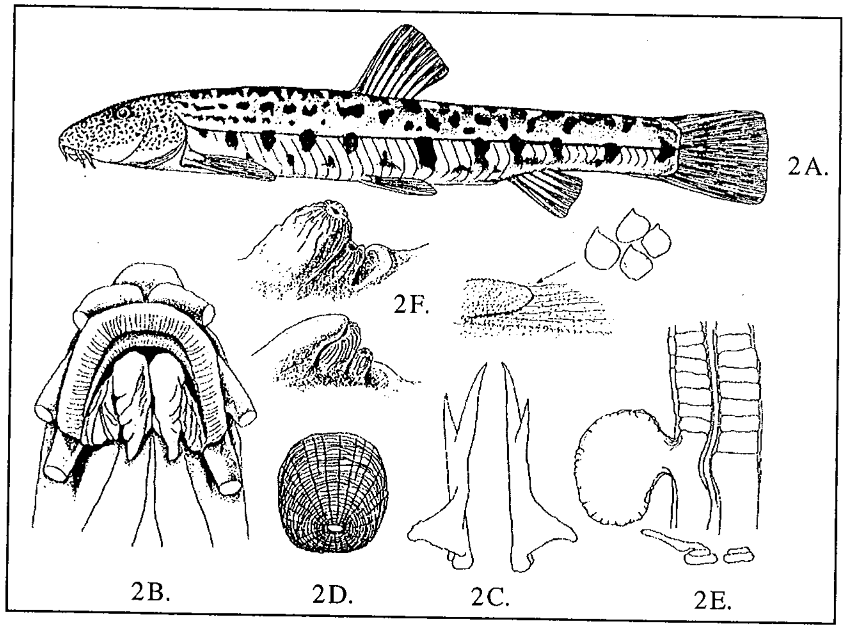

Fig. 2

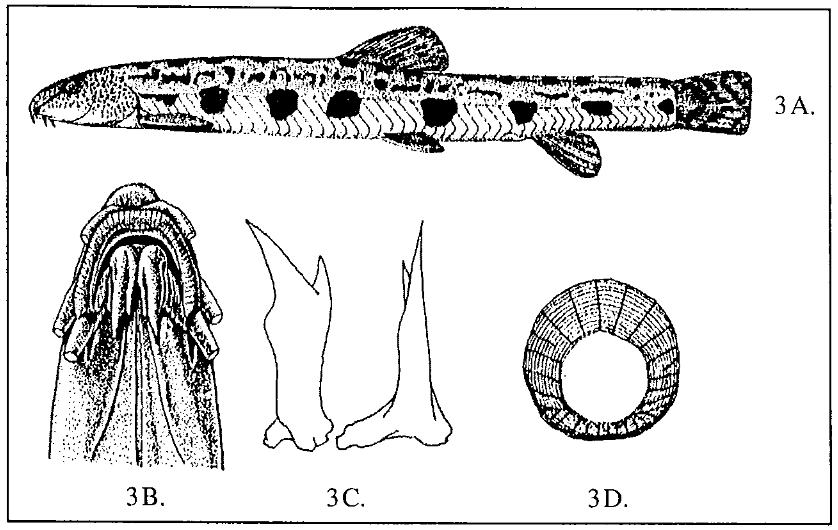

Fig. 3

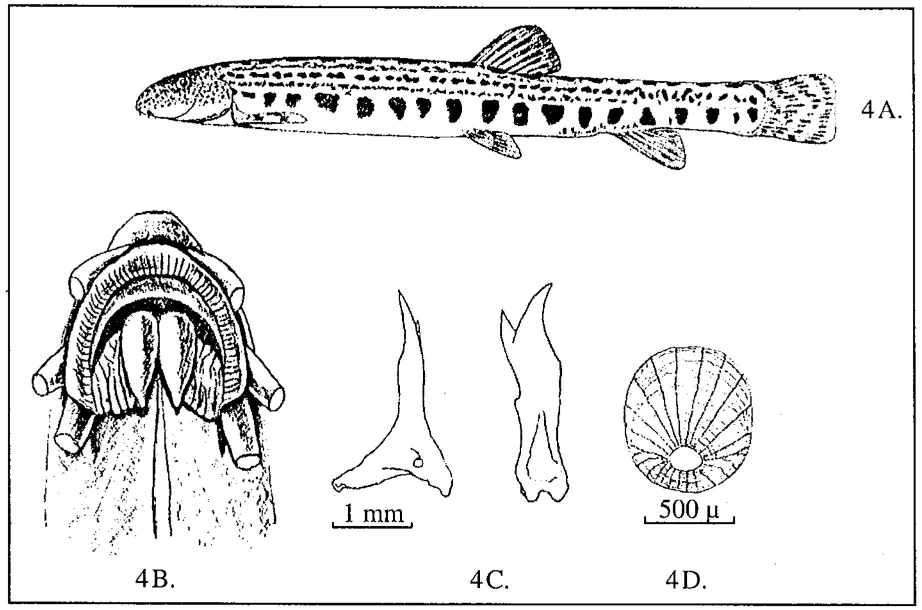

Fig. 4

body, a similar disposition of the body spots, an oblique spot at the base of caudal fin but this spot being however brownish and not black and longer mental lobes on the lower lip (Fig. 2 B). But the scales of *bilseli* differ very much from those of *elongata* because they have a small and eccentric focal zone (compare Figs. 1 D with 2 D). Most important of all, in the males of *bilseli* there is a well developed and osseous *lamina circularis* or *Canestrini's scale* at the base of the second pectoral ray (Fig. 2 E). It is obvious that *bilseli* and *elongata* are unrelated, their common characters resulting through convergence (homoplasy).

Cobitis macrostigma has about the same size as *elongata*, a similar oblique black spot at the base of caudal, long mental lobes of the lower lip (even longer and narrower than in *elongata*, see Fig. 3 B), rather round and similar scales with a large and almost central focal zone (Fig. 3 D) and a relative small suborbital spine (Fig. 3 C). The spots on the sides of body are fewer than in *elongata* (Fig. 3 A) and round not elongate (compare with Fig. 1 A). The intermediate pigmentation is reduced in *macrostigma,* lacking the Gambetta's zones I and III. It is very interesting that in *macrostigma* the anal-genital orifices are far from the anal fin, which represent an apomorphy (autapomorphy). Concerning the sexual dimorphism in *macrostigma*, it is not yet clarified. The senior author has examined five specimens in the AMNH collection and no traces of *lamina circularis* were found, although one of them seemed to be a male on the basis of gonads. However, we are informed that one specimen of the syntype sery (in the Museum National d'Histoire Naturelle, Paris) has a vague indication (a rudiment) of *lamina circularis*. More probably, the males of *macrostigma* are devoid of *Canestrini's scales* or *lamina circularis* like in the males of *elongata.*

There is a third species, not mentioned in our earlier publications (2, 7, 8) as possible relative of *elongata* and those males certainly have no *lamina circularis* or *Canestrini's scale*: *Cobitis calderoni* Bacescu, 1961, from the northern half of the Iberian Peninsula (drainage areas of the rivers Tajo, on the Atlantic watershed and Ebro, on the Mediterranean watershed. *Cobitis calderoni* shares also other common features with *elongata*: a similar but not identical colour pattern (the lateral spots are round in *calderoni* while in *elongata* they are elongate), almost identical shape of mental lobe (Fig. 4 B), round scales with large and slightly eccentric focal zone (Fig. 4 D) and reduced suborbital spine (Fig. 4 C). The spot at the base of caudal fin is oblique as in *elongata* and *macrostigma*, but brownish not intensively black. *Cobitis calderoni* differs from *elongata* and *macrostigma* mainly in its much smaller size: 100 mm SL is maximum known.

We believe that *elongata, calderoni* and *macrostigma* form a monophyletic group that extends from East Asia to the Iberian Peninsula but with isolated areas for each species. We regard the loss of sexual dimorphism in these three species as an apomorphic condition (i. e. a synapomorphy which unites them in a lineage, *Acanestrinia*). The penetration of this stem in Europe from East Asia probably took place in the upper Miocene, about 10–8 my ago. In our opinion the genus *Cobitis* was already formed at the end of Oligocene in East Asia. Along the whole Miocene epoch it was spread west-ward in several waves according to the formation of Siberian river network (Briggs, 10, p. 158). The present diversity of lineages within this genus in Europe suggests this hypothesis.

INTRASPECIFIC VARIATIONS OF *COBITIS ELONGATA*

Complete biometric studies on a high number of specimens and the determination of average values, their probable fluctuations and standard deviation, have been published only for two populations of *Cobitis elongata*: those from the river Nera in Romania (7) and from the river Morava in Serbia (19). Some 18 parameters were determined in the former population and only ten for the population of Morava basin. The difference coefficients for ten characters was established after the formula: $(M_1 - M_2)/(m_1 - m_2)$ which have very low values, namely: in % of the standard length:

- maximum body depth = 0.5419
- minimum body depth = 0.228
- length of caudal peduncle = 0.406
- head length = 0.307
- predorsal distance = 0.368
- preanal distance in % of the head length: = 0.309
- horizontal diameter of eye = 0.545
- preorbital distance = 0.559
- postorbital distance = 0.630

The biometrical values of the lectotype and paralectotype of *elongata* as well as those of the specimen from Rossitsa river, Iantra drainage, Bulgaria (recorded by Marinov, 16) are included within the range of variation of the specimens from river Nera and river Morava.

The single specimen from the river Jiu at Pesteana de Jiu differs enough from those from Nera and Morava in the following respects: the third pair of barbels is shorter: 2.90% of SL and 16.4% of head length versus 3.1–3.75% and 16.9–21.4% respectively in the Nera population, the interorbital space is wider (2.58% of SL versus 1.64–2.51% in the Nera population. The body is narrower in the specimen from Jiu than in Nera population: (body width 65.75 % of the maximum body depth, versus 70.5–72.6%). Since *elongata* is presently extinct from the drainage area of Jiu river and unfortunately there are no other specimens in collections, it will never be possible to analyse statistically the peculiarities of this population. The single population geographically close to those of the river Jiu is that of the river Vit in Bulgaria. A few examples from the river Vit at Pleven, collected in August 12, 1926 by A. Petrov, are in the Drensky Collection of the Zoological Institute of Bulgarian Academy of Sciences in Sofia. Unfortunately, nobody has studied them biometrically.

It is worth mentioning that a slight exchange of individuals between the populations of the rivers Nera, Sava and Morava is possible even in the present day conditions, in spite of the fact that *elongata* does not live in the main channel of the Danube. In the river Nera, *elongata* is also present a few kilometers upstream from the confluence with the Danube, at Socol, in a great number. Although this species does not live in a small and short river, Camenitza, a tributary of the Danube, a young specimen of *elongata* was found close to the confluence with the Danube. It is clear that the specimen has been carried by the high waters from Nera, Sava or Morava into the Danube and farther downstream.

COBITIS ELONGATA A THREATENED SPECIES AND ITS PROTECTION STATUS

Cobitis elongata is listed among threatened fish species in Romania (3, 5) in Slovenia and in general in Europe (14, 15) mainly because its restricted ranges to a limited number of Danube tributaries and not only on short stretches in these. The species has become extinct from the river Jiu, where one specimen has been collected in 1948 at Pesteana de Jiu, either in the river itself or in a small tributary. Presently, the river Jiu and especially its tributaries are strongly polluted and no specimens of *elongata* could be found, although many field investigations were carried out between 1957 and 1992.

The senior author of the present paper has seen *elongata* in great number in the river Nera at Sasca Montana in September 1, 1943 but no specimen was collected. The first specimen was obtained in August 1948. Starting with 1956 numerous trips were undertaken on this river and the species has always been seen and collected in a great number. It can be asserted that it is presently as abundant in the river Nera as it was half a century ago. Actually *elongata* is not threatened in this river. The upper reach flows through a National Park where no economic uses are allowed. In the middle reach, near the village Bozovici there is a small industrial activity that does not influence the quality of water. Most of the middle and lower reaches of the river flow through another National Park where there are no economical activities, damming or other uses of water. The only necessary protection measure is to prevent the deterioration of the water quality on the remaining lower stretch of the river between Sasca Montana till the confluence with the Danube river.

Dr. Vitko Sorić informed us (in litt.) that in Serbia, *elongata* retained its former abundance in the Morava river basin.

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THE SYSTEMATICS OF THE BLACK SEA SPECIES OF TRACHURUS, WITH REMARKS ON THE SYMPATRIC OCCURRENCE OF TWO SIBLING SPECIES AND AN OVERVIEW OF THE SPECIES OF THE GENUS (TELEOSTEI: CARANGIDAE)

PETRU M. BĂNĂRESCU, TEODOR T. NALBANT

The "common" and "giant" forms of horse mackerel of the Black Sea, until recently considered groups of populations of *Trachurus mediterraneus ponticus*, actually are reproductively isolated, hence distinct species: *T. mediterraneus* (the giant) and *T. ponticus* (the common form). The latter is endemic to the Black Sea; one suggested that it originated from a swarm of mediterranean horse-mackerels that entered the Black Sea during an earlier interglacial period and evolved subsequently in isolation. A strong argument is mentioned in favour of the hypothesis that *T. picturatus* is an occasional visitor in the Black Sea. The 15 presently recognized species of *Trachurus* are reviewed; 12 of them are ascribed to three groups of related species; the three others are taxonomically isolated.

The horse-mackerels of the genus *Trachurus* are abundant in the Black Sea and represent an important object of economic fisheries. Pallas (32) was the first author who recorded horse-mackerels in this sea, identifying the most abundant species of this group as the common Atlantic and Mediterranean *Scomber trachurus* Linnaeus (now *Trachurus trachurus)* and also describing a new species, *S. lacerta.* Latter authors followed Pallas in identifying the common horse-mackerel of that sea with the species described by Linnaeus as *Scomber trachurus*; they used various synonym names: *Caranx trachurus* (19, 29), *Trachurus linnaei* (31), *Trachurus* s. *Caranx trachurus* (22), *Trachurus trachurus* (31, 12, 13, 34, 35, 17). Three of these authors (21, 22, 35) also list *T. lacerta* Pallas.

Actually none of these authors, with the exception of Slastenenko (35) seems to have made even a superficial examination of the specimens, to have counted the rays and lateral line scales and scutes. For example Knipovitch, (22), asserts that the common horse-mackerel of the Black Sea has 70 to 73 scales and scutes in the lateral line: he obviously took these figure from the literature referring to the Atlantic and Mediterranean true *T. trachurus;* while the common Black Sea species actually has 78–92 scales and scutes.

Slastenenko alone (35) seems to have made counts: he gives for the common Black Sea horse-mackerel 80–90 scales and scutes and for the species identified by him as "*T. trachurus lacerta*" higher figures: 88–99. He did not realise however that the Atlantic/Mediterranean true *T. trachurus* has only 67–81 scales and scutes and that the values found by him in the common Black Sea species actually correspond to those of *T. mediterraneus* (or *T. trachurus* forma *mediterraneus*).

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SYSTEMATIC STATUS OF THE COMMON AND OF THE "GIANT" BLACK SEA HORSE-MACKERELS

The first original taxonomic study of the common Black Sea horse-mackerel, as that of Bănărescu (7), based on biometrical investigations of more than 500 specimens collected in the Romanian waters of the Black Sea at Agigea, south of Constanţa. He concluded that in all characters – total number of scales and scutes in the lateral line (78–92, X = 84.91) length of the accessory lateral line (ending beneath the beginning of the second dorsal fin), the second inflexion of the main lateral line beneath the 6-th to 9-th branched ray of the second dorsal fin – the common Black Sea horse-mackerel differs from *T. trachurus trachurus*, being almost identical to Steindachner's "*T. trachurus* forma *mediterraneus*" or simply *T. mediterraneus*. He asserted, in the main Romanian text, as well as in the French summary that the morphological hiatus between *T. trachurus* and *mediterraneus*, and also their sympatric occurrence are arguments in favour of the specific status of *mediterraneus* (7, p. 275), in translation: "Hence, the morphological criterion (length of the accessory lateral line and absence of intermediary specimens) as well as the geographical one plead for the separation of *mediterraneus* in a distinct species", p. 281: "L'auteur maintient pour *mediterraneus* le rang de sous-espèce, quoiqu'il y aurait des motifs pour considérer cette forme comme bonne espèce").

He retained for *mediterraneus*, provisionally, the subspecific status especially because other ichtyologists, including Letaconnoux (23) did the same, also considering that the differences between *trachurus* and *mediterraneus* are smaller than those between each of them and *picturatus*, also considering that in the marine habitat two conspecific subspecies can occur sympatrically, each of them in another "layer" of water.

Bănărescu also mentioned a few differences between the Black Sea *mediterraneus* and the population from the Gulf of Gascogne. An average number of branched rays in the second dorsal fin – The Black Sea: 30.63 in males, 30.12 in females; Gulf of Gascogne: 31.21. Average number of branched rays in the anal fin – Black Sea: 26.47 in males, 26.97 in females; Gulf of Gascogne: 27.87. Average total number of lateral line of scales and scutes – The Black Sea 84.91, Gulf of Gascogne 86.91.

Aleev identified in his first paper (1) the Black Sea horse-mackerel as *T. trachurus*; he assigned it later (2, 3) to *T. mediterraneus* (ranked as valid species) and even to a distinct subspecies, endemic to the Black Sea: *Trachurus mediterraneus ponticus* Aleev, 1956. The main feature distinguishing the Black Sea from the *mediterraneus* subspecies is the height of the lateral line scutes. The highest scutes (scales) in the anterior part of the lateral line represent 12.4–17.9% (X = 15.0) of the head length in *T. mediterraneus mediterraneus* and 8.6–14.0% (X = 11.0) in *T. mediterraneus ponticus*, while the height of the scutes in the posterior part of the lateral line range between 14.4 and 19.2% of the head length (X = 16.6) in the former and between 11.9 and 18.6% (X = 14.8) in the latter subspecies. Another difference concerns the total number of scales and scutes in the lateral line. On the contrary, the total number of scales and scutes in the lateral line is practically the same in both subspecies *T. mediterraneus mediterraneus* from the Gulf of Gascogne: 78–95 (X = 84.91) (2, 3), from the Mediterranean Sea: 76–94 (X = 85.9) (3).

T. mediterraneus ponticus: Romanian coasts: 78–91 (M = 85.91) (7); Ukrainian coasts 74–95 (X = 85.0) (3).

Numann (30) arrived, independently from Bănărescu and Aleev, at the conclusion that common Black Sea horse-mackerel is *Trachurus mediterraneus*.

Aleev's conclusions received until 1979 general acceptance the name *T. mediterraneus ponticus* having been adopted in (36, 37, 8, 20).

A difficult problem has however raised because of the presence, in the Black Sea, of a giant form of horse-mackerel, very similar to *Trachurus mediterraneus ponticus* in respect of the number of rays, scales and scutes, length of the accessory lateral line, but reaching a larger size and differing biologically from the common horse-mackerel. Antipa (6) seems to have been the first who reported the existence of this giant form, asserting that it lives in deeper layers of water and comes occasionally in the upper ones. Swarms of giant horse-mackerels have been fished during 1954 near the coasts of Anatolia, Transcaucasia and even Romania.

Aleev (3) payed much attention to the giant horse-mackerel, considering that it represents the southern group of populations ("stad" in Russian) of *T. mediterraneus ponticus*, that inhabits during the summer mainly the coasts of Anatolia and during the winter the Marmara Sea and the extreme south-western area of the Black Sea. The two other groups of populations are the western one, present during the summer on the Romanian and Bulgarian coasts and during the winter near the Bosporus and in the Sea of Marmara (here sympatric with the southern group) and the northern group, present in the north of the Black Sea and during the winter along the southern coasts of Crimeea. There are practically no differences between the specimens from the western and northern groups but those of the southern groups (the "giant") differ from the others in:

– a much larger size, up to 45 cm, as against 16.5, rarely up to 30 cm in the western groups;

– a higher longevity, reaching an age of 12 years, while the members of both other groups never live more than eight years;

– a more intensive rate of growth, the average body length being sit the age of:

	southern group	western group
2 years	16.1 cm	14.2 cm
3 years	21.0 cm	16.7 cm
4 years	25.7 cm	20.6 cm
5 years	29.5 cm	23.3 cm
6 years	32.3 cm	24.4 cm
7 years	35.6 cm	25.0 cm

	southern group	western group
8 years	38.0 cm	28.1 cm
9 years	39.5 cm	–

– apparently a higher number of scales and scutes. Aleev's assertion is not clear enough on this matter. We found 88 and 92 scales and scutes in the lateral line in the only two giant horse-mackerels which we could obtain from the Romanian coasts of the Black Sea, while in the 200 common horse-mackerels from the same coasts the figures range between 78 and 91 (exceptionally 77 and 92), the average value being 84.91 ± 0.208.

Other authors mention two other, more important differences: Altukhov and Apekin (4) found serological difference of specific rank between the common and giant form, while Feider et al. (20) found great differences in the surface of the gill (the "giant" form is "juvenile" in this respect).

These data, besides the sympatric occurrence of both forms in the Sea of Marmara, at least during the winter demonstrate that they are reproductively isolated. Adopting Mayr's (24, 25) biological species concept, the only species concept that is actually objective, it results that the two "forms" are actually distinct species.

What specific name must be adopted for the giant form?

We initially thought that the giant horse-mackerel must be described as a new species. But we later considered other facts:

– Turkish fishermen design the giant horse-mackerel as "mediterranean stavrid";

– the specimens of *Trachurus mediterraneus* from the Gulf of Gascogne and the Mediterranean Sea reach the same large size as the Black Sea giant "form";

– the average number of scales/scutes in *T. mediterraneus* from the Mediterranean Sea and the Gulf of Gascogne is higher than that of the common, western Black Sea common horse-mackerel; the giant Black Sea "form" has a higher number of scales, too;

– the giant form is confined to the south of the Black Sea close to the Mediterranean Sea.

These facts convinced us that the giant Black Sea horse-mackerel is identical to *T. mediterraneus*, while the "common" form that is reproductively isolated from the true *T. mediterraneus* deserves full specific rank and must be designed as *T. ponticus* Aleev.

We have demonstrated this in an earlier paper (9) and have used the name *T. ponticus* for the common and *T. mediterraneus* for the giant horse-mackerel.

The above mentioned contribution (9) is a chapter of a comprehensive monograph of the Black Sea mackerel (32) edited by late E. A. Pora. It is regretable that much confusion results from the strong contradiction between the conclusion of this chapter (the giant horse-mackerel being identified as *T. mediterraneus* the common one assigned to a distinct species, *T. ponticus*, and both the title of the book "Le chinchard de la Mer Noire (*Trachurus mediterraneus ponticus*)" and the contents of the introductory chapter of the book, signed by the editor (32) in which the common *Trachurus* of the Black Sea is designed with the older name, *T. mediterraneus ponticus* and the giant horse-mackerel is briefly mentioned as the name *T. gigas*, being considered as having derived from *T. mediterraneus ponticus*.

It is necessary to explain how this contradiction occurred.

The book edited by Pora (32) printed in 1979, was elaborated several years earlier and it was not possible to publish it then. When the chapter on systematics was elaborated in the initial, not published version, we already realised that the common and the giant horse-mackerels are reproductively isolated, distinct species. Considering, following the tradition, the common form to be *T. mediterraneus ponticus*, we proposed the name *T. gigas* for the giant form. Realizing later that the giant form is actually *T. mediterraneus* and that the common form is specifically distinct, we raised the former subspecies *ponticus* to specific rank. Chapter (9) was printed in this manner. Unfortunately, the editor did not pay attention to this fact, seemed not to have looked at our new manuscript (although we informed him that our opinion had changed). Finally the book (32) and the introductory chapter were printed unchanged.

One of the aims of the present paper is to explain the contradiction between the title of the book (32), the introductory chapter and the conclusion of the chapter on systematics (9).

OTHER SPECIES OF *TRACHURUS* PRESENT IN THE BLACK SEA

1) *Trachurus trachurus* (Linnaeus, 1758)
Synonym: *Scomber lacerta* Pallas, 1811

The true *T. trachurus*, characterized by long accessory lateral line, extending to beneath the last branched rays of the second dorsal fin, L. lat. (67) 69–79 (–81), D_1 (VII) VIII (IX), D_2 28–35, A II–I (25) 26–30 (31), second inflexion of the main lateral line beneath the 6-th to the 8-th branched ray of the second dorsal fin, is also present in the Black Sea, but in a small number, its range in this sea being restricted to the south west, single specimens being occasionally found farther north and east, one specimen, 370 mm st. length has been found on the Romanian coast by Periteasca, south of the Danube Delta, in 1955 (26). Like many other fish species of Mediterranean origin, *T. trachurus* does not spawn in the Black Sea, only in the Marmara Sea.

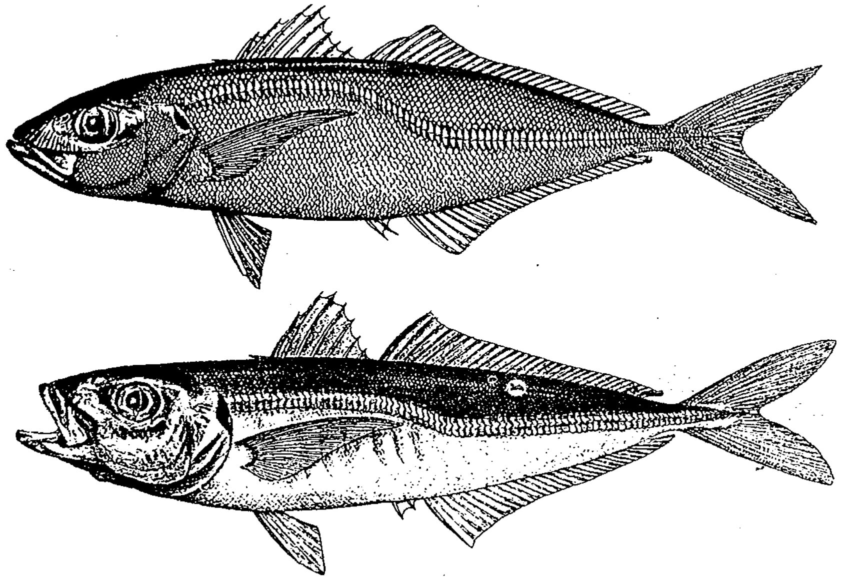
The occurrence of this species in the Black Sea has been reported by Numan (30), Nalbant (26), Aleev (3) and Svetovidov (37).

Based on the original description and illustration of "*Scomber lacerta*" Pallas, Svetovidov (37) has demonstrated that the species described under this name actually is *T. trachurus*. Hence this species is (or was, almost two centuries ago), at least occasionally, also present on the coasts of Crimeea.

2) *Trachurus picturatus* (Bowdich, 1825)

This species, characterized by L. lat. 90–108 the accessory lateral line reaching to beneath the 11-th branched ray of the second dorsal fin, a lower and thicker body comparatively to its other European congeners, has never been directly reported from the Black Sea. Its occurrence in this sea has been suggested by Bănărescu (7, 8), who pointed out that the short description by Slastenenko (35) of the presumed "*T. trachurus lacerta*" (wrongly believed by him to be identical with *T. mediterraneus)* mentions 89–99 scales (+ scutes) in the lateral line, these figures corresponding to the formula of *T. picturatus*, and are much higher than the values characterizing *T. mediterraneus, T. ponticus* and *T. trachurus* as well. Bănărescu suggested that specimens of *T. picturatus* do (or did in the recent past) occasionally enter the Black Sea on the coast of Anatolia, Caucasus and Crimeea, some specimens having been collected by Slastenenko.

A serious argument in favour of this hypothesis can be presently advanced, G. Antipa (1867–1944), author of the well-known monograph of the freshwater fishes of Romania (5) intended also to publish a monograph of the Black Sea fishes. This intention has not been realized, but the painter Polonic, who made the excellent drawing of fishes of Antipa's 1909 book (5) also made a lot of drawings of Black Sea fishes collected by Antipa. Many of the drawing are preserved in the "Grigore Antipa" Museum of Natural History in Bucuresti. Among these there are three drawings of horse-mackerels, noted by Antipa as "*Trachurus trachurus*". These drawings are reproduced here (Figs. 1–3). It is obvious that Fig. 3 represents *T. picturatus*: one count about 95 scales and scutes and that the second inflexion of the lateral line lies beneath the 11-th branched ray of the second dorsal fin; also the slender body (comparatively to the two other specimens – Figs. 1 and 2) can be remarked. It is also obvious that Polonic realized that these specimens differ.



Figs. 1, 2. – Specimens of horse-mackerels from the Black Sea, drawn by the painter Polonic, determined as *Trachurus ponticus* by the authors.

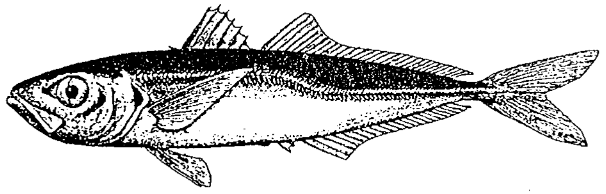


Fig. 3. – Specimen of horse-mackerel from the Black Sea, drawn by the painter Polonic, determined as *Trachurus picturatus* by the authors.

This drawing, besides the figures mantioned by Slastenenko for the lateral line formula of the presumed "*Trachurus trachurus lacerta*", proved that *T. picturatus* is or was an occasional visitor in the Black Sea.

Hence four species of the genus *Trachurus* are present in the Black Sea:

1. *Trachurus ponticus* Aleev, 1956, the most abundant and present in all seasons; distributed in the west, the north and the east of the sea.
2. *Trachurus mediterraneus* (Steindachner, 1868) usually confined to the south of the sea.
3. *Trachurus trachurus* (Linnaeus, 1758), present in a small number, possibly only a regular intruder from the Egeean and Mediterranean seas.
4. *Trachurus picturatus* (Bowdich, 1825), an occasional intruder.

SYMPATRIC OCCURRENCE OF TWO CLOSELY RELATED SISTER SPECIES, PROBABLY RESULTING FROM DOUBLE COLONIZATION

T. mediterraneus and *T. ponticus* are very closely related, more closely to each other than to any other species of the *mediterraneus-japonicus* complex of species; they differ mainly in body size, serologically and, above all, biologically. The ranges of the other members of this species complex are largely or even totally vicariant.

The sympatry of these two sister species in the Black Sea resulted from the process of double colonization as described and analyzed by Mayr (24, 25). The Black Sea had a complex evolution during the Quaternary, being alternatively connected with the Caspian Sea and separated from the Egeean and Mediterranean Seas during the glacial periods and connected with the Egeean Sea and separated from Caspian Sea in interglacial periods. The Black Sea was brackish during the glacial periods and colonized by a brackish water fauna of Caspian origin; it became salty during the interglacials, being colonized by Mediterranean fauna, the Caspian one retiring in the Azov Sea and in the brackish water estuaries (limans) in the north of the sea (14, 35). But probably not all Mediterranean species disappeared; during the glacials some may have survived in certained parts of the sea which retained a certain degree of salinity. The *T. mediterraneus* stock from which *T. ponticus* later evolved was one of them; the small size and slow rate of growth of *T. ponticus* are consequence of a long survival in unfavorable conditions. Mechanisms of reproductive isolation developed during this period. *T. mediterraneus* is a post glacial immigrant; when it entered the Black Sea, *T. ponticus* was already reproductively isolated.

OVERVIEW OF THE SPECIES OF *TRACHURUS* RAFINESQUE, 1810

Horse-mackerels, presently included in *Trachurus*, are widely distributed in temperate, warm and even subtropical and tropical seas. Nine species and "varieties" have been described between 1825 and 1915 (besides *Scomber trachurus* Linnaeus) five being initially ascribed to *Caranx* and one to *Seriola*. Nichols (27) was the first to key and overview them and the first who raised *Caranx trachurus* "var." *mediterraneus* and *C. trachurus japonicus* to species rank. He accepted as valid species seven earlier described forms, synonymized *Trachurus novae-zelandiae* Hutton with *Caranx declivis* Jenyns and described three new species, u. oth. *T. mccullochi* as new name for "*T. declivis*", not of Jenyns, recorded by Mcculloch from southern Australia. Nichols used in the key the most important differential characters: extension of the accessory lateral line, number of lateral line scutes (without distinguishing the scales from the scutes), height of scutes, relations between the straight and curved parts of the lateral line, besides morphometry. He, however, neither discussed the phyletic affinities of the species, nor distinguished groups of species. Nichols described later (28) a new subspecies, *T. picturatus binghami* from the Gulf of Mexico and changed his earlier (27) opinion, recognizing only three species – *trachurus, mediterraneus* and *picturatus*, downgrading the seven others from those accepted by him earlier to subspecific status.

Cadenat (16) described *T. trecae* from the Atlantic coasts of western Africa: this is the species with the shortest accessory lateral line. Finally, Letaconnoux (23) recognizes only two valid species: *trachurus* (with the subspecies *mediterraneus, declivis* and *trecae*) and *picturatus*, putting the others in synonymy.

None of these authors was aware of the occurrence of the genus in the Black Sea, Letaconnoux alone mentioning (16) that *Trachurus* "existerait aussi dans la Mer Noire" and none of them mentions *T. lacerta* (described from this sea) as either valid or synonym.

A more recently described species, *Suareus furnestini* Dardignac & Vincent, 1958 proved later to be a synonym of *T. mediterraneus* (10, 11); *Caranx suareus* Risoo, 1833, considered valid in a few recent papers is a synonym of *T. picturatus* (10, 11), similarly *Decapterus longimanus* Norman, 1935 (11; considered, however, a valid species in 10).

Bănărescu (8) tried to group the related species with vicariant ranges described until 1964 in polytypic species. He accepted seven valid species, four monotypic (*trecae, declivis, suareus* and *fuenestini* – the two latter proved afterwards to be synonyms of other species) and three polytypic:

– *mediterraneus*, with the subspecies *ponticus*, *lathami*, *japonicus* and *australis*;

– *trachurus*, with the subspecies *semispinosus*, *capensis* and *mcculochi*;

– *picturatus* with the subspecies *binghami*, *symmetricus* and *murphyi*.

Bănărescu and Nalbant (9) did the same. Since in the meantime *furnestini* and *suareus* have been put in synonymy, *ponticus* proved to be reproductively isolated and two other species have been described – *indicus* Necrassov, 1966 from the Arabian Sea and *delagoa* Necrassov, 1970 from the Indian Ocean, the two authors recognized 11 valid species: *trecae* and *declivis* monotypic, *trachurus* with four subspecies, *picturatus* again with four subspecies (the same as in 8) and six species of the *mediterraneus* complex, among which *indicus* and *delagoa*.

Two synopsis (actually revisions) of the *Trachurus* species were more recently published:

1. Berry & Cohen (11) who recognize only species, not accepting subspecies. They synonymize *T. semispinosus* with *T. trachurus* and the two former species or subspecies from the Caribbean and South American coasts of the Atlantic Ocean – *australis* and *binghami*, with *T. lathami* of the *mediterraneus* complex. Without being aware of the description of *T. delagoa*, they describe the same species as new, under the name *T. margaretae*. They finally list 13 species: *trecae, declivis,* the three species of the *trachurus* group, three of the *picturatus* group (excluding *binghami*) and five of the *mediterraneus* group (among them *Trachurus margaretae*, but excluding *ponticus* and *australis*).

2. Ben Salem (10) who accepts a single valid subspecies, *T. mediterraneus ponticus* and 11 species, the same as in (11) but, using the name *T. delagoa* instead of *T. margaretae* and *T. novae zelandiae* (Richardson, 1842) instead of *T. mccullochi* Nichols, 1920 and one species more: *T. decapterus* (Norman 1935), initially described as a *Decapturus,* ascribed to *Trachurus* by Duhamel (18).

The affinities of the species are discussed in both papers and the most important characters are mentioned: extension of the lateral line, number of scales/scutes and rays, relations between the straight and the curved parts of the main lateral line – position of the second inflexion of the lateral line – height of the scales and scutes, a few morphometric characters. The ranges of variation and average values are mentioned, but for specimens from the entire range of distribution of the species, the geographic variability is analysed only for *T. lathami* (11).

Since these two papers (11, 10) give a more detailed description than we had in 1977, it is possible the suggest another grouping of the taxa of the genus.

I. COMPLEX *TRACHURUS TRACHURUS*

Accessory lateral line very long, reaching beneath the terminal part of the second dorsal fin. Second inflexion of the main lateral line beneath the 6-th to 8-th soft dorsal ray.

Two species with vicariant disjunct ranges on the easter coasts of the Atlantic Ocean:

1. *Trachurus trachurus* (Linnaeus, 1758)

Coasts of the eastern Atlantic Ocean, from northern Europe and the Black Sea and Cape Verde. The data mentioned by Nichols (27) justify the separation of the northern European populations in a distinct subspecies, *T. trachurus semispinosus* (Nilsson, 1832).

2. *Trachurus capensis* Castelnau, 1861

Atlantic coasts of Africa, from Nigeria to Capetown and Indian Ocean coasts, north to Mozambique.

The differences between both species, in respect of the length of the accessory lateral line (shorter in *capensis*), number of scales/scutes (lower in *trachurus*), rays and gill rakers, height of scutes are mentioned in (11) and (10). Except for the number of gill rakers(56-65 in *trachurus* X = 61.1, 66–76 in *capensis,* X = 70.3) the extreme values overlap.

II. COMPLEX *T. MEDITERRANEUS – T. JAPONICUS – T. LATHAMI*

Accessory lateral line much shorter than in the species of the *T. trachurus* complex, extending to beneath the last rays of the first and the anterior rays of the second dorsal fin. The second inflexion of the main lateral line has a variable position, beneath the 3-rd to the 10-th branched rays of the dorsal fin. The total number of scales and scutes ranges between 65 to 79 in most species, between 78 and 95 in *T. mediterraneus* and *T. ponticus.*

This group of species is clearly delimited from *T. trachurus* group, in which the accessory lateral line extends posteriad almost beneath the and of the second dorsal fin. The delimitation from the *T. picturatus* group of species is more difficult. The accessory lateral line in the species of this group is longer, extending to beneath the 11-th to the 18-th dorsal ray in *T. picturatus*, to beneath the 7-th to 16-th ray in the two other species; there is however an overlap of ranges between both groups of species, the accessory line extending to beneath the 9-th to 17-th dorsal ray in *T. japonicus*, beneath the 8-th to 14-th in *T. mccullochi* (= *novae-zealandiae*), (10) of the *T. mediterraneus* group. There is a slight overlap of values also in respect of the second inflexion point of the main lateral line: beneath the 9-th to 15-th branched dorsal ray in the three species of the *picturatus* group, beneath the 3-rd to 9-th, or even to the 10-th ray in the species in the *mediterraneus* group (10). There are but clear differences in the total number of scales and scutes in the main lateral line: 65–93 in the *mediterraneus* group, 89–113 in the *picturatus* group.

This complex comprises seven species:

3. *Trachurus mediterraneus* (Steindachner, 1868)

Eastern Atlantic to the south of the Black Sea.

4. *Trachurus ponticus* Aleev, 1956.

The Black Sea, during the winter also in the Marmara Sea. These two species are dealt with in the preceding pages.

5. *Trachurus lathami* Nichols, 1920

(= *T. picturatus binghami* Nichols, 1940, *T. picturatus australis* Nani, 1950). L. lat, 68–78; accessory lateral line reaching beneath the 8-th to 13-th dorsal fin ray (X = 9.70); second inflexion of the main lateral line beneath the 3-rd to 9-th dorsal ray. Atlantic coasts of North, Central and South America. The geographic variation of the species is dealt with in (11).

6. *Trachurus japonicus* (Temmick and Schlegel, 1844)

L. lat. 67–74; accessory lateral line longer than in the other species of the group, extending to beneath the 9-th to 17-th dorsal fin ray; second inflexion of the lateral line more posteriad, beneath the 7-th to 10-th dorsal ray. Pacific watershed of temperate East Asia.

7. *Trachurus indicus* Necrassov, 1966

L. lat. 70–79. Accessory lateral line extending beneath the 4-th to 9-th dorsal ray, second inflexion point of the main lateral line beneath the 7-th to 10-th ray, Arabian Sea (Gulf of Oman and Persian Gulf), perhaps also western area of the Indian Ocean.

8. *Trachurus delagoa* Necrassov, 1970

(= *T. margaretae* Berry & Cohen, 1974). L. lat. 71–74. Accessory lateral line extends beneath the 8-th to 11-th dorsal ray; second inflexion of the main lateral line more anterior than in all other species of the group, beneath the 3-rd to 6-th dorsal ray (more often the 5-th). Indian Ocean watershed of southern Africa.

9. *Trachurus novae-zelandiae* Richardson, 1842

(= *T. mccullochi* Nichols,1920).The nomenclatorial status of this species is controversial. Nichols (27) proposed the new name *mccullochi* for a species wrongly identified by Mcculloch in 1915 as *T. declivis*. The name has been accepted as valid by most subsequent authors (28, 8, 9, 11); Ben Salem (10) has shown that it is a junior synonym of *T. novae-zelandiae.* L. lat. 65–74 (X = 72.37 according to 10); accessory lateral line reaching beneath 8-th to 18-th dorsal ray (X = 10.04), second inflexion of the main lateral line under the 5-th to 9-th ray (X = 7.30). This species has been considered a member of the *T. trachurus* group (28, 27, 8, 9); the accessory lateral line is however short reaching beneath the 8-th spines to 2-nd dorsal soft ray (11), i.e. beneath the 8-th to 14-th ray (spines and soft rays being counted together: 10). Hence, the species actually belongs to the *T. mediterraneus* group.

III. COMPLEX TRACHURUS PICTURATUS

The accessory lateral line extending further posteriad than in the species of the *trachurus* and *mediterraneus* complexes; also the second inflexion of the main lateral line is more posterior, beneath the 9-th to 15-th dorsal fin ray (usually beneath the 11-th or 12-th ray). Scales and scutes in the main lateral line more numerous, 89 to 107.

Range disjunct: one species in the eastern Atlantic, the two others along the American coasts of the eastern Pacific.

10. *Trachurus picturatus* (Bowdich, 1825).

L. lat. 91–107 (X = 97.85 according to 10); accessory lateral line reaching to beneath the 11-th to 18-th dorsal ray (X = 15.29), second inflexion of the main lateral line beneath the 9-th to 13-th ray (X = 11.09). Atlantic coasts of Europe and northern Africa, Mediterranean Sea, occasionally entering the Black Sea.

11. *Trachurus symmetricus* (Ayres, 1855)

L. lat. 91–113 (X = 99.95), accessory lateral line to beneath the 7-th to 16-th dorsal ray (X = 9.87), second inflexion of the main lateral line beneath to 9-th to 15-th dorsal ray (X = 11.44). Pacific watershed of North America.

12. *Trachurus murphyi* (Nichols, 1920)

L. lat. 85–105 (X = 97.39), accessory lateral line reaching to beneath the 9-th to 15-th (X = 12.1) dorsal ray, second inflexion of the main lateral line beneath the 9-th to 14-th dorsal ray. Pacific watershed of South America.

Both latter species are more similar to each other than to *T. picturatus*, they may prove to be conspecific subspecies.

ISOLATED SPECIES

13. *Trachurus declivis* (Jenyns, 1841)

L. lat. 74.84 (X = 80.36 according to 10), accessory lateral line longer than in the species of the *mediterraneus*, even than in those of the *picturatus* group, reaching to beneath the 14-th to 19-th dorsal ray (X = 16.17); second inflexion of the lateral line beneath the 3-rd to 6-th dorsal ray. This species is intermediate between those of the *mediterraneus* and the *picturatus* groups. Coasts of Australia and New Zealand.

14. *Trachurus trecae* Cadenat, 1949

L. lat. 68–81 (X = 73.04 according to 10). Accessory lateral line very short, extending only to beneath the 1-st to 6-th spinified ray of the dorsal fin: second inflexion of the main lateral line beneath the 7-th to 11-th dorsal ray. Atlantic coasts of subtropica and tropical Africa.

15. *Trachurus longimannus* (Norman, 1935)

(= *T. picturatus aleevi* Rytov & Razumovskaya, 1984). L. lat. 98–100 (X = = 99.0); accessory lateral line shorter even than in *T. trecae*, reaching only to be the 1-st to 3-rd dorsal (spinified) ray, second inflexion of the main lateral line beneath the 10-th to 11-th dorsal ray a little known species, Berry & Cohen (11) list it as a synonym of *T. picturatus;* actually the number of scales-scutes and the position of the second inflexion of the main lateral line justify this synonymy; however, according to Ben Salem (10) who examined three specimens, the accessory lateral line is very short, similar only to that of *T. trecae*. The species is known only from the coasts of Tristan Dacunha island in the southern Indian Ocean, not far from the ranges of both *T. picturatus* and *T. trecae*, *T. longimannus*; it may be an interspecific hybrid.

ZOOGEOGRAPHICAL CONSIDERATIONS

Both species of the *T. trachurus* complex, the three ones of the *T. picturatus* complex and most of the seven species of the *T. mediterraneus* complex have vicariant ranges, the closely related *T. mediterraneus* and *T. ponticus* being sympatric; as mentioned earlier, their sympatric resulted from double colonization. Hence, the speciation is the genus *Trachurus* followed, as usual in biparental organisms, the geographic (allopatric) model.

Quite remarkable is the continuous distribution of species or pairs of sister species of the genus along the coasts of the two main oceans, in temperate and tropical areas: the two species of the *T. trachurus* group in the north and the south of the eastern Atlantic, *T. lathami* in the western Atlantic from temperate North America to temperate South America, the closely related *T. symmetricus* and *T. murphyi* in the eastern Pacific.

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MICROEVOLUTION PROCESSES IN THE RETEZAT MASSIF

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The investigation started from the premises that the Retezat massif is isolated by more or less efficient barriers (orographic, climatic, etc.), which could determine by their action the development of certain processes of evolution during recent geological ages. There are given reasons for choosing the Retezat massif to test this hypothesis based on faunal arguments obtained by long-term investigations.

The taxonomical research is based more and more on principles (8, 14, 15, 39, 44, 50, 63) according to which:

– it is recognised that the species are the only taxonomical category determined objectively;

– it is recognised the key position of the species within the biological hierarchies;

– it is recognised the value of the diagnosis that expresses, by the chosen taxonomical character, the dynamics of evolution.

In the process of elaboration of a species diagnosis, the following traits are considered of a major importance: the origin of the species, the *antiquity* of the species, the genetic fund gained in tandem with its phenotypical expression, the ecological role of the species, the spatio-temporal dynamics of species distribution, spreading capacity of the species, etc. All these co-ordinates may assure studying perspectives of the species at different levels: genetic, ecological, zoogeographic (arealographic), chronological (historical). Unfortunately, this type of study is achieved many times in a reductionist manner. We consider that these levels can and must be known and mastered by the taxonomist with the methodologics currently at hand, even if sometimes they are too elaborate. The final purpose to which all these sources of information contribute equally is the identification and fitting, as correctly as possible, of the element, of the species, within the taxonomical hierarchy.

If the taxonomical research is approached and solved in such a manner, it creates the premises for the accumulation of a very rich pool of information that can be used for thorough thematic extensions.

The wide issue of determining the origin and present structure of the fauna of Romania is just an example in this context.

This subject was approached within the GAR entitled "Taxonomical dynamics of the zoogeographical units of Romania", accepted and financed in two stages: 1995 and 1996 so far.

We take this opportunity to thank the Romanian Academy for understanding the importance of achieving this project.

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Without detailing on the general thematic fundamentation of the GAR, we shall mention, however, that in starting the problem of this study, we started from some factors that we considered to be determining:

– in the geographical area of Romania the limits of the following zoogeographical regions meet: central-European, east-European and south-European;

– Romania is situated in the vicinity of the glacial refuges that became centres of spreading and evolution of the species; the territory of Romania itself was, partially, a centre of spreading;

– Romania is crossed by migration routes of many animal species: from east to west and from south to north (and vice versa);

– zoogeographically, Romania is influenced by the type of relief: 1. the Carpathians, playing role of orographical barrier; 2. other areas, with local pattern;

– in Romania, five biogeographical districts are delimited: Dacic; Panonic (central-European); Moesic (sub-Mediterranean); Pontic (ponto-turanic); Moldavian;

– recent processes of speciation and sub-speciation took place on the territory of Romania.

In determining these arguments for fundamenting our investigations, we consulted numerous references among which we selected as examples the following: 7, 8, 9, 10, 16, 23, 30, 31, 33, 40, 45.

For solving this subject we proposed five hypothesis. The testing of these hypotheses should reveal particularities of the taxonomic dynamics of the fauna of Romania within the Euro-Asiatic and world-wide context.

One of the five working hypothesis was: "The Retezat massif and the Apuseni mountains are units isolated by more or less efficient barriers, in which, during recent geological ages, an evolution at intraspecific level could have taken place".

THE SPREADING BARRIERS

The process of multiplication is the essential characteristic by which the species ensures its continuity and evolution both in space and time. To be more specific, at the level of the species, by its population or populations, according to the pressure made by population's size, the species has the tendency to expand its habitats and area.

Expanding the area involves, many times, a variety of obstacles known generically as barriers. Also a barrier must be considered any change in the conditions of existence beyond the limits tolerated by a given species (10).

Without detailing, we must mention, however, that the barriers can be of two types: steep, which includes mechanical obstacles (tall mountains, sea branches, etc.) and discrete, such as the physiographic, ecological and especially climatic barriers.

Both the steep and discrete barriers can be absolute or relative according to the possibility of the species to overcome them. A barrier can be steep for one group of organisms and just discrete for another one (10).

It is considered that the barriers have a very important role in the process of speciation. Thus, a few individuals who succeed in overpassing a certain type of barrier and who remain isolated from the rest of the population of origin, can evolve independently, resulting in time in a new species. This is the explanation for the large number of endemic species and subspecies from the islands and from continental areas isolated by chains of mountains from the rest of the continent.

It is also considered that the most important distinction between the steep and discrete barriers is their historical nature. While the steep barriers have a permanent position and from the moment of their emergence, they prevented the displacement of the floristical and faunal populations and communities (such as the Pirinei, Alps and Balkans mountains during the Pleistocene), the discrete barriers, on the contrary, do not have fixed historical co-ordinates. They have a climatic, physiographic or ecological character and their action were continuous and changing, being perceived in our days too (10).

All these barriers can be and are crossed by certain routes, denominated by several authors among who Barry Cox, as corridor, filter and sweepstake route.

Returning to the content of the hypothesis mentioned earlier, we must point to several aspects: the investigations were conducted so far only in the Retezat massif. The purpose of the investigations was to determine the type of barriers that might have influenced the fauna of the Retezat massif and to obtain data which to confirm the efficiency of the action of these barriers by the development of processes of evolution.

WHY THE RETEZAT MASSIF? ARGUMENTS

Starting from the premises that the determination of the origin and structural configuration of the fauna of Retezat massif requires the spatial and temporal correlation of the taxonomical dynamics of its fauna with that of the geological, physico-geographical, etc. processes, that have occurred or that bear influence in this area, we determined and delimited some markers that were necessary:

– the Retezat massif forms the western part of the Meridional Carpathians. By its extent (800 sq. km) and by its height (Peleaga, 2509 m) it dominates all the other mountains in the region;

– the geological map of the Retezat massif includes granodiorites, crystalline schists, Mesozoic limestone and other sedimentary rocks (49);

– the relief of the Retezat massif has a particular high frequency of high altitudes: 20 peaks exceeding 2300 m, 40 peaks exceeding 2200 m; it is also very massive (37):

– the Retezat massif has the highest humidity and drainage among the Romanian Carpathians, due to its position towards the advection of oceanic air masses and towards other physico-geographical parameters;

– the hydrographic system of the Retezat massif is very well represented by: phreatic water, springs, lakes, rivers etc.;

– the Retezat massif has the most numerous and most varied glacial traces: circles, valleys, moraines, lakes (over 80 – the largest is Bucura, 10 ha, the deepest is Zănoaga, 29 m)(26).

Information from other research directions on the Retezat massif provided us with other important data as follows:

– recently, investigations were conducted in the Retezat massif in order to reconstitute the history of the Quaternary vegetation: sporopollinic analysis on a sample collected from a superior frontal moraine belonging to a small glacial circle situated on Slavoiu ridge (2000 m) indicated the stage of the last pleniglacial (Hochglazial), and the sporopollinical diagram obtained from the lake sediment collected at Taul Zanogutei, offers the most comprehensive image of the history of the late glacial vegetation, conducted so far in the Retezat massif (11);

– The Retezat massif shelters since 1935 the National Park Retezat, which means that this area is recognised as having a particularly important natural patrimony and shows the preoccupation for protecting and preserving it. The studies conducted in the Scientific Reservation from the National Park Retezat resulted in the collection of rich geological, geographical, botanical and faunal information;

– faunal evidence collected from preserving biotopes such as: springs (Bucura, Gemene, Căldarea Berbecilor), glacial lakes (Bucura, Zănoaga, Florica, Ana, Lia, Gemenele, Judele, Negru, Viorica, Taul cu Plaur), from some sfagneta (Gemenele) and from many rivers (Barlii, Zlătuia, Netis, Văgăuna Neagră, Radeş, Bistra, Râul Mare, Lăpuşnicul Mare, etc.), showed the presence of glacial relics;

– the presence in different biotopes of the Retezat massif of populations belonging to species inhabiting boreal and alpine areas, close relatives of northern species;

– the situation of genus *Chionophylax* Sch. (trichopterae) which originated after it separated from genus *Acrophylax*, represented by two species of altitude, one of them an alpine species. *Chionophylax* is considered to be a homogenous genus including the species *mindszentyi* Sch. from the Retezat and *czarnohoricus* Dz. with two geographical breeds *C.c. czarnohoricus* Dz. from the northern part of the Oriental Carpathians and *C.c. monteryla* Bots. from Ryla mountains (Bulgaria). As a conclusion, *C. mindszentyi* Sch. from the Retezat can be considered to have had an intraspecific evolution developing within the genus Carpathian and Balkan affinities, and developing supragenerically, more remote alpine affinities (16).

EVIDENCE SUPPORTING THE HYPOTHESIS

Returning to the hypothesis according to which the Retezat massif would represent by its more or less efficient barriers an isolated setting favourable to intraspecific evolution, we shall comment briefly some evidence taken from a recent paper (1993) on the Retezat massif:

– the fauna of nematods of Retezat massif consists so far of 142 species of which 2 species (*Chitwoodilus retezatensis* Popovici, 1990 and *Funaria meridionalis* Popovici, 1990), are new and possibly endemic for the area of the Retezat massif; other 34 species were identified for the first time in the fauna of Romania (43);

– the fauna of lumbricids from the Retezat massif, although relatively poorly represented by only 13 species, has three species: *Allobophora opisthocystis (Rosa), Dendrobaena alpina (Rosa), D. clujensis Pop*, that can be considered as particular species. Important is the assertion of V. V. Pop who considered that: "the low number of species of lumbricids in the Retezat massif is probably due to the isolation of the massif to north by the corridor of Mureş, and to west by the valley of Cerna by changing the climatic conditions" (42);

– the fauna of oribatids from the Retezat massif consists so far of 103 species. The species *Metabelba pseudoitalica* and *Oribata foliata* had been identified so far only in the Caucasus. *Melanozetus interruptus* and *Camisia borealis* were found for the first time in the Romanian Carpathians (55);

– the fauna of uropodids of the Retezat massif is represented so far by 10 species, eight of them belonging to the same genus, *Trochytes*. Furthermore, one of the species *Trochytes augusta* Hutu is a new one and possibly endemic for Retezat (29);

– the fauna of colembols of the Retezat massif includes so far 83 species. One species, *Micromurida retezatica* Gruia and Harsia, 1990, is new and possibly endemic for Retezat (28);

– the fauna of chilopods of the Retezat massif counts so far 23 species, four of which, *Stregamia lutea* Matic, *S. paucipora* Matic, *S. crinita* Atlens and *Monotarsobius pustulatus* Matic, are considered endemic (38);

– the fauna of lepidopters of the Retezat massif is estimated currently at 1200 taxa, of which 680 are microlepidopters; eight species of microlepidopters are considered to be endemic for Retezat (46).

Although we might continue in this manner, we shall present subsequently, information provided by the investigations conducted on chironomids, a group of dipters extremely well represented in all the types of fresh water ecosystems.

Chironomids were studied both in the larval stage and in the adult stage on quantitative and qualitative samples collected from a large number of biotopes situated in different zones of the Retezat massif as follows:

– from springs (Bucura, Gemene, Căldarea Berbecilor);

– from glacial circles (Bucura, Zănoaga, Florica, Ana, Lia, Gemene, Negru, Viorica);

– from mires (Gemene);

– from streams and rivers (Ana-Lia, Gemene, Bucura; Barlii, Bistra, Netis, Radeş, Râuşor, Zlătuia, Văgăuna Neagră, Lăpuşnicul Mare, Râul Mare, etc.).

The evidence on the chironomids of the Retezat massif (1, 2, 3, 4, 5, 12, 27, 53), completed with other evidence obtained from the literature (6, 17, 18, 19, 20, 21, 22, 24, 25, 32, 34, 35, 41, 47, 48, 51, 54, 58) led to the following observations:

– a total of 104 species belonging to the family of Chironomidae (Table 1) were identified so far in the Retezat massif;

– the structure by subfamilies of the species of chironomids is the following:

– sub-family Tanypodinae	10 species
– sub-family Diamesinae	5 species
– sub-family Pseudodiamesinae	1 species
– sub-family Orthocladiinae	68 species
– sub-family Chironominae	20 species

The species belonging to the sub-family of Orthocladiinae are clearly dominant. According to Brundin, 1956, these species originated from cold running waters. This sub-family also has the most ancient fossil representatives (Superior Jurassic) identified so far;

– there are many genera well represented in this species: Diamesa, Brillia, Briophaenocladius, Corynoneura, Eukiefferiella, Limnophyes, Metriocnemus, Rheocricotopus, Polypedillum, Micropsectra (Table 1);

– there are many ecosystems in which several species of the same genus are represented: in Taul Lia live three species of genus *Diamesa*, four species of the genus *Micropsectra*; in Taul Gemene live three species of genus *Corynoneura*, three species of genus *Limnophyes* and all three species of genus *Rheocricotopus* identified in Retezat; at Gura Zlata (Zlatuia) live all four species of the *Bryophaenocladius* identified in Retezat, four species of genus *Eukiefferiella*, all the species belonging to genus *Polypedillum*, etc. (Table 1);

– interesting is the frequency of some genera which are known to display, optionally, parthenogenesis: *Corynoneura, Limnophyes, Metriocnemus, Pseodosmittia, Tanytarsus*, etc.;

– of the total of 104 species, 29 were identified so far in the fauna of Romania only in Retezat;

– there are species identified so far in Retezat and only on the Cerna valley and in the Danube in the area of The Iron Gates (Table 1). This fact might explain the spreading of these species through the Cerna corridor, a similar situation also met in other groups, such as trichopterae (16) and lepidopterae (31);

– of the 104 species, 45 are criostenothermal, crenoxenous, polyoxybiont, they live in mountain waters (springs, streams, glacial lakes, rivers).

Chironomids are holometabolical dipters known for their large ecological plasticity. However, they do display certain preferences as follows:

– selectivity towards the basin in which they lay the eggs;

– reactivity towards temperature, the most important natural factor throughout the developmental stages;

Table 1

Chironomids taxa recorded in the Retezat Massif

TAXA	RETEZAT MASSIF	ROMANIA	ZOOGEOGRAPHICAL FEATURE	ECOLOGICAL FEATURE
1	2	3	4	5
SUBFAM. TANYPODINAE *Conchopelopia pallidula* (Meigen, 1818)	Zănoaga, Râușor	Jiu (Jiu, Motru, Gilort, Tismana)	Palearctic	Crenoxenous, rheophilous, cryostenothermic, stenotopic
Krenopelopia binotata (Wiedermann, 1817)	Zănoaga, Lia, Gura Zlata, Bârlii, Văgăuna Neagră, Zlătuia, Căldarea Berbecilor	–	Palearctic	Cryostenothermic
Macropelopia nebulosa (Meigen, 1804)	Gemene, Negru	Sinaia, Jiu (Motru)	Palearctic, Asian	±Cryostenothermic polyoxiphilous
Nilotanypus dubius (Meigen, 1804)	Zlătuia, Râușor, Văgăuna Neagră	Sinaia	Palearctic	Cryostenothermic rheophilous
Paramerina cingulata (Walker, 1856)	Gemene, Negru, Zlătuia	Cerna (Toplet), Jiu (Livezeni)	Palearctic, Asian	Eurythermic, eurytopic
Procladius choreus (Meigen, 1804)	Bârlii	Danube, Danube Delta, Argeș, Bistrița, Criș, Ialomița, Jiu	Palearctic, Asian	Eurybiont
P. (Psilotanypus) oltezii Cure, 1971	Gemene	Olt (Olteț), Argeș (Neajlov), Moldova	Romania	Lithodetritophilous, oxycryophilous
Thienemanimyia geijskesi (Goetghebuer, 1934)	Zlătuia, Bârlii, Râușor	Sinaia	Palearctic	Cryostenothermic, rheophilous

(continues)

Table 1 (*continued*)

1	2	3	4	5
T. laeta Meigen, 1818	Gemene	Prahova (Bobeș), Olt (Olteț), Sinaia	Palearctic, Asian	Psammophilous, cryrheophilous
Zvrelimyia melanura (Meigen, 1818)	Lia	Danube, Bistrița, Moldova, Olteț, Jiu,etc.	Palearctic	Cryostenothermic
SUBFAM. DIAMESINAE *Boreoheptagia rugosa* (Sanders, 1930)	Zănoaga, Râușor	–	France (Alps)	Lithorheophilous
Diamesa bohemani Goetghebuer, 1932	Lia	Sinaia, Olt (Lotru)	Holarctic	Cryostenothermic
D. latitarsis (Goetghebuer, 1921)	Brook between Ana & Lia	Sinaia, Agapia, Jiu (Motru), Ialomita	Palearctic	Cryostenothermic, lithorheophilous
Pseudodiamesa branckii (Nowicki, 1873)	Negru	–	Holarctic	Cryostenothermic
SUBFAM. PRODIAMESINAE *Prodiamesa olivacea* (Meigen, 1818)	Negru	Danube (Iron Gates), Bistrița, Moldova	Holarctic	Eurytopic
SUBFAM. ORTHOCLADIINAE *Brillia immaculata* Botn.& Cure, 1956	Gemene	Danube, Argeș, Jiu, Olt, Prahova	Romania	Pelophilous
B. modesta (Meigen, 1830)	Viorica, brook between Ana & Lia	Lotru spring, Valea Vinului, Borșa, Vișeuț, Sinaia, Olt	Palearctic, Asian	Cryostenothermic, rheophilous
Bryophenocladius ictericus (Meigen, 1830)	Gura Zlata	–	Palearctic	Cryophilous
B. (Odontocladius) pectinatus Albu, 1974	Gura Zlata	–	Romania	Cryophilous

1	2	3	4	5
B. scanicus (Brundin, 1947)	Gura Zlata	Olt, Ieselta, Danube (Iron Gates)	Sweden	Rheophilous
B. subvernalis (Edwads, 1929)	Zlătuia	Jiu (Liv.), Olteț, Sinaia	Palearctic	Phytophilous
Camptocladius stercorarius (De Geer, 1781)	Negru	Danube (Iron Gates), Chirnogi, Olt, Sinaia	Holarctica, Asian	Terrestrial, dunk, wet silt
Chaetocladius dissipatus (Edwards, 1929)	Negru	–	Palearctic	Glacial lakes
C. gelidus Brundin, 1956	Negru	–	Palearctic	Cryostenothermic, glacial lakes
C. suecicus (Kieff. in Thien. & Kieff., 1916)	Gura Zlata, Netis	–	Palearctic	Springs, brooks
Corynoneura celeripes Wiennertz, 1852	Zănoaga, Gemene	Danube, Argeș, Jiu, Olt, Someșu Cald, Bistrița	Holarctic	Mountain waters margins, phytophilous
C. edwardsi Brundin, 1956	Gemene, Negru	–	Palearctic	Mountain waters, stones biodermis
C. lobata Edwards, 1924	Zănoaga, Ana-Lia, Lia	–	Holarctic, Asian	Phytophilous, mountain waters
C. scutellata Wiennertz, 1846	Negru, Gemene, Bucura, Lia, Căldarea Berbecilor	Argeș, Crapina-Jijila, Chirnogi	Holarctic, Asian, Neotropical	Phytophilous
Cricotopus annulator Goetghebuer, 1927	Zlătuia	Sinaia, Olt, Lotru, Muntele Mic	Palearctic	Running Waters, lakes
C. fuscus (Kieffer, 1909)	Zănoaga	Danube, Argeș, Ialomița, Olt, Prahova, Someșul Cald și Mic	Palearctic	Lakes, brooks, springs, mires
C. similis Goetghebuer, 1921	Gura Zlata	Sinaia, Olt, Argeș	Palearctic, Asian	Rheophilous

(*continues*)

Table 1 (continued)

1	2	3	4	5
Diplocladius cultriger Kieff.in Kieff.&Thien., 1908	Lia, Bârlii, Bistra, Netis, Râușor, Căldarea Berbecilor	Ialomița (Cheile Tătarului)	Holarctic	Springs, brooks, lakes
Eukiefferiella brevicalcar Kieff., 1911	Negru, Viorica, Lia, Ana-Lia, Gemene, Căld. Berb.	Bistrița, Jiu, Sinaia, Danube	Palearctic	Lithorheophilous
E. claripennis (Lundbeck, 1898)	Zlătuia, Bârlii	Danube (Iron Gates), Jiu, Olt, Sinaia	Holarctic, Asian, Neotropical	Eurythermic, rheophilous, phytophilous
E. coerulescens Kieff. in Zavrel, 1926	Gura Zlata	Sinaia	Palearctic, Asian	Rheophytophilous
E. devonica (Edwards, 1929)	Gura Zlata	–	Holarctic, Asian, neotropical	Running waters, lakes
E. gracei (Edwards, 1929)	Gemene, Zănoaga	Danube, Argeș, Jiu, Moldova, Mureș, Someșul Cald, Someșul Mic	Holarctic, Asian	Phytorheophilous
E. minor (Edwards, 1929)	Negru	Sinaia, Cheile Tătarului	Palearctic	Rheophilous
E. rectangularis (Goetghebuer, 1940)	Negru	Sinaia	Palearctic	Rheophilous
Heleniella extrema Albu, 1972	Negru	–	Romania	Cryostenothermic
H. ornaticolis (Edwards, 1929)	Zlătuia	Sinaia, Câineni, Muntele Mic	Palearctic, Asian	Rheophilous
Heterotanytarsus apicalis (Kieffer, 1911)	Gura Zlata, Netis, Radeș	Bistrița, Jiu, Trotuș	Palearctic	Rheophilous
Heterotrissocladius marcidus (Walker,1856)	Gemene, Negru, Bârlii, Râușor, Radeș	Jiu, Olteț	Holarctic	Cryostenothermic

1	2	3	4	5
Krenosmittia boreoalpina (Goetghebuer, 1944)	Negru, Viorica, Zlătuia	Sinaia, Olt, Muntele Mic, Jiu	Holarctic	Boreoalpine
K. camptophleps (Edwards, 1929)	Negru, Viorica, Zlătuia	Sinaia, Muntele Mic, Jiu	Holarctic	Boreoalpine
Limnophyes eltoni (Edwards, 1921)	Negru, Gemene, Viorica, Florica, Lia	Sângiorz, Teleorman, Olt, Lotru, Sinaia	Holarctic	phytophilous, oligotrophic lakes
L. gurgicola Edwards, 1929	Bucura, Viorica, Florica, Gemene Brook	Borșa, Sinaia, Olt	Palearctic, Asian	phytophilous
L. minimus (Meigen, 1818)	Bucura, Lia, Bârlii, Netis, Zlătuia	Budești, Chirnogi, Sinaia	Holarctic, Asian	Rheophilous
L. prolongatus (Kieff. in Thienemann, 1921)	Bucura, Zlătuia, Căldarea Berbecilor	Danube (Iron Gates), Jiu, Olt, Prahova	Palearctic, Asian	Oligotrophic lakes
L. pumilio (Holmgren, 1869)	Florica	–	Palearctic	Mountain waters
Metriocnemus atratulus Zetterstedt, 1850	Zănoaga	Bistrița, Jiu, Olt, Ialomița, Prahova, Someșul Cald, Dimbovița, Sinaia	Palearctic	Rheophilous
M. hygropetricus Kieffer, 1912	Negru, Gura Zlata	Argeș, Ialomița, Jiu, Moldova, Olt, Prahova, Trotuș, Danube (Iron Gates)	Holarctic	Rheophilous
M. picipes Meigen, 1818	Gura Zlata	Sinaia	Holarctic	
M. tristellus Edwards, 1929	Gura Zlata	–	Palearctic	
Orthocladius (Eudactylocladius) *fuscimanus* (Kieffer, 1908)	Gura Zlata	–	Palearctic	
O. (E.) mixtus (Holmgren, 1869)	Negru	–	Palearctic	

(continues)

Table 1 (continued)

1	2	3	4	5
O. (Orthocladius) frigidus (Zetterstedt, 1838)	Gemene	Jiu	Holarctic	Brooks
O. (O.) obumbratus Johansen, 1905	Zlătuia	Jiu	Holarctic	Biodermis, cryophilous
O. (O.) saxicola Kieffer, 1911	Negru, Gura Zlata	Sinaia, Danube, Argeș, Bistrița, Jiu, Moldova	Palearctic	
Parachetocladius retezati Albu, 1972	Lia	–	Romania	Cryorheophilous
Paracladius alpicola (Zetterstedt, 1850)	Gura Zlata	Bistrița, Trotuș, Dimbovița, Sinaia, Olt, Lotru	Holarctic	Eurybiontic
Parametriocnemus stylatus Kieffer, 1924	Zlătuia	Jiu	Palearctic, Asian	Springs, brooks, running waters
Paraorthocladius nudipennis Kieffer, 1923	Zlătuia	Danube, Jiu, Olt	Palearctic	Cryostenothermic
Paraphaenocladius impensus (Walker, 1856)	Gemene	Sinaia, Cerna, Dimbovița	Holarctic, Asian	Springs, brooks
P. irritus (Walker, 1856)	Negru	–	Holarctic, Asian	Lakes
Paratrichocladius rufiventris (Meigen, 1830)	Gura Zlata	Sinaia	Palearctic, Asian	Cryostenothermic
Psectrocladius bisetus Goetghebuer, 1942	Zlătuia, Gemene	–	Palearctic	Boreoalpine
P. octomaculatus Wülker, 1956	Negru, Gemene, Lia, Căldarea Berbecilor	–	Palearctic	Boreoalpine, phytophilous
P. psilopterus Kieff. in Kieff. & Thien.,1906	Zănoaga	Danube, Argeș, Jiu, Mureș, Olt, Prahova	Holarctic	Phytophilous
Pseudosmittia gracilis (Goetghebuer, 1913)	Bucura	–	Holarctic	Psammophilous

1	2	3	4	5
P. recta Edwards, 1929	Gura Zlata	–	Palearctic	
Rheocricotopus atripes (Kieffer, 1913)	Gemene	Sinaia, Danube (Iron Gates)	Palearctic, Asian	
R. effusus (Wülker, 1956)	Gemene, Zlătuia, Căldarea Berbecilor	Sinaia, Olt	Holarctic, Asian	Crenoxenous, phytophilous
R. fuscipes Kieffer, 1909	Gemene	Sinaia, Olt, Ada Kaleh	Palearctic, Asian	
Smittia aterrima (Meigen, 1818)	Negru, Gemene	Sinaia, Olt, Cerna	Palearctic, Asian	
S. superata Goetghebuer, 1939	Florica	Muntele Mic	Palerctic	
Symposiocladius lignicola (Kieff. in Pothast,1915)	Gura Zlata	–	Nearctic	
Thienemanniela clavicornis Kieffer, 1911	Negru, Gemene, Gura Zlata	Danube (Iron Gates), Muntele Mic, Prahova	Palearctic, Asian	Rheocrenobionta
Tvetenia bavarica (Goetghebuer, 1934)	Zlătuia, Râușor, Netis, Văgăuna Neagră	Danube (Iron Gates), Argeș, Bistrița, Prahova, Someșul Cald și Rece	Palearctic, Asian	Rheophilous
T. calvescens (Edwards, 1929)	Negru, Gemene, Căld.Berbecilor	Sinaia, Olt, Someșul Cald, Someșul Mic	Palearctic Asian	Cryostenothermic, stenooxybiotic
T. verralli (Edwards, 1929)	Zlatuia	–	Palearctic	Mountain rivers
SUBFAM. CHIRONOMINAE				
Chironomus dorsalis Meigen, 1830	Gemene	–	Holarctic, Asian	Mountain waters
Cryptocladopelma lateralis Goetghebuer, 1934	Negru, Gemene	Gâlcescu, Danube, Argeș, Jiu, Ialomița	Palearctic	Mountain lakes, psammophilous
Endochironomus tendens (Fabricius, 1775	Gemene	Danube (Iron Gates), Crapina-Jijila	Palearctic	phytophilous

(continues)

Table 1 (*continued*)

1	2	3	4	5
Polypedillum (P.) *albicorne* (Meigen, 1838)	Gura Zlata	Sinaia, Valea Vinului, Vatra Dornei	Palearctic	Cryostenothermic
P. (P.) *convictum* (Walker, 1856)	Gura Zlata, Netis Zlătuia, Bârlii, Văgăuna Neagră	Danube, Argeș, Mureș Bistrița, Criș, Ialomița, Moldova, Olt, Someș	Holarctic	Running waters, lakes
P. (P.) *laetum* (Meigen, 1818)	Gura Zlata	Sinaia	Holarctic	Lakes margins, running waters
P. (Tripodura) *elongatum* Albu, 1970	Gura Zlata	Sinaia	Palearctic	Still mountain waters
Micropsectra bidentata Goetghebuer, 1921	Lia	Sinaia, Vatra Dornei, Lotru, Neajlov	Palearctic	Springs, lakes
M. contracta Reiss, 1969	Viorica, Lia, Gura Zlata	–	Palearctic	Cryostenothermic
M. fusca (Meigen, 1804)	Zănoaga	Sinaia	Holarctic	Running waters
M. junci (Meigen, 1818)	Negru, Gemene, Lia, Bârlii, Netis, Râușor, Văg.Neagră Căld. Berbecilor	Danube (Iron Gates), Liu, Lotru, Doftana, Ialomița, Valea Vinului	Palearctic	Crenophilous, polyoxybiotic, lakes, springs
M. lindrothi (Goetghebuer, 1931)	Viorica	–	Holarctic	Crenophilous, Oxybiotic
M. recurvata Goetghebuer, 1928)	Lia	–	Holarctic	Crenoxybiotic, stenotopic
Parapsectra nana (Meigen, 1818)	Gemene Brook	–	Palearctic	Mountain brooks, cryostenothermic
Paratanitarsus austriacus Kieffer, 1924	Negru, Gemene	–	Palearctic	Eurythermic
Rheotanitarsus nigricauda Fittkau, 1960	Zlătuia, Râușor, Radeș, Văgăuna Neagră	Olt	Palearctic	Cryostenothermic. rheooxyphilous

1	2	3	4	5
Stempellinella brevis (Edwards, 1929)	Gemene, Ana-Lia, Zlătuia, Bârlii, Căld. Berbecilor	Danube (Iron Gates), Bistrița, Argeș	Palearctic	Oligotrophic lakes and running waters
S. saltum (Goetghebuer, 1921)	Zlătuia	Sinaia, Olt, Muntele Mic	Palearctic	Running waters
Tanytarsus bathophylus Kieffer, 1911	Negru, Bucura, Lia	–	Palearctic	Cryostenothermic
T. gregarius Kieffer, 1909	Negru, Gemene, Lia, Zănoaga, Bârlii, Văgăuna Neagră	Danube, Argeș, Olt, Prahova	Palearctic	Lakes, running waters

– reactivity towards the oxygen concentration on the water, which is a limiting factor in the case of the reophilous forms;

– reactivity towards humidity, which in the lack of food, is an essential factor for the adult stage because it allows them to avoid drying;

We have seen that within the structure of the chironomidae of the Retezat massif (Table 1), dominant are the species displaying a preference for biotopes situated at high altitude, low temperatures of water and air, high concentrations of oxygen in the water, etc. In a word, they are stenotopic, specialised forms;

– from the 104 species, 48 are Palearctic (north and central European areas); 17 species are Palearctic and Asiatic; 22 species are Holarctic; 9 species are Holarctic and Asiatic; 3 species are Holarctic, Asiatic and Neotropical;

– of the 104 species, four are new species: *Bryophaenocladius* (*Odontocladius*) *pectinatus* Albu, 1974, *Helleniella extrema* Albu, 1972, *Parachaetocladius retezati* Albu, 1972, *Polypedillum* (*Tripodura*) *elongatum* Albu, 1980;

– of the 104 species, 2 species are endemic for the Retezat massif: *Helleniella extrema* and *Parachaetocladius retezati*.

SYSTEMATIC POSITION OF THE NEW SPECIES OF CHIRONOMIDS IDENTIFIED IN THE RETEZAT MASSIF

– *Bryophaenocladius pectinatus* Albu, 1974 and *B. nigrus* Albu, 1974 were described and included in the sub-genus *Odontocladius* by Albu in 1974. This inclusion was invalidated (6), but we expressed again our opinion, validating it (52). Species *B. (O.) pectinatus* was described based on samples collected at Gura Zlata, and *B. (O.) nigris* was described based on samples collected at Ieşelniţa (The Iron Gates). These two species are resembling the most within the genus of *Bryophaenocladius*. They might spread through the Cerna corridor;

– *Helleniella extrema* Albu, 1972. Until 1967, genus *Helleniella* Gowin, 1943, included only one species, *H. ornaticolis* (Edw.). In 1967, two new species were identified in the French Alps: *H. dorieri* Serra-Tosio and *H. intermedia* Serra-Tosio. In 1968, Reiss described *H. asiatica* identified in Nepal and in 1969, Saether described *H. curtistila* and *H. hirta* identified in Canada. In a sample collected from the surface of Taul Negru (2036 m altitude) have been found a male of the genus *Helleniella* resembling to *H. dorieri*, but having significant differences from it. Albu, 1972, described it as *Helleniella extrema*, species situated on the same line of evolution with *H. dorieri*, but much more specialised by the aspect of the distal article of the hypopygium, of the anal tip and by the low values of AR index;

– *Parachaetocladius retezati* Albu, 1972. In 1959, Wulker created within the genus *Chaetocladius*, the sub-genus *Parachaetocladius* in order to include there *C. (P) abnobaeus* found in Feldberg (Germany); in 1969, Saether elevated the sub-genus to the rank of genus, also describing the species *P. hirtipectus* which has some common characters with the first species, but some distinctive traits too, which raised the issue of kinship of this genus with the genus *Limnophyes*.

In a sample collected from the shore of lake Lia (1910 m altitude) we found two males. Based on the description of Albu, 1972, this species remains close to the species described by Wulker, *abnobaeus* identified in the mountains of Germany;

– *Polypedillum elongatum* Albu, 1980. By its morphological traits, this species can be placed between the sub-genera *Tripodure* and *Polypedillum* s.str., as described by Towes (1945). To be more specific, this species resembles to *P. (T.) gomphus* Townes identified in the Nonarctic area and to *P.(P.) apfelbecki* whose type was identified at Sarajevo (Yugoslavia).

CASES OF HETEROCHRONIA IDENTIFIED IN CHIRONOMIDAE

Botnariuc and Albu, 1971, presented several observations regarding some abnormalities identified in the chironomids collected from Taul Negru and Taul Gemene in 1969. These abnormalities were observed in five species: *Psectrocladius octomaculatus* Wulk., *Chironomus alpestris* Goetgh., *Paratanytarsus austriacus* (Kief.), *Tanytarsus bathophylus* (Kief.), *T. gregarius* Kief.

We note them and we insist on their presence in this group of insects because there are opinions according to which heterochronia would play a certain role in macroevolution. The thesis which appeared during the past century (Kollmann, 1885, in 15) was resumed recently by Gould, 1977.The phenomenon of heterochronia in the individual development as a possible mechanism for the fast appearance of new taxa is explained by two processes: pedogenesis or progenesis (= prothotelie), when some characters of the adults appear at young (larval) stages and neotenie (= methatelie), when some juvenile characters persist in the adults. These processes correlate with the two types of strategies of selection: r and k.

Botnariuc (1992), insisting on the conditions of manifestation of this process, showed that in chironomids, he found out (13) that progenesis appeared in two, very different situations: "in the water of rice fields where the eggs were laid by pupae, and in glacial lakes in the Retezat massif (Carpathians) where characters of pupa were observed in larvae. The common factor which, we think, triggers the occurrence of this phenomenon is the short period of development induced by the conditions of the respective ecosystems: draining of the rice fields, in the first case and the short duration of the temperatures optimal for development, in the second case". Without making any evaluations for or against the importance and role of these states in the onthogenetic development of the individual, which can, however, be a possible mechanism for the fast appearance of new taxa and, therefore, a possible way for macroevolution, we would like to point out that:

– the presence of these states in the particular situation of chironomids is connected directly to the existence of certain conditions of the ecosystem;

– the phenomenon can be included among the barriers of ecological nature.

In conclusion, by its position, by its geomorphological structure, by its physico-geographical conditions, the Retezat massif provides orographic, climatic, physiographical and ecological barriers for certain populations of organisms.

We consider that processes of evolution were possible in the Retezat massif because:

– in the recent history, there were conditions for ensuring the genetic diversity and, at the same time, the organisatoric heterogeneity (structural and functional) (many glacial relics);

– the Retezat massif has a high floristical and faunal diversity;

– each faunal group mentioned here contains species identified for the first time in the fauna of Romania;

– almost each faunal group that was analysed includes new species, all of them possibly endemic for the Retezat massif;

– irrespective of the philogenetic level, there are genera very well represented as number of species;

– some authors say that the low level in which some faunal groups are represented (for example the oligochete) was determined by the action of the orographic and climatic barriers;

– in the Retezat massif there are many stenotope, specialised forms. This observation is very important for the process of evolution, to the extent to which "the hypothesis of the effect" of Vrba, 1980, should be considered: the rates of speciation and of extinction are much lower in the euritope species than in the stenotope species.

Finally, we shall mention the thesis of Margalef, 1970, regarding the relation between the evolutive characters of the species and the ecological succession of the ecosystem. In the situation of the Retezat massif, according to this thesis, we consider that there are mature stages of the ecological succession in which:

– the representative species live longer;

– the reproductive communities are smaller with relatively few offsprings;

– they have limited means of dispersion;

– they are well integrated in the system, both by their metabolism and by their behaviour.

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CONTINENTS, OCEAN BASINS AND FRESHWATER ZOOGEOGRAPHY. III. THE NORTHERN CONTINENTS

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One can distinguish on the one hand amphi-atlantic lineages of freshwater animals, present in the western Palearctis and eastern in North America and amphi-pacific ones, ranging in eastern Siberia, East Asia and North America, on the other hand palearctic and nearctic ones. There are only few amphi-atlantic lineages, much more amphi-pacific ones. The main amphi-pacific or beringian dispersal route links eastern Siberia, arctic and eastern North America; East Asia proper and western North America have been populated indirectly. Nevertheless, numerous lineages have presently a disjunct East Asian – eastern North American distribution most strictly palearctic lineages have southern Asian affinities, while most nearctic ones (present in eastern and western North America) derive from amphi-Pacific superlineages.

Parenti's 1991 assumption (29) that the distribution of freshwater fishes corresponds to ocean basins rather than to the present-day continents has been contradicted in two earlier papers (4, 5) in which it has been demonstrated that:

1. The fauna of primary freshwater fishes and invertebrates of the western (Atlantic watershed) and eastern (Indian Ocean watershed) of tropical Africa have closer ties with each other than the former with the South America and the latter with the southern Asian one, on the opposite side of the Atlantic, respectively of the Indian Ocean. Most lineages present in South America and Africa are not confined to the western watershed of the latter continent, being also present on the eastern one. Similarly, most lineages shared by Africa and southern Asia and absent from South America are not restricted to eastern Africa, but also range in the west of the continent, many being even restricted to the west, others including more western than eastern African species. Even more remarkable is that within most lineages present in South America and both watersheds of Africa, the western and eastern African genera and species usually are more closely related to each others than with the South American ones (4,6).

2. Contrary to the African faunas of primary freshwater animals, those of peripheral freshwater animals (i.e. of marine origin) confirm Parenti's viewpoint: the eastern African peripheral fauna has closer ties with the southern Asian one (both deriving from the very rich Indo-West-Pacific marine fauna) while most genera and species of the western African peripheral freshwater fauna (fishes, prawns, mussels etc.) have closer ties with the species and genera of the peripheral fauna on the Atlantic watershed of South America. It is worth mentioning however that western African genera of fishes and prawns, strictly confined to freshwater but belonging to primarily marine families (Clupeidae, Atyiidae, Alphaeidae) are members of prevailingly Indo-West Pacific supergeneric taxa which are ab-

sent from the eastern African inland waters. It can be assumed that their ancestors entered the fresh waters of eastern Africa from the Indian Ocean; reached western Africa by continental route, later becoming extinct from eastern Africa (4, 6).

3. Two distinct freshwater faunas can also be delimited in South America (5, 6): a tropical one on the Atlantic watershed, opposite to Africa and a temperate and cold one in the south of the continent, which has formerly been connected with Australia. Most primary freshwater animals from tropical South America (fishes, sponges, some families of molluscs, a few of aquatic insects) have African ties. But not all these lineages are confined to the tropical South America, more than a quarter from them being also present in the south of the continent. Some primary freshwater lineages confined to temperate and cold South America (one family of each fishes and crayfishes, some families and groups of genera of aquatic insects) have Australian or New Zealand ties, while others, especially among fishes, besides many genera of caddis flies and one of diaptomid copepods are derivatives of the tropical South American fauna. It is worth mentioning that some lineages with clear Australian or Antarctic ties are not restricted to the south, being also present in the tropical areas of the continent, the most significant example being the mussel subfamily Hyriinae, whose distribution within the continent is identical to that of the family Mycetopidudae, which has African affinities.

Hence, the distribution of the South American taxa of primary freshwater animals, contrary to that of the African ones, confirms, to a large measure, Parenti's (29) assumption: most lineages present in tropical South America have African affinities and the majority of them are absent from the temperate and cold areas of the continent, while the majority of those living in the latter areas have circum-antarctic, above all Australian ties, and do not live in the tropical areas. The primary freshwater fauna from tropical South America is more closely related to the African than to the temperate/cold South American one, while the latter is more closely related to the Australian fauna.

4. A tropical and a southern-temperate freshwater fauna can also be distinguished in the Australian region (Australia and New Guinea). Northern Australia / New Guinea lies at a short distance from south-eastern Asia, but only a few lineages of primary freshwater animals from the area have southern Asian affinities: the archaic fish genus *Scleropages* and the viviparid snails, besides aquatic insects (mainly caddis flies) and diaptomid copepods with transmarine dispersal possibilities. Most primary freshwater lineages have circum-antarctic, mainly Australian ties: parastacid crayfishes, hyriid mussels, two families of caddis flies, one of leehes; all are present (and even more numerous) in the south of Australia, but also live in northern Australia and New Guinea.

5. The primary freshwater fauna of southern Australia consists almost exclusively in lineages also present in South America or other formerly Gondwanian continents. As mentioned above, most also range in northern Australia / New Guinea and within them, the southern Australian genera and species are more closely related to the northern Australian / New Guinea than to the South American ones (5, 6).

Hence the situation is similar to that in Africa: there are closer affinities between the primary freshwster fauna of both halves of the continent, than between the faunas of southern Australia and of South America. On the contrary, the peripheral freshwater fauna of northern Australia and New Guinea has closest ties with the southern Asian one.

The aim of the present contribution is to analyze the relationships of the aquatic faunas of the two northern continents, Eurasia and North America. They are separated by two oceans; a continental link existed between eastern North America and Europe until the Eocene while the Beringian link between north-eastern Siberia and north-western North America was established during the Cretaceous and lasted, with short periodical interruptions, until late, postglacial times. On the other hand, Europe has been separated from Siberia until the Oligocene by a marine barrier, the Turgai Sea, while a north-south seaway cut off western from eastern North America, from the early Cretaceous until the early Paleocene; the present-day Rocky Mountains maintain isolated the aquatic faunas of western and eastern North America.

This complex geological history as well as the distance between the western and eastern areas of both continents and the existing barriers explain the difference between the aquatic faunas from various areas of North America and Eurasia. The following types of distribution can hence be expected to be present in the northern continents:

– amphi-atlantic (present in the western Palearctis, i.e. Europe, north-western Africa and certain western Asian areas and in North America, especially in eastern North America, absent from the eastern areas of Eurasia) and amphi-pacific (present in the eastern areas of Asia, i.e. East Asia proper and north-eastern Siberia and in North America, absent from the western Palearctis;

– palearctic (widely distributed throughout temperate Eurasia or disjunctly in western and eastern Eurasia, absent from North America) and nearctic (present in eastern and western North America, absent from Eurasia).

The problem actually is more complex than in the case for ex. of Africa. Certain distributions cannot be assigned to any of the four types mentioned above. This is the case for example with the fish subfamily Scaphirhynchinae, with one genus in eastern North America and the second in the Aral Sea basin of central Asia, about equally distant from the Atlantic and from the Pacific Ocean. In the absence of paleontological data it is not possible to decide whether the distribution of this subfamily is amphi-Atlantic or amphi-Pacific.

Paleontology often disproves the conclusion derived from the recent distribution of species and genera. For example, the fish genus *Umbra* has two species in eastern North America and one in central Europe; this distribution can be considered as amphi-Atlantic. However, fossils have been found also in Siberia (subgenus *Proumbra*: 27) on the other hand, the recent species are too closely related for accepting an Eocene or pre-Eocene divergence; the genus probably dispersed between both continents more recently, by the north Pacific link.

A better example of non-concordance between deductions derived from the present-day distribution and paleontological data is furnished by the fish family Catostomidae. The three interrelated more apomorphic subfamilies Cycleptinae, Ictiobinae and Catostominae are confined to North America, comprising eight eastern and two western genera and one in both halves of the continent (28). Their common trunk can be considered on the base of the recent distribution, as nearctic. However, fossils, belonging to two or three extinct and to six recent North American genera (four eastern, one western,one eastern and western) have been found in the Paleogene of Mongolia, Siberia and Kazakhstan (40). Hence the lineage consisting of these three subfamilies is amphi-Pacific, not nearctic.

It is worth mentioning that one fossil genus *Anyzon* had a wide distribution from western Kazakhstan across southern Siberia to western North America.

Another difficult problem is that of the lineages disjunctly distributed in the western Palearctics and western North America, which are absent from Siberia, East Asia and eastern and northern North America as well. The most typical example is that of the crayfish family Astacidae: genus *Astacus* in Europe and the Aral Sea basin, *Pacifastacus* on the western watershed of North America (22). A similar distribution is displayed by a pair of sister genera of stoneflies: *Tyrrhenoleuctra* (south-western Europe and north-western Africa) and *Moselia* (western watershed of North America) (32). Both groups can be considered either amphi-atlantic because of their occurrence in the western or absence from the eastern Palearctis, amphi-pacific on the basis of their occurrence in western and absence from eastern North America.

Both northern continents comprise not two, but three subdivisions: a western, a eastern and a northern one. The northern Eurasia comprises Siberia proper, i.e. the drainage areas of the rivers flowing into the Arctic Ocean and into northern Pacific, north to the Jablonoi Stanovoi mountain range, without the Amur River basin, that belongs politically to Russia, but whose aquatic fauna is typically East Asian (Chinese). The recent very poor aquatic fauna of Siberia, at least in respect of fishes, peracarid crustaceans and molluscs, can be designed as an empoverished European fauna, most species present in Siberia also living in Europe. But the Siberian fauna was much richer during pre-glacial times and there are strong paleontologic arguments in favour of the hypothesis that the recent European, mainly central European aquatic fauna derives from the Neogene fauna of Siberia.

Northern or arctic North America comprises the rivers of the Atlantic watershed north of the Great Lakes and of St. Lawrence River, of the Hudson Bay, of the Arctic Ocean proper and the Pacific watershed north of Fraser River. The aquatic fauna of arctic North America is similar to that of Siberia, a depauperate one and is much similar to the eastern than to the western North American one, sharing a higher number of common genera and species.

The Beringian link between Eurasia and North America implies the northern (arctic) areas of the two continents and implicitly the western Palearctis (whose aquatic fauna is the closest to the Siberian one) and eastern North America. East Asia (i.e. the area south of the Stanovoi-Jablonoi mountains: the Amur River basin, most of China, Corea, Japan, northern Vietnam) and western North America (the rivers of the Pacific Ocean watershed from Frazer River to Rio San Pedro in Mexico) have no direct contact at least in the present-day hydrographic conditions), but only through the intermediary of north-eastern Siberia and arctic North America. This is why most amphi-pacific lineages are present in eastern, not in western North America. (This assertion refers mainly to primary aquatic animals – fishes, higher crustaceans, branchiate molluscs – unable to disperse by land: – not aquatic insects, able to cross narrow divides between river basins and whose Siberian and East Asian faunas are not as sharply delimited as those of fishes, higher crustaceans, etc.).

It is worth mentioning also that the various areas of North America and temperate Eurasia are in close contact with tropical areas: South America, tropical Africa (the "Ethiopian region") and southern Asia. This fact has zoogeographical implications. The contact between the two Americas and between the western Palearctic and tropical Africa had affected only in a minor manner their aquatic faunas. The aquatic fauna of East Asia, and indirectly those of the western Palearctis and even of North America have on the contrary strong affinities with that of southern, above all of south-eastern Asia. Speciose lineages of primary freshwater fishes (the families Cobitidae and Siluridae, the subfamily Cyprininae include most genera and species in south-eastern Asia) are also present in great number in East Asia, but also include some members in Siberia and Europe (3). Similarly, the endemic North American catfish family Ictaluridae is usually considered related to the speciose Bagridae widely distributed throughout East and southern Asia, also comprising some species in Africa and with fossil records from the Paleogene of eastern Kazakhstan and western Mongolia (40).

In the light of the above-mentioned data, let us review the amphi-atlantic, amphi-pacific, palearctic and nearctic lineages of primary freshwater animals and their degree of representativity in the faunas of the various northern continental areas.

AMPHI-ATLANTIC LINEAGES

A single taxon of primary freshwater fishes of the recent fauna is undoubtedly amphi-atlantic: the family Percidae, that includes an endemic eastern North American and an endemic central European tribe, is totally absent from East Asia, western North America etc. Its dispersal history has been reconstructed by Collette and Bănărescu (15) in the light of the phyletic relationships of the genera, tribes and subfamily accepted then. More recently Coburn and Caglione (14), later Wiley (45) suggested alternative classifications of the family, considering that the central European tribe Romanichthyini is the closest relative of the eastern North American Etheostomatini. Accepting their viewpoint, the former dispersal of their common ancestor by a North Atlantic continental link becomes more evident.

A few fish lineages presently endemic to eastern North America have fossil recording east of the Atlantic, hence they must be ascribed to the amphi-atlantic category, too: Amiidae (fossils in Europe), Lepisosteidae (fossils in western Africa and Europe), Percopsiformes (fossils in Europe).

Among the amphi-atlantic lineages of freshwater invertebrates are: *Iberobathynella* among the Syncarida (south-western Europe, south-eastern and extreme western North America (36), *Linderiella* among Anostraca (same distribution – 41), the subfamily Lithoglyphinae (one genus in Europe, five in eastern and one in western North America – 13, 38) and the genus *Viviparus* (Europe, Anatolia, western Siberia, eastern North America (13, 38) among prosobranchiate snails, the genus *Hesperophylax* (Europe, eastern and western North America) among caddis flies, the families Mideidae, Bogatiidae, Neoacaridae and the genera *Piersigia, Tartarothyas* and *Chappuisides* among water mites (2, 44). The three families and two of the three genera are confined in North America to the eastern watershed. Water mites are obviously the group of aquatic animals including a relatively high number of amphi-atlantic lineages; it is worth mentioning, however, that little is known about the water mites fauna of East Asia outside Japan; some lineages, presently recorded only from the western Palearctis and eastern North America may actually be present in continental East Asia, too.

The archaic fish family Amiidae, endemic to eastern North America has fossil record also from North Europa, being hence amphi-atlantic, too.

Amphi-atlantic may also be a group of genera of pleurocerid prosobranchiate snails, comprising the central european *Holandriana* (= *Amphimelania*); it is but not known if this is closer to one or a few North American genera or to a East Asian one.

Two genera of primary freshwater fishes, *Umbra* (Umbridae) and *Stizostedion* (Percidae) have presently an amphi-atlantic distribution but inhabited formerly also Siberia are believed to have dispersed by the north Pacific continental link.

AMPHI-PACIFIC LINEAGES

The number of amphi-pacific lineages is much higher than that of amphi-atlantic ones. Several categories can be distinguished among them:

1. Disjunctly distributed in East Asia and eastern North America absent from the arctic areas of both continents (north-eastern Siberia and arctic North America) and from western North America.

The fish family Polyodontidae (having however fossil recordings from Europe, too), the related Bagridae (east and southern Asia) – Ictaluridae (eastern North America), two genera of caddis flies (*Mexipsyche* with a very widely disjunct range in southern China and south-eastern U.S.A./Mexic – 43 and *Psilotreta* – 30).

But by far the largest taxon displaying this distribution is the cray-fish family Cambaridae, comparing monogeneric subfamilies in the northern areas of East Asia – Amur River basin, Korea, Japan and Liaoho River in northern China) and two subfamilies, with more than ten genera and hundreds of species in eastern North America, quite few of them having reached the Pacific watershed of Mexico – 22.

To the same historical zoogeographical category belong several more widely distributed taxa, whose range on the temperate northern zone is confined to East (or also high) Asia and to eastern North America: the subfamily Acroneurinae (also in southern Asia and tropical Central and South America and the tribe Neoperlini (also in southern Asia and Africa) among the perlid stoneflies (37), the families Xiphocentronidae (also present in southern Asia and tropical South America – 35) and Hyalopsychidae (also in southern Asia and even in northern Australia and tropical Africa (30, 34) of caddisflies. The tropical ranges of these lineages can be considered to be a prolongation of their East Asian and North American ranges.

Another specious and more widely distributed taxon, the mussel subfamily Ambleminae comprises most genera and species in East and south-eastern Asia and in eastern North America, only few in the western Palearctis and western North America (2).

It is worth mentioning that most families and other higher taxa distributed throughout the northern hemisphere are more diversified in eastern North America and in East Asia than in any other northern area.

2. Disjunctly distributed in East Asia and in western North America. Much fewer lineages display this type of distribution: the subfamily Paraperlinae with two species in the north of East Asia and four in western North America (46), the genus *Paraleuctra* distributed in East and High Asia and western North America, among stoneflies (32, 46), three related genera of pomatiopside operculate snails (*Blanfordia* and *Fukuia* in Japan, *Cecina* in western North America – 17). The endemic Californian isopod genus *Calasellus* is closest to *Asellus* distributed throughout temperate Eurasia and in arctic North America. Finally, the cyprinid fish genus *Pogonichthys*, with two species in the central areas of western North America, is considered to be the closest related sister of *Tribolodon* from the northern part of East Asia. Disjunctly distributed in East Asia and western North America also are three genera of Blepharoceridae midges (1) and the genus *Gumaga* of Sericostomatidae.

3. Present in East Asia and in both temperate areas of North America. Some lineages of this category are also present in the arctic area of North America, others only in the temperate (eastern and western) ones, their range being disjunct.

Such distribution is displayed by the most plesiomorphic families of arctoperlarian stoneflies: Pteronarcyidae (also present in arctic North America) and Peltoperlidae (absent from arctic North America and also ranging in south-eastern Asia (46); a similar distribution in the northern continents, but extending from North America into Central and South America has the stonefly subfamily Acroneurinae (37), the caddisfly family Arctopsychidae (excepting one species, *Arctopsyche lagogensis*, that has a wide and continous circumpolar distribution, evidently as a consequence of quite recent dispersal (33), the caddisfly subgenus *Dolophilodes* s.str. (20) and some other supraspecific taxa of caddisflies.

4. Present in Siberia (or also in Europe) and in arctic and eastern North America, absent from East Asia and from western North America.

It has already been mentioned that the Beringian link between both northern continents is represented by north-eastern Siberia, which is in direct contact with central and western Siberia and indirectly with Europe, and arctic North America that is in direct contact with eastern North America, while the Jablonoj-Stanovoj mountain range and the Rocky Mountains represent important barriers between East Asia and arctic (north-eastern) Siberia and respectively between western and arctic/eastern North America. Hence the main amphi-pacific dispersal route lies between arctic Siberia and arctic North America. The numerous taxa present in East Asia and North America have formerly also ranged north-eastern Siberia.

A typical Euro-Siberian and arcto/eastern North America distribution is displayed by the snail subfamily Viviparinae (presently absent from eastern Siberia where it formerly lived). Its closest relative, the subfamily Bellamyinae, ranges throughout whole East Asia, in southern Asia and in Africa (2, 38). The fish genus *Perca* has the same range: *P. fluviatilis* lives in Europe and Siberia (not in the Amur River basin which zoogeographically belongs to East Asia), *P. flavescens* in arctic and eastern North America, the east-Siberian populations of *P. fluviatilis* are, to a certain measure, intermediate between both species (39), this fact proving that the dispersal took place by the Beringian route.

Arguments have also been advanced that two fish genera, *Umbra* and *Stizostedion*, with a disjunct amphi-atlantic range in Europe and eastern North America (the latter also in arctic North America) have dispersed by the Beringian route, their absence from Siberia being due to recent extinction (2, 15).

The only cyprinid genus present both in Eurasia and North America, *Phoxinus*, comprises a Palearctic widely distributed species (Europe to eastern Siberia and the Amur basin in East Asia), three central Asian ones and several in eastern or also in arctic North America (26); its dispersal by the Beringian route is obvious.

It can be assumed that the entire subfamily Leuciscinae belongs to the same category. This is the northern most subfamily of Cyprinidae, the only one present in North America and absent from southern Asia; contrary to the others, it has only few species in East Asia, but many genera and species in the western Palearctis, some of which also range and Siberia (while many others were present prior to the Ice Age) many more others being native in North America. There are few data on the interrelations of the genera. According to the more recent opinions, the eastern North America *Notemigonus* may be related to the European/western Asian (formerly also Siberian) *Alburnoides,* while all other Amarican genera, eastern and western as well, are ascribed to the "phoxinines", a subdivision of Leuciscinae, alongside the already mentioned *Phoxinus* and six Eurasian genera (two of them confined to the north of East Asia one to western Mongolia). The leuciscines have an older fossil record from East Asia and Siberia and reached both Europe and North America in Oligocene times (28).

These data obviously suggest that the subfamily initially lived in Siberia, reached North America by the Beringian route and simultaneously extended to Europe after the disappearance of the Turgai Sea.

Minor groups of amphi-pacific lineages are those present only in the cold areas of Siberia and in arctic North America (some cold-adapted genera of Anostraca: *Artemiopsis* and both genera of Polyartemiidae, one Euro-Siberian, the second arctic American (12, 16), in the north of East Asia in arctic North America (the copepod genus *Nordodiaptomus* – 18).

The number of families and other supra-specific taxa present in the temperate areas of both continents is exceedingly high; when the phyletic (sister) interrelationships of their component members are clarified, it will be possible to ascribe them (on their sublineages) to the geographic categories mentioned above. Discovery of new genera and species often modifies former opinions about their position. A good example is furnished by the caddisfly family Beraeidae, unanimously considered as amphi-atlantic, since it was known from the western Paleartic and eastern North America. A new genus, until now monospecific, has recently been described from Japan (9); the family hence has a holartic-east Asian range and may have dispersed by the Beringian route.

PALEARCTIC LINEAGES

Most lineages of primary freshwater fishes present in the western Palearctic also range in East Asia: almost all Ostariophysi, with the partial exception of Leuciscinae: three subfamilies of Cyprinidae (Gobioninae, Acheilognathinae, Cyprininae), a few genera of Cobitidae and Siluridae. The subfamilies Gobioninae and Acheilognathinae and the genera *Cobitis*, *Misgurnus* and *Orthrias* of Cobitidae are almost exclusively Palearctic in distribution extending only slightly in south-eastern Asia; while the endemic western Palearctic *Sabanejewia* is the closest to *Cobitis*. Cyprininae and Siluridae are on the contrary prevailingly southern Asia; some of the endemic western Palearctic genera of Cyprininae may be closest to southern Asian ones (2).

Palearctic lineages of aquatic invertebrates are; the prosobranchiate snail genus *Bythinia* (of a family widely distributed in the eastern hemisphere, even in tropical

Africa and Australia and absent from the America – 38), two genera of Anostraca or fairy shrimps (*Chirocephalus* and *Drepanosurus* – 12), two of diaptomid copepods (*Mixodiaptomus* and *Acanthodiaptomus* – 18), a family of caddis flies, Thremmatidae with a distinct range (one genus in Europe, the second in the Amur River basin, East Asia), three genera of phryganeid caddis flies (20), at least one of water mites (*Zschokkea*), one of branchiobdellid worms (*Branchiobdella*, disjunctly distributed in Europe and Japan (24, 25).

To these must be added the mussel subfamily Unioninae, also present in southern Asia and isolated in eastern and southern Africa, but absent from North America; it is worth mentioning that the European species are congeneric with the African ones and the East Asian genera more closely related to the southern Asia than to the European ones (21, 38).

Most palearctic lineages have closer relationships with the tropical Asian and even with the African than with the American ones (examples; the three families of ostariophysan fishes, the bythiniids and unionines); a remarkable exception is *Branchiobdella*, of a family more diversified in North America and absent from the tropical areas of the Old World (24, 25).

NEARCTIC LINEAGES

Present in eastern and western North America and absent from Eurasia are: the fish families Hiodontidae, Centrarchidae and Percopsidae (the latter is related to exclusively eastern North American families), the group of three interrelated apomorphic subfamilies of Catostomidae (with fossil record also in Asia the subfamily Nymphophilinae of hydrobioid snails, the genera *Stygobromos* (crangonyctid amphipods), *Eubranchipus* (chirocephalid fairy shrimps – 12), *Xironogiton, Oedipodrilus* and *Cambarincola* (branchiobdellid worms – 24), *Thyopsella* (water mites), eight genera of stoneflies (46), seven of caddis flies and the pair of sister-genera *Gillia* (eastern) and *Fluminicola* (western) of lithoglyphine snails (42).

OCCURRENCE AND RELATIVE ABUNDANCE OF THE VARIOUS CATEGORIES OF LINEAGES IN THE NORTHERN CONTINENTAL AREAS

1. Europe and other western Palearctic areas

The species of the amphi-atlantic lineage of primary freshwater animals represent only a small percentage of European aquatic fauna, Percidae being the most important of these lineages. It is worth remembering that certain genera present in Europe and eastern North America dispersed between both continents by the north Pacific link (e.g. *Umbra, Stizostedion*). Much more numerous are the members of the palearctic lineages. Numerous are also the species of lineages considered here amphi-pacific, because they dispersed between Eurasia and North America by the Beringian route. Among these are the genera of leuciscine cyprinid fishes. This group obviously originated in the Paleogene of Siberia, the ancestors of the American genera dispersed by the Beringian route, those of the western Palearctic genera dispersed across western Siberia, after the retreat of the Turgai Sea. These are old continental migrants in the European freshwater; their zoogeographic status is similar to that of the Palearctic lineages, the latters having however an East Asian origin and several of them affinities with the tropical Asian fauna, while the western Palearctic genera of leuciscines originated in Siberia (drainage area of Arctic Ocean) and seem never to have lived in East Asia proper. It is worth remembering that only two of the leuciscine genera ascribed by Caverder (23) to the "phoxinine" group (alongside all North American genera) are present in Europe (*Phoxinus* and *Eupalasella*, the latter only in north-eastern Europe), the others ranging in East and Central Asia.

A similar dispersal history have the exclusive Euro-Siberian lineages, u. oth. the monogeneric cyprinid subfamily Tincinae.

2. East Asia

The palearctic lineages include much more species in East Asia than the western Palearctic and in Siberia (e.g. the Acheilognathinae about 40 species as against a single one in Europe, the Gobioninae 111 species in 20 genera, as against eight species in one genus in the western Palearctic and a single species in Siberia); many of the Palearctic lineages originated in East Asia and colonized later Siberia and Europe.

Well represented are also the amphi-pacific lineages, some of which include more species and genera in East Asia, other in North America.

Numerous also are the lineages shared with southern Asia (some of them also with tropical Africa) being absent from both the western Palearctic and North America: two subfamilies of cyprinid fishes (Cultrinae only East and southern Asia, Rasborinae also in Africa), three subfamilies of Cobitidae (two formerly considered distinct families) many genera and groups of genera in other subfamilies, three families of Siluroidei and three fish families in other orders, the subfamily Bellamyinae of the viviparid snails (sister of the strictly Holarctic Viviparidae), two families caddis flies (Limnocentropodidae and Phryganopsychidae). It is worth mentioning that most palearctic lineages are subdivisions of higher taxa also present in southern Asia or are at least related to southern Asian taxa.

3. North America

The amphi-atlantic lineages are better represented in eastern North America than in Europe: e.g. Percinae include almost 200 species in North America and only 14 in Europe and Siberia; the Amiidae, Lepisosteidae and Percopsiformes survive in North America but became extint from the western Palearctic, the Lythoglyphinae comprise a single European genus and five North American ones.

However, in comparison with the amphi-pacific and nearctic lineages, the amphi-atlantic ones represent a small minority in the eastern North American aquatic fauna. Amphi-atlantic can also be considered the few lineages present in Europe and western North America: astacid crayfishes etc.

The bulk of the North American aquatic fauna, eastern and western as well, consists of members of the amphi-pacific lineages. Numerous are also the genera and species belonging to the nearctic lineages, present in eastern and western North America. Several of these lineages actually represent subdivisions of amphi-pacific lineages, i.e have formerly also ranged in temperate Asia (e.g. Catostomidae), others are offshoots of ancient taxa which evolved in the northern continents (e.g. the percopsiform fishes and the crangonictyd amphipod genus *Stygobromos*), while a few others seem never to have lived outside the North American mainland (the centrarchid fishes).

It results from the above-mentioned facts that the present distribution pattern of the primary freshwater fauna of the northern continents have been determined to a very large extent by the amphi-pacific continental connection and by the close contact between temperate East Asia and tropical southern Asia. The aquatic fauna of North America consists mainly, and that of East Asia to a great extent in genera and species of these lineages; even genera having presently an amphi-atlantic distribution in Europe and eastern North America have dispersed by a Siberian-Beringian-arctic North American route. This fact confirms, to a certain extent, Parenti's assertion that the distribution of freshwater animals corresponds mainly to ocean basins.

But the Beringian link lasted, with short interruptions, a very long period corresponding to an almost entire Cenozoic era. Its interruption is quite recent, while all other former continental connections, including the north-Atlantic one, ceased their existence between the Jurassic and the early Eocene.

Former proponents of the theory of permanencea and immobility of continents are criticised by paniogeographers and vicariance biogeographers for having considered that the Beringian link has been the only dispersal route between the eastern and western hemisphere. Actually it has not been the single but the most important one and has determined to a great extent the present day distribution of living organism.

PERIPHERAL FRESHWATER LINEAGES

The peripheral species of fishes and lampreys inhabiting the river drainages of the Atlantic watersheds of Europe and North America, some of which are sedentary, others migratory, are congeneric and closely related, some being even present in both continents. Most belong to cold-adapted families: Petromyzonidae, Salmonidae, Osmeridae, Gasterosteidae and Acipenseridae (the latter lives mainly in the temperate, even warm-temperate zone). Two pairs of vicariant sister species have been delimited among them: *Acipenser sturio* (Europe), *A. oxyrhynchus* (eastern North America) and *Osmerus eperlanus* (Europe), *O. mordax* (eastern and partially arctic North America – 8). On the contrary, there are no direct ties between the European and the eastern North American species of sculpins (*Cottus*).

There are also philetic affinities between the European and North American species of *Morone* (= *Roccus*), inhabitants of warm-temperate marine and fresh-waters. Even the European (*Anguilla anguilla*) and North American (*A. rostrata*) else are closer to each other than to any other species of the genus.

There are apparently no peripheral freshwater invertebrates on the European watershed of the Atlantic Ocean; those living on the North American watershed, mainly on its southern areas have tropical eastern Atlantic marine ties.

A special mention deserve the hypogean fresh- and brackish water crustaceans in several families (two of Decapoda, one of Thermosbaena, two of Mysidaecea, six of Isopoda, about four of Amphipoda) whose distribution corresponds to the former extension of the Tethys Sea or includes only a part of it. Their present range encompasses the Caribbean area (also including the Atlantic slope of the southern U.S.A.), the circum-mediterranean area, eastern Africa, part of central Asia and the Indonesian/Indochinese area. Two of these areas, the Caribbean-North American and the circum-mediterranean ones concern the subject of this paper. Their Tethyan faunas bear certain similarities but are not identical. Shared by both areas are only four genera, a single one being exclusively Caribbean/Mediterranean (*Stygiomysis* with one species in Italy and two in the Lesseer Antilles). *Speleaeomysis* also range on the shores of the Indian Ocean while *Bogidiella* and *Microcerberus* have a very wide range. About 30 genera are present only in the Caribbean/Mexican/eastern North American area most being endemics with restricted ranges. Some genera are confined to the eastern watershed of the North American continent, being absent from the Antilles and from South America, e.g. the two genera of stenasellids (southern U.S.A. and northern Mexico), *Antrolana* (a cave in Virginia, an area not covered by the sea since Paleozoic times – 10). Present in the circum-mediterranean area and absent from the North American/Antillean one are about 18 genera, most of them endemic; among the more widely ranging ones is *Stenasellus*, distributed in southern Europe (including France), Turkmenistan, eastern Africa, Thailanda and Borneao or Kalimantan island of western Indonesia.

The distribution of certain hypogean genera of Tethyan origin in inland waters corresponds to the former zoogeography of the Tethyan marine fauna. Already Ekman (19) mentions that the Tethys included a central American and an European-Malay province.

Briggs (11) gives more detailed data: he distinguishes, on the base of recent paleontological literature, a Caribbean province of the Cretaceous Tethys and an Indo-Mediterranean realm, the latter subdivided in several provinces, one of which included the eastern African areas inhabited by genera of the Tethyan lineages. The recent distribution of stenasellids (*Stenasellus* from Europe to central Asia, eastern Africa and Indonesia, closely related genera in the same areas) and more distinct genera on the Atlantic slope of Mexico and of the southern U.S.A. perfectly corresponds to the Cretaceous zoogeography of the Tethys.

The fauna of the peripheral fishes of both watersheds of the North Pacific Ocean consists of the same families and partially genera as that of the northern Atlantic. Exclusively north Pacific is the genus *Oncorhynchus*, present both in Eastern Asia and western North America. Contrary to the northern Atlantic, the genus *Cottus* comprises numerous, partially related species in both continents. Some of these are estuarine. It seems probable that the genus, which belongs to a primarily marine family, initially colonized the rivers of north-eastern Siberia and north-western America and subsequently dispersed by continental routes throughout both continents.

Other families and genera of peripheral fishes are either East Asian (Salangidae, *Siniperca, Coreoperca*) or western North American (*Hysterocarus* of the prevailingly marine north Pacific Embiotocidae).

Some peripheral amphipods from the freshwaters of Japan, Korea and those of China belong to Pontogeneidae, a marine family widely distributed in the tropical and northern Pacific; there are no data about the possible occurrence of related genera or species in western North America. Two strictly freshwater genera present in East Asia belong to another northern marine family.

The bulk of the peripheral fauna of fishes and invertebrates in East Asia consists of species belonging to prevalently Indo-West Pacific marine lineages. In spite of their tropical affinities, these lineages are distributed as far north as Japan and even the Amur River basin. Gobiidae is the tropical fish family comprising the highest number of species (followed by Tetraodontidae, Kuhliidae, Clupeidae etc.) there are also three families of prawns Palaemonidae (comprising an endemic genus, *Typhlocaridina*), Atyidae and Sergestidae, four of prosobranchaire snails (among which Neritidae and Thiaridae, two of mussels). None of them has any relations with the western North American peripheral freshwater fauna.

Also the very poor fauna of peripheral freshwater animals from the temperate and warm sections of the western North American watershed has no affinities with that of Eastern Asia.

An unexpected conclusion derives from these data: there are stronger affinities between the western North American and Eastern Asian faunas of primary freshwater animals than between those of peripheral ones present in the temperate and warm sections of the same continental areas. This fact is due to the extreme width of the Pacific Ocean and to the tropical Indo-West Pacific character of the East Asian peripheral freshwater fauna.

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SOME ASPECTS CONCERNING THE STUDY OF THE SUGAR BEET NEMATODE *HETERODERA SCHACHTII* IN ROMANIA

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Within this article there are presented some historical, geographical and of economic importance data, concerning the sugar beet nematode *Heterodera schachtii* Schmidt and also, the study of the attack of *H. schachtii* in the Satu Mare district and the experiment which demonstrated the impossibility to use the beet infested by *H. schachtii* as food for bovines.

During the eighty years that followed the discovery of the sugar beet nematode *Heterodera schachtii* Schmidt, all the cyst nematodes observed were included generally under this name. In 1850 Herman Schacht [2] observed fields in which the soil became apparently exhausted, a condition known as Rübenmüdigkeit or the fatigue of beet. This condition was attributed to the fact that the fields produced beet continually, without a proper crop rotation system. The beets from such fields were generally stunted and with hairy roots. Schacht observed on them small, white, lemon-shaped bodies, which he considered to be the females of an undescribed nematode species. In 1859 he published his discovery and in 1871 Schmidt named the pest, *Heterodera schachtii* [3].

This nematode that belongs to Tylenchida: Tylenchoidea: Heteroderidae: Heteroderinae is one of the most important pests of the beet plants. According to the EPPO data, *H. schachtii* is widely distributed in Austria, Belgium, Denmark, France, Italy, the Netherlands, Russia, Spain, Sweden, South-Africa, Argentina, Canada, the U.S.A., New Zealand and restrictedly distributed in Bulgaria and China. In Romania, *H. schachtii* occurs on restricted areas, in the Botoșani, Brașov, Suceava and Satu Mare districts.

The damage caused by *H. schachtii* depends on the initial density of the nematode population, on the pedological and climatic conditions which influence the development of the host plant and the survival of the nematode, on the sowing period, etc. In the temperate climate, the most part of the damage results from the diminution in weight, while in the warmer climate, the sugar contained in beets can be also much decreased. The attack of *H. schachtii* increases often the damage caused by other pathogenic organisms, like *Cercospora beticola, Rhizoctonia solani, Beta virus 4*, etc.[4].

In the Romanian literature, *H. schachtii* is often mentioned among the main pests of the beet crops (Pricina, 1910; Rogojanu, 1959, 1968; Manolache & collab., 1969). However, excepting the mention did by Rădulescu (1937), in other works there are not presented data concerning the presence of the nematode in the country, the affected area or the damage caused. Rădulescu (1937) refers to the fact

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that the nematode *H. schachtii* is found in the areas where sugar beet is widely cultivated, indicating in this sense the Feldioara locality from the Brașov district. In 1972, the nematode has been found again, in several localities of the Brasov district, namely Feldioara, Rotbav, Halchiu, Prejmer, Bod, Grid, in isolated centres of contagion, both in the sugar beet crops and the mangel wurzel crops (Romascu, 1973) [1].

After the manifestation in the field of *H. schachtii* in the Brașov district in 1972, a new attack of this nematode on the sugar beet plants, studied by Carmen Mihaileanu Dombi, occurred in the Satu Mare district, Carei locality, in 1996, so over a period of 24 years. The whole infested area = 7.71 ha, from which: 3.79 ha to the "New Life" Camin Society and 3.92 ha to the "Forum" Camin Society. At the "New Life" Society, on the infested area of 3.79 ha, there were examined 301 sugar beet plants, from which 228 plants were infested and 73 plants were healthy, resulting a frequency and an intensity of the attack, of 75.74% respectively 57.23% and a degree of damage of the sugar beet crop of 43.35%. At the "Forum" Society, on the infested area of 3.92 ha, from 388 sugar beet plants examined, 299 plants were infested and 89 plants were healthy, the frequency and the intensity of the attack being of 77.06% respectively 53.09% and the degree of damage of the sugar beet crop having a value of 40.91%.

The plant samples were taken at each 10 m, according to the following sampling patterns: parallel vertical straight lines, simple diagonal line, M, Z, W.

The soil samples were washed with the Fenwick can, finding about 2000 cysts/100 g of soil and about 200 cysts /10 g of soil.

Measures taken:

– the removal of the infested areas from the beet production;

– the annual estimate of the stock of cysts in the field;

– the recommendation of cultivation on the infested areas, of «non host» plants, preferably leguminous plants;

– the disking of the infested areas.

The working out of the data delivered by the Point for prognosis and warning from Carei, for the months January-September, showed that the attack of *H. schachtii* in the field, in the Satu Mare district, in October 1996, took place under a cold and humid climate, as show the sum and the medium/9 months, respectively/ 4 months (for the height of the snow layer), of the monthly average values of temperature (med., max., min.) and humidity of the air and of the monthly amount values of precipitations and height of the snow layer.

	T° med.	T° max.	T° min.	Humidity %	Precipitations (mm)	The height of the snow layer (cm)
Sum	83.7	146.2	64	698	616.1	55.6
Medium	9.3	16.2	7.1	77.5	68.4	13.9

This attack presumed the existence in the field of a biological stock of cysts which appeared in the presence of a favourable host plant, the sugar beet and under the conditions of a favourable climate.

At the question if the beet infested by *H. schachtii* could be or could be not used as food for animals, I tried to give the answer through an experiment which was carried on, as follows:

∗ infested beets were used as food, together with maize silo and lucerne hay, for cow and buffalo cow, at the Research Institute for the Amelioration and the Reproduction of the Bulls, in the Balotești locality;

∗ the excrements of cow and buffalo cow amassed at the complete end of the digestion, were set in plastic bags and brought to the Central Laboratory for Phytosanitary Quarantine, for analysis;

∗ the whole quantity of fresh excrements = about 50 kg cow + about 50 kg buffalo cow;

∗ the whole quantity of excrements was washed with the Fenwick can and analysed on DIN sieves of 0.2 mm =1 kg/100 g/10 DIN sieves – cow + 1 kg/100 g/ 10 DIN sieves-buffalo cow; the samples were taken in very small cores/the whole quantity of excrements;

∗ number of viable cysts small + large, intact, found/10 DIN sieves = 0–7 – cow; idem buffalo cow;

∗ the action of the digestive juices drawed of all the five compartments of the digestive system of cow and buffalo cow, on the white females and viable cysts of all sizes of *H. schachtii*:

- quantity of digestive juice/each of the five compartments = about 100 ml;
- number of females and cysts/100 ml = 10;
- the result observed after 48 hours and after a month:
  - it was recovered the same number of females and cysts which was putted in the digestive juice, at the beginning of the experiment;
  - the state of the recovered females and cysts – intact, viable turgescent; at some females, the colour remained white, whereas at the others, it followed its normal course of change from white to different brown hues.

Conclusion: it is not recommended to use the beet infested by *H. schachtii* as food for bovines, because it was proved experimentally that the digestive juices of bovines do not affect the females and the cysts of *H. schachtii*, intact, viable, turgescent, in the excrements of the bovines, existing the danger of dissemination of this nematode, through the agency of excrements.

H. schachtii is a very small harmful organism, but very well adapted to survival. The recovery of this nematode from the field is hard work, but it is important that the periodical checks in the field to be done correctly, with the purpose of reducing the errors as much as possible. This phytoparasite nematode is considered as a phytosanitary quarantine organism in some countries, this statute being available also in Romania at present, but not in others. The presence of viable cysts of *H. schachtii* in the beet crop generates a lot of effects on the beet production:

∗ the quantitative and qualitative fall in value/destruction of beet plants;

∗ the removal of the infested areas from the beet production and the placing in practice of an optimum rotation crop system for a number of years that depends on the level of infestation;

∗ the return of the infested areas in the beet production, on condition that, the periodical checks of *H. schachtii* in the field, conduct to the official statement that there are not any more viable cysts of *H. schachtii*, in the infested area;

∗ the avoidance of the one-crop system for the purpose of decreasing the risk of making the biological stock of cysts in field more active;

∗ the establishment and the respecting of all the safety measures which can stop the dissemination of this harmful organism, in the areas which are not infested;

∗ it is not recommended to use the infested beets as food for bovines, because the risk of dissemination of *H. schachtii* through the agency of excrements is very high.

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HISTOPATHOLOGICAL MODIFICATIONS OF THE *XIPHOPHORUS HELLERI* LIVER INDUCED BY THE HEAVY WATER

II. ELECTRON MICROSCOPY STUDY

WANDA BUZGARIU, S. LAZĂR, PAULA PRISECARU, MARIA CALOIANU

There have been studied the liver modifications at the ultrastructural level induced by 25% heavy water. The samples have been collected at various intervals: 1, 2, 7 and 28 days and have been studied in electron microscopy.

Our results showed the early appearance of the degenerative processes, the presence of a large number of lysosomes and multivesicular bodies after 2 days of contact with heavy water. At 7 days of exposure to 25% deuterated water one can remark the cytoplasm vacuolisation and the cell membrane breaking up. At a month of exposure, it is noticed the hypertrophy of biliary canaliculi, the presence of necrotic bodies and the loss of the contact between the adjacent cells.

Natural water contains only a trace amount (about 0.02%) of deuterium oxide (D_2O). The increased deuterium concentrations are cytotoxic (12) and significantly affect the biological processes, as shown in numerous studies realised on various biological systems: microorganisms (3, 4), plants (5, 6), animals (7, 8, 9). It was demonstrated that short term exposure to high levels of D_2O can induce chromosomal aberrations in cultures of human lymphocytes. D_2O treated cultures had increased frequencies of chromatid gaps, chromatid and isochromatid breaks (10). It was shown that D_2O, an agent that stabilises microtubules, prevented the internucleosome fragmentation of DNA in thymocytes exposed to γ-radiation and dexamethasone in vitro (11).

The presence of heavy water in medium affects the transformation of cytoplasmic microtubules in mitotic spindle in interphase-prophase transition (12) and the kinetic behaviour and nucleation ability of centrosome (13).

The oral administration of heavy water at mice leads to the damage of numerous metabolic processes including the reproductive potential of both female and male (7, 14). Male rats when administered 30% D_2O mixed in drinking water showed signs of subfertility within 4 weeks of treatment (15). Histological damage following D_2O administration comprised arrest of spermatogenesis and heavy desquamation of the germinal components and the presence of spermatid clumps and the occurrence of giant cells in the seminiferous tubules (16).

The results of our research also demonstrate severe alterations of *Xiphophorus helleri* embryos at the level of all its organs (17).

It has been demonstrated in some cases the damage of the metabolic and physiological processes by an increased concentration of D_2O. It has been discovered that D_2O stimulated glycolysis, especially lactate production from glucose

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(18). Heavy water has been used as a putative inhibitor of the plasma membrane H^+-ATP-ase and the plasma membrane redox system (19).

A very recent study has demonstrated that D_2O inhibits cancer cell locomotion in phagocytokinetic analysis and D_2O may be applied for the therapeutic use against pancreatic cancer (20).

In the previous work we presented the structural modifications of the liver induced by 25% heavy water (21). In this work we continue the presentation of the histopathological modifications of the liver determined by heavy water at ultrastructural level.

MATERIALS AND METHODS

Our investigations concerning the heavy water action on the living organisms followed the praising of the teleosts fish *Xiphophorus helleri* liver modifications with the view to establish the damaging degree.

The experimental models were done in parallel series of fish batches grouped depending on the water quality. First, the fishes were acclimated a week in dechlorinated tap water, pH = 7.8, temperature of 20 ± 3°C, 8.3 mg/l disolved O_2.

The experiments took place in a direct, closed system, for the control and constant maintenance of the D_2O concentration in the medium.

The samples were drawn at one day, 2, 7 and 28 days intervals. For the electron microscopy study, the samples were fixed in 2.5% glutaraldehyde in 2M cacodylic buffer, postfixed in osmium tetroxide, washed and serially dehydrated in ethanol, included in Epon 812 and cut with ultramicrotome. The grids were stained with uranil acetate and lead citrate.

RESULTS

In the present paper we have studied the effects of deuterium oxide at the ultrastructural level on the *Xiphophorus helleri* liver.

The teleosts liver, the principal target organ of xenobiotics, is the most frequently cited as a parenchymal site affected by the exposure to different chemical agents (22).

In electron microscopy, the normal hepatic cells present a specific euchromatic nucleus (Fig. 1). In the cytoplasm there are situated considerable quantities of rough endoplasmic reticulum (Fig. 2) and a few glycogen particles.

The lipid drops sometimes occupy a great proportion of cytoplasm. Supranuclearly are localised electronodense bodies represented by peroxysomes, lysosomes and residual bodies. The microtubules and the multivesicular bodies are occasional. The hepatocytes are laterally united by "gap" junctions.

Between the hepatocytes and synusoid capillaries exists a space called the Disse space. The bile secreted by the hepatic cells is collected by the biliary canali-

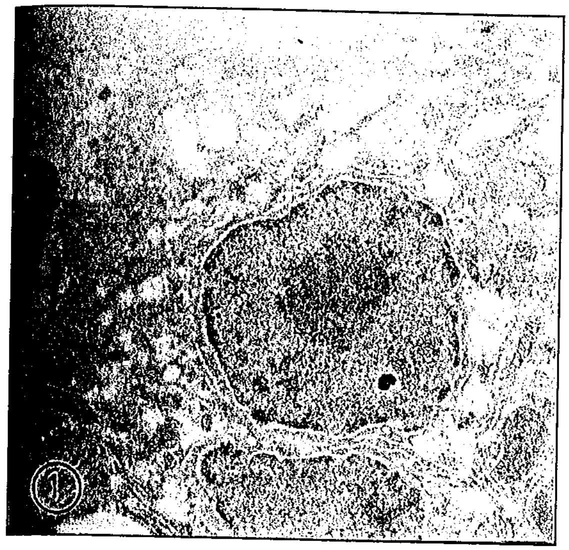

Fig. 1. – Normal hepatocytes. ×8000

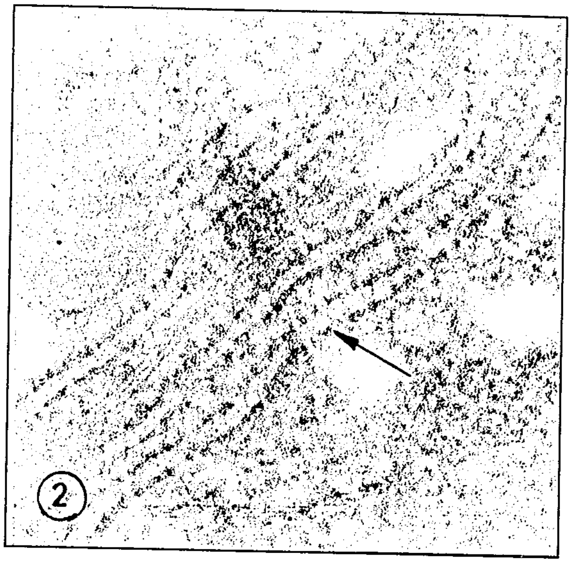

Fig. 2. – Rough endoplasmic reticulum from hepatocyte cytoplasm (arrow). ×6000

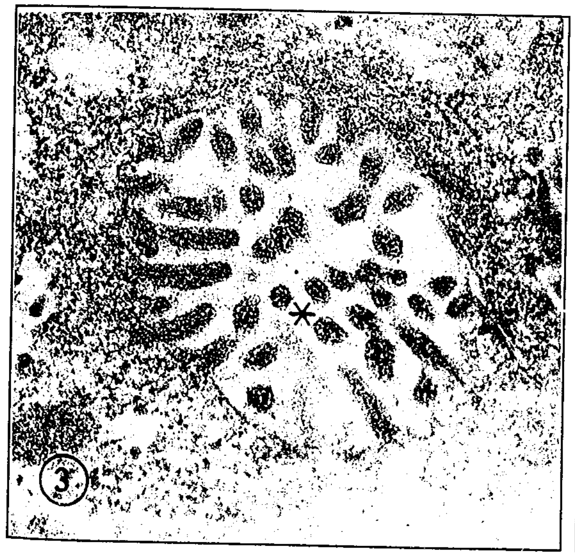

Fig. 3. – Normal biliary canaliculi (*). ×3000

Fig. 4. – Vacuolisation (arrow) of the hepatocytes after 2 days exposure to 25% heavy water. ×8000

culi that are formed by putting together 3–5 hepatocytes (Fig. 3). In the vicinity of the biliary canaliculi lumen, the hepatocytes are joined through tight jonctions formed by desmosomes. In the lumen of biliary canaliculi the hepatocytes microvilli extend.

In the case of the liver, heavy water produced modifications depending on the administered dose and on the time interval at which fishes were in contact with the increased concentration of deuterium.

The modifications induced by the heavy water appear early, after 2 days of contact with heavy water, noticing an excessive vacuolisation of hepatocytes (Fig. 4).

There are numerous lysosomes and multivesicular bodies (Fig. 5) in the hepatic cells that indicate a cell degeneration process. Frequently, it is noticeable the obturation of the Disse space by degenerated cell fragments (Fig. 6).

After 7 days of exposure to 25% deuterated water in electron microscopy there are remarked a lot of hepatic cells that present a necrotic phenotype characterized by the vacuolization of the cytoplasm, the disorganization of the cytoplasmic organites and the rupture of the cell membrane (Fig. 7). Some hepatic nuclei are vacuolised (Fig. 8) or pycnotic (Fig. 9).

The interhepatic cells are also altered, the nuclear chromatin being disorganized (Fig. 10). In the macrophages cytoplasm there are remarked some large phagolysosomes (Fig. 11).

At 28 days of exposure to 25% D_2O, the noticed modifications in the optic microscopy (21) are accompanied by severe ultrastructural modifications. At this time interval numerous intercellular spaces appear (Fig. 12) fact that suggests the loss of the contacts between the adjacent cells.

In the apical region of the hepatocytes there are numerous vacuoles (Fig. 13A) sometimes very large (Fig. 13B), lysosomes (Fig. 13A) and lipid droplets (Fig. 14).

Moreover in hepatocytes there are many swollen mitochondria (Fig. 15). Some mitochondria were seen in association with the lamellar body (Fig. 16), or these lamellar bodies are in the mitochondrial matrix (Fig. 17). Occasionally in Disse space there were observed membrane fragments (Fig. 18).

The biliary canaliculi are hypertrophied, the hepatocytes that bound these canaliculi present a vacuolated cortical cytoplasm without microvilli (Fig. 19).

A lot of endothelial cells and erythrocytes are altered (Fig. 20). These cells are cytolised and characterized by the loss of the normal granular aspect of the euchromatin and heterochromatin that form amorphous masses.

DISCUSSIONS

The structural and ultrastructural modifications observed by us at the level of the specialized cells of tissues and organs reflect important processes at the molecular level determined by the exchanges at membrane level between internal and

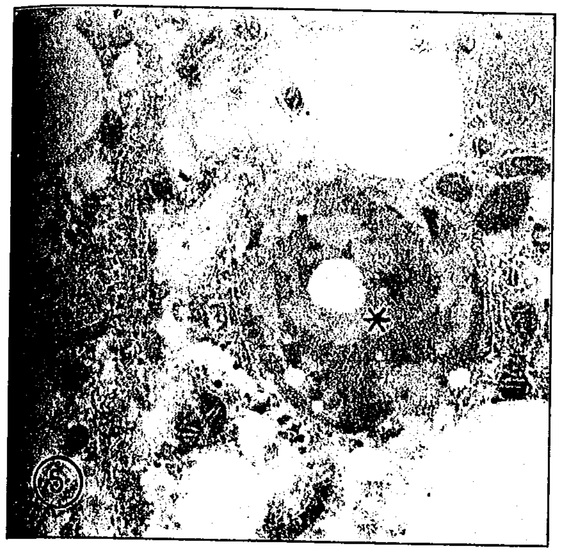

Fig. 5. – Multivesicular bodies (*) in the cytoplasm of hepatocytes. ×12000

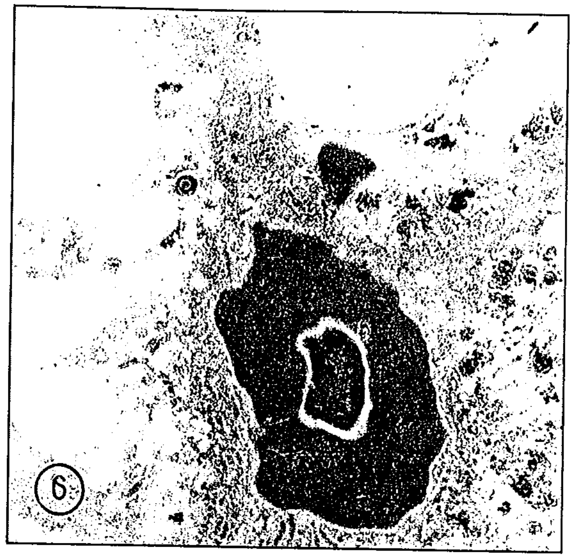

Fig. 6. – Disse space obturated by degenerated cell fragments after 2 days exposure. ×8000

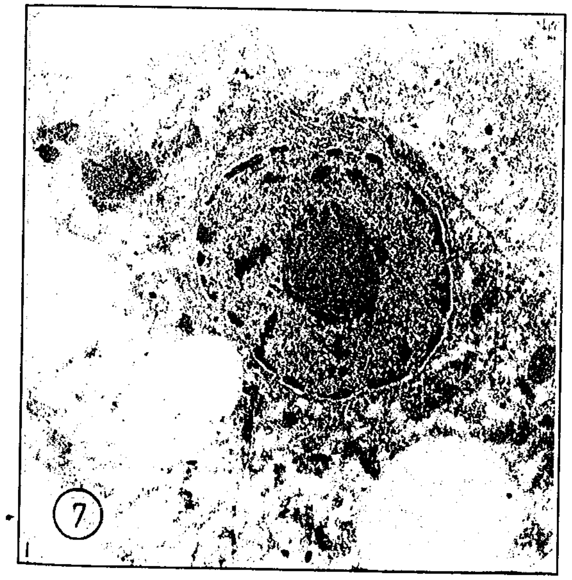

Fig. 7. – Necrotic hepatocytes after 7 days exposure to 25% heavy water. ×8000

Fig. 8. – Vacuolised hepatic nuclei (arrow) at 7 days contact with 25% D_2O. ×16000

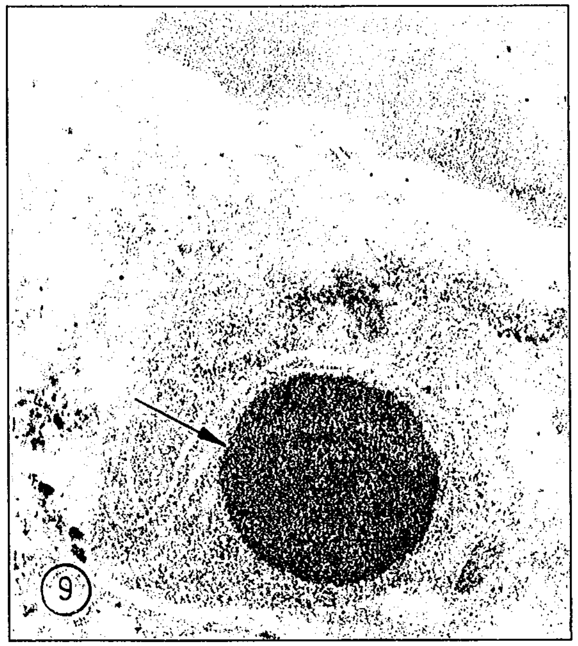

Fig. 9. – Pycnotic nucleus (arrow) after 7 days exposure. ×16000

Fig. 10. – Disorganization of nuclear chromatin after 7 days exposure. ×16000

Fig. 11. – Phagolysosomes (*) observed in the macrophages cytoplasm after 7 days exposure. ×8000

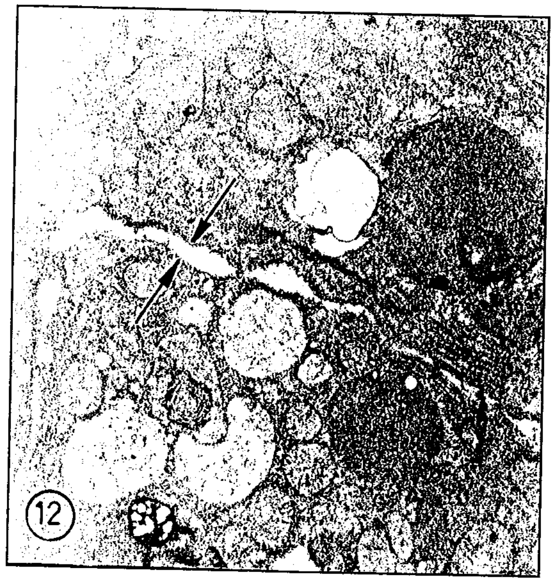

Fig. 12. – At 28 days contacts with 25% heavy water appear numerous intercellular spaces (arrow). ×8000

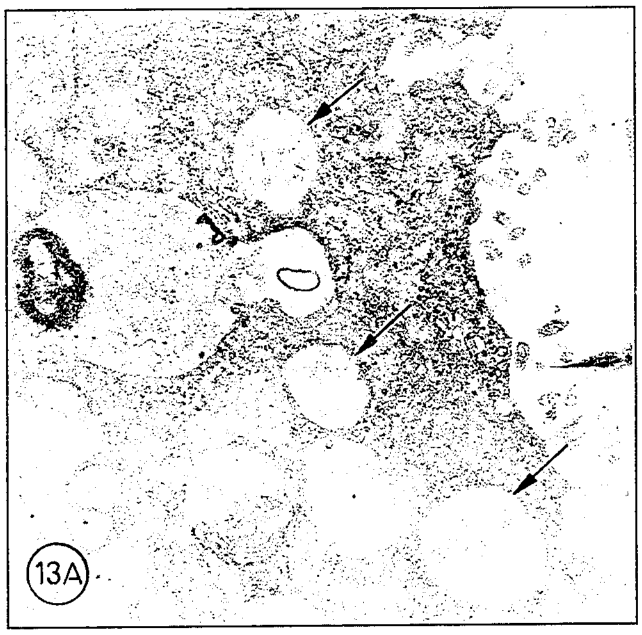

Fig. 13A. – Numerous vacuoles are present in the apical region of the hepatocytes after 28 days exposure to 25% D_2O (arrows). ×12000

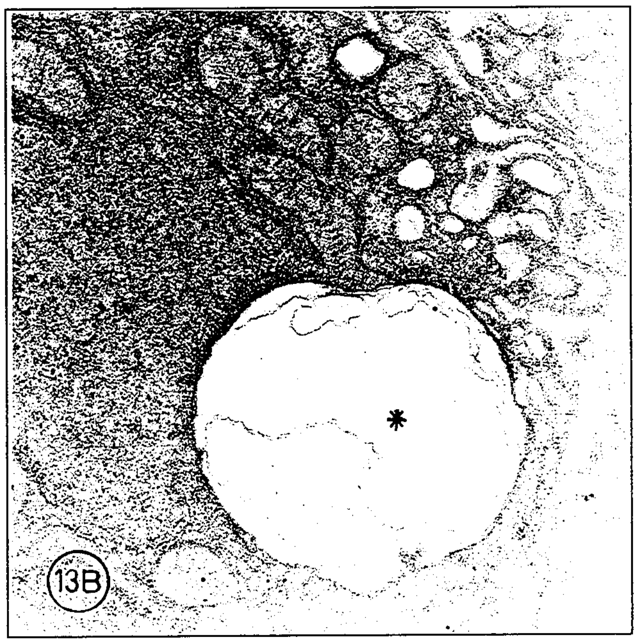

Fig. 13B.– Very large vacuoles in the apical region of the hepatocytes (*). ×12000

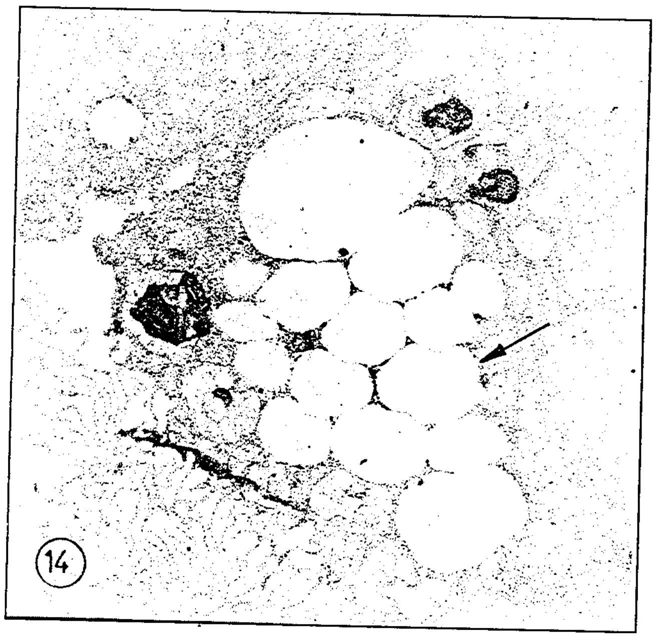

Fig. 14. – Lipid droplets present in hepatocytes after 28 days exposure (arrow). ×8000

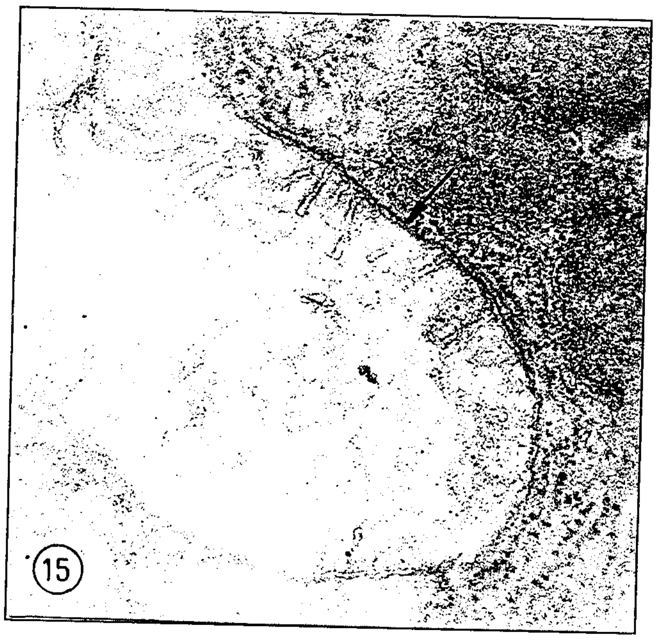

Fig. 15. – Swollen mitochondria in hepatocytes after 28 days exposure (arrow). ×4000

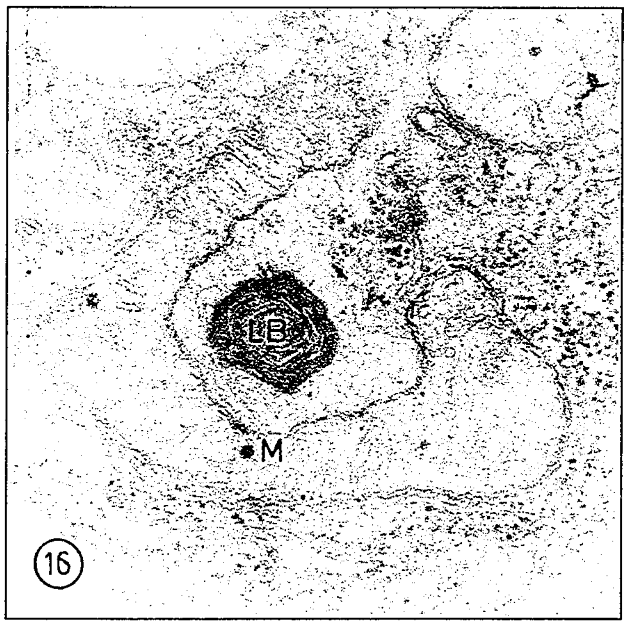

Fig. 16. – Mitochondria (M) in association with lamellar body (LB) after 28 days exposure to 25% heavy water. ×40000

Fig. 17. – Lamellar body (LB) is present in mitochondrial matrix at this time interval exposure. ×30000

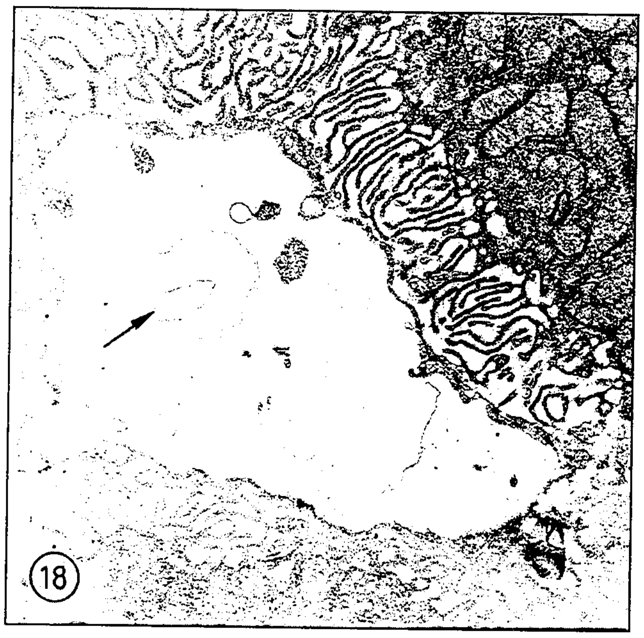

Fig. 19. – Hypertrophied biliary canaliculi without microvilli after 28 days exposure. ×8000

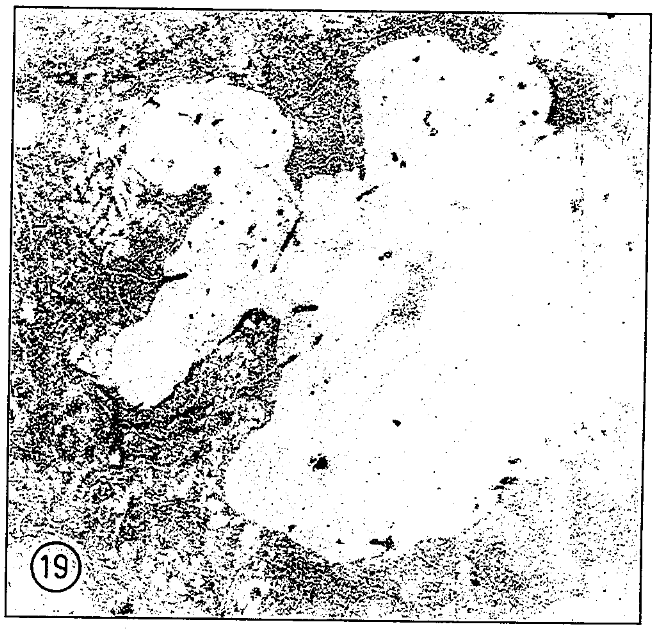

Fig. 18. – Membrane fragments (arrow) observed in Disse space after 28 days exposure. ×8000

Fig. 20. – Nuclei from cytolysated cell at the same interval exposure. ×8000

external medium, with the modification of the isotopic composition of the cell components.

Although isotopes are known to have similar physico-chemical properties, they are not the same for the hydrogen isotopes. H, D and T are isotopes very different from each other, that leads to strong isotope effects. Lower D_2O concentrations generally inhibit or slow down the processes under investigation. Uphaus et al. (23) therefore called D_2O a "chaotropic reagent", which paraphrases the fact that a certain single mode of action of D_2O does not exist.

Therefore, we can discuss about the heavy water effect on the biological systems from three points of view:

a) Primary isotopic substitution: here D substitutes for H at the reaction site in the molecule.

b) Secondary isotopic substitution: here D substitutes for H at sites not directly involved in the reaction. This effect contributes to the modification of the proteic structures stability, being known that the hydrogen bonds play an important role in the stabilization of these structures (26).

c) Solvent effect, is that attributable to the properties of D_2O acting (instead of H_2O) as the general solvent in which cellular processes take place (27).

Under the action of the increased concentration of D_2O in the medium on the hepatic tissue, hepatic necrosis is produced, which is of "coagulative" type (cell protoplasm viscosity increases and irreversible gelation occurs) (22).

The ultrastructural modifications of the hepatocytes under the influence of D_2O correlated with the observations done at structural level (21) showed the damage of the whole hepatic system, at the most profound levels of organization: the nuclei pycnosis, the vacuolisation of the cytoplasm, massive degradation and degeneration.

All these experimental findings are in concordance with the phenomena observed by Rabinowitz concerning the action of the same heavy water concentration (25%) on the mice liver (28). They have observed in light microscopy that the lesions progress uniformly throughout the liver and show no preferential localization. These findings suggest that D_2O, at the administered concentration, produces pronounced structural changes in the cytoplasm, a decrease in the number of round mitochondria with swelling and the rearrangement of the filamentous mitochondria (28).

Loss of canalicular microvilli indicates a cholestasis. This change is a primary hepatocellular disorder related to alterations in the bile load, bile salt transport, membrane fluidity and cytoskeletal functions (29). Mitochondrial swelling is associated with the uncoupling of oxidative phosphorylation (29).

Biochemical and morphological studies concerning the D_2O effect on hepatocytes have not been systematically realized. There are few informations concerning the profound metabolic modifications induced in the liver under the heavy water action (18).

The complexity of the mechanisms of cell degradation and degeneration induced by the increasing of the D_2O concentration in the medium imposes the continuation and the profound study of the researches also at biochemical level.

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CLATHRIN IMMUNOLOCALIZATION DURING CRUCIAN CARP OOGENESIS

OTILIA ZĂRNESCU, RADU MEŞTER

We used indirect immunoperoxidase technique to study distribution of clathrin during oogenesis of crucian carp, *Carassius auratus gibelio*.

Examination of early previtellogenic follicles (~0.084 mm diameter) revealed that antigen was detected as a punctate reaction in ooplasm, and diffuse, ring-shaped structure situated around nucleus.

Larger previtellogenic oocytes (~0.116–0.285 mm diameters) exhibited only a punctate reaction in cytosol.

In the vitellogenic follicles immunolabelling were associated with oocyte microvilli and cortical cytoplasm. Moreover, an accumulation of stain was observed throughout the ooplasm, around yolk globules and perinuclearly.

Also, the stain was associated with the surface epithelium of vitellogenic follicles.

The major source of the components required for embryo growth is the yolk that is formed during the differentiation of the oocyte by deposition of massive amounts of plasma-derived molecules – the process of vitellogenesis. Receptor – mediated endocytosis assures selective, efficient, and accumulative uptake of yolk components and mediates oocyte growth (14, 16). The role of extensive micropinocytotic activity at the surface of vitellogenic oocytes has been demonstrated by electron microscopy for several species of teleosts (5).

Receptor-mediated endocytosis begins with binding of vitellogenins to receptors on the oolemma. This complex then clusters in clathrin-coated pits and, after endocytosis, intracellular vesicles appear. This process requires a considerable amount of ooplasmic clathrin.

Observation carried out mosquito (7, 11) and *Xenopus laevis* oocytes (9) provide evidence suggesting that before the onset of endocytosis, the previtellogenic oocyte has the capacity to accumulate an extensive amount of clathrin. In contrast, in highly differentiated cells, including hepatocytes (4) and macrophages (15), the intracellular content of clathrin remains fairly constant and is independent of the endocytic activity of the cell.

In the present study, experiments were carried out to determine distribution of clathrin during oogenesis in crucian carp, *Carassius auratus gibelio*.

MATERIALS AND METHODS

Fragments of crucian carp, *Carassius auratus gibelio*, ovaries were fixed in 10% formaldehyde in 0,1 M phosphate-buffered saline, pH-7.4 (PBS), with 1% dimethylsulphoxide (DMSO), overnight, at 4°C.

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After washing in PBS, samples were then transferred in 2% glycine in PBS, to quench the free aldehyde groups, dehydrated and embedded in paraffin.

Slides were given several 10-min rinses in 0.1 M PBS and sequentially incubated in methanol: H_2O_2 (9:1), to remove endogenous peroxidase activity (30 min), PBS plus 10% normal rabbit serum to remove non-specific background staining (1 h), goat anti-clathrin, primary antibody (Sigma), diluted 1:40 (overnight, at 4°C), rabbit anti-goat IgG peroxidase conjugate (Sigma), diluted 1:200 (1 h, at room temperature). Each incubation step was followed by four 5 min rinses in PBS. To visualize the primary antibody binding sites, the slides were incubated for 5–15 min in a solution of 3,3'-diaminobenzidine (0.05%) and 0.015% hydrogen peroxide, dissolved in 0.1 M PBS. The slides were rinsed several times in water, dehydrate, clear and mount. Antibody controls were prepared by substitution of the primary antibody with normal rabbit serum. Following immunoperoxidase technique control sections of vitellogenic ovary were counterstained with 1% neutral red.

RESULTS

To determine the distribution of clathrin in variously sized oocytes, immunocytochemistry was carried out using the clathrin heavy chain antibody on tissue slices.

Examination of early previtellogenic follicles (~0.084 mm diameter) revealed that antigen was detected as a punctate reaction in ooplasm and diffuse, ring-shaped structure situated around nucleus (Fig. 1A).

Larger previtellogenic oocytes (~0.116–0.285 mm diameters) exhibited only a punctate reaction in cytosol (Fig. 1B–1C).

Moreover, in all previtellogenic oocyte the localization of the antigen was uniformly distributed in the nucleoplasm, except for nucleoli.

In the vitellogenic follicles immunolabelling were associated with oocyte microvilli which are passing through the pore of zona radiata, and cortical cytoplasm (Fig. 2A).

Furthermore, an accumulation of stain was observed throughout the cytoplasm, also around yolk globules (Fig. 2B).

In addition, vitellogenic oocytes exhibited perinuclearly immunostaining (Fig. 2C). These staining appeared diffuse with a somewhat granular texture.

Also, the stain was associated with surface epithelium of vitellogenic follicles (Fig. 2A).

In controls (Figs. 2D, 2E, 2F) where tissue sections were reacted with nonimmune serum, neither the punctate nor the diffuse reaction were detected.

DISCUSSION

Clathrin has been immunodetected previously in the amphibian oocytes (9) and hemipteran previtellogenic oocites (3). However, the distribution of clathrin during oocyte differentiation in fish has not been extensively studied.

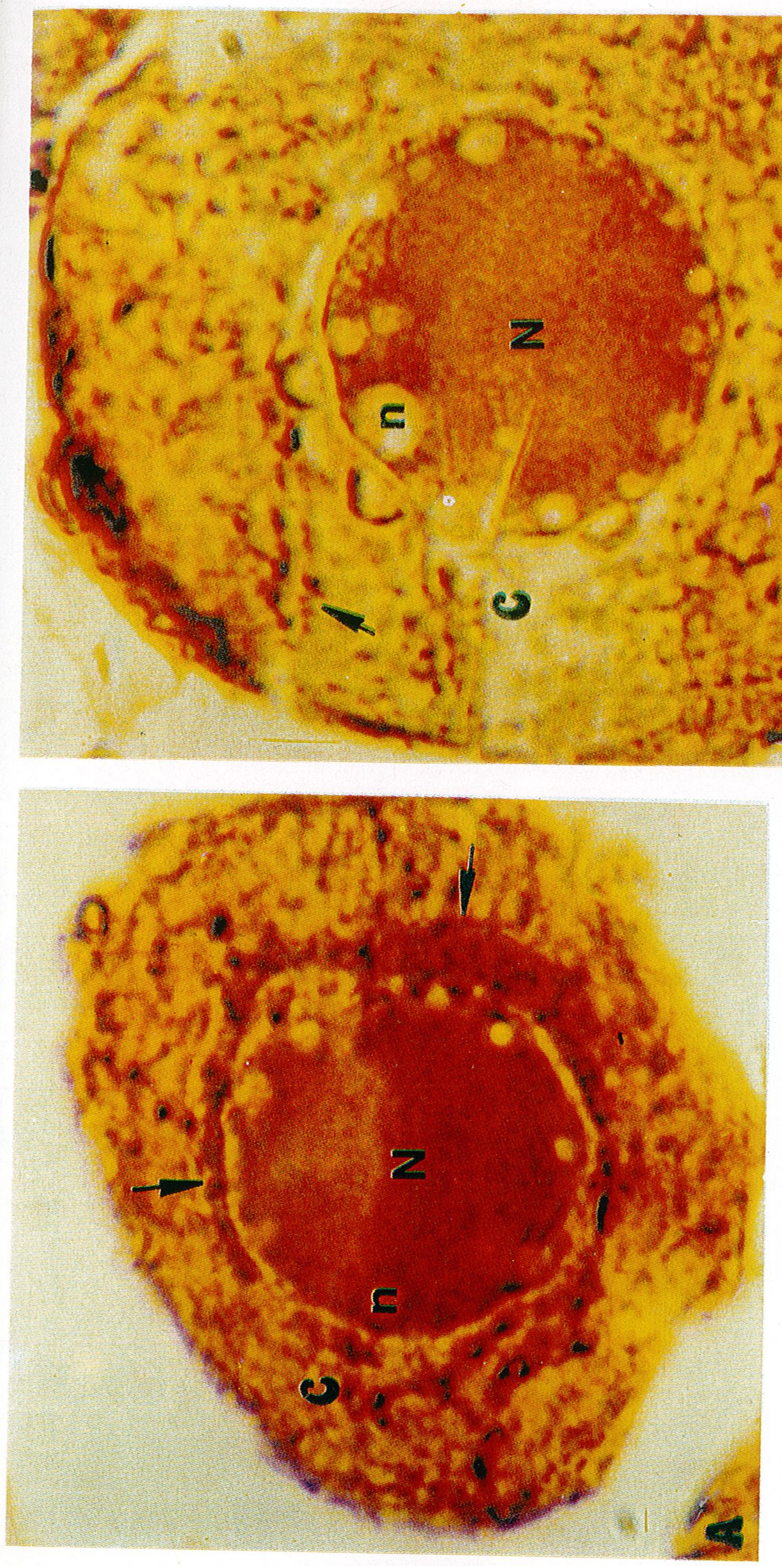

Fig. 1. A, B – **Immunolocalization of clathrin in the previtellogenic oocytes.** In the early previtellogenic follicles (~0.084 mm diameter) antigen was detected as a diffuse, ring-shaped structure situated around nucleus (**A**, arrows). Larger previtellogenic oocytes with diameters of 0.116 mm (**B**) and 0.285 mm (**C**) show a punctate reaction in cytoplasm (arrows). Note the presence of stain in the nucleoplasm, except for nucleoli (**A, B, C**). The specificity of the reaction was seen by the absence of stain in controls, sections reacted with nonimmune serum (**D**). N – nucleus; C – cytoplasm; n-nucleolus; ca-cortical alveoli. A, B – ×640; C, D – ×320.

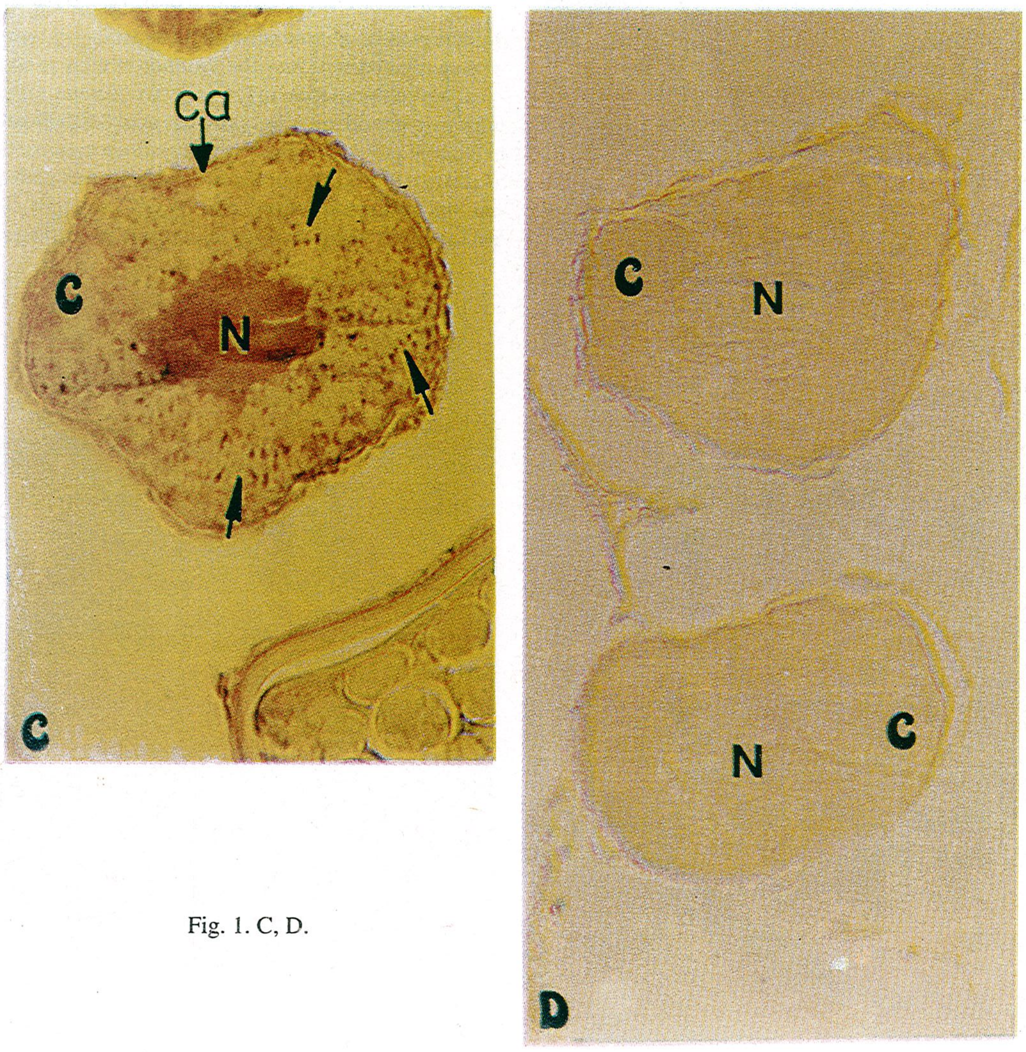

Fig. 1. C, D.

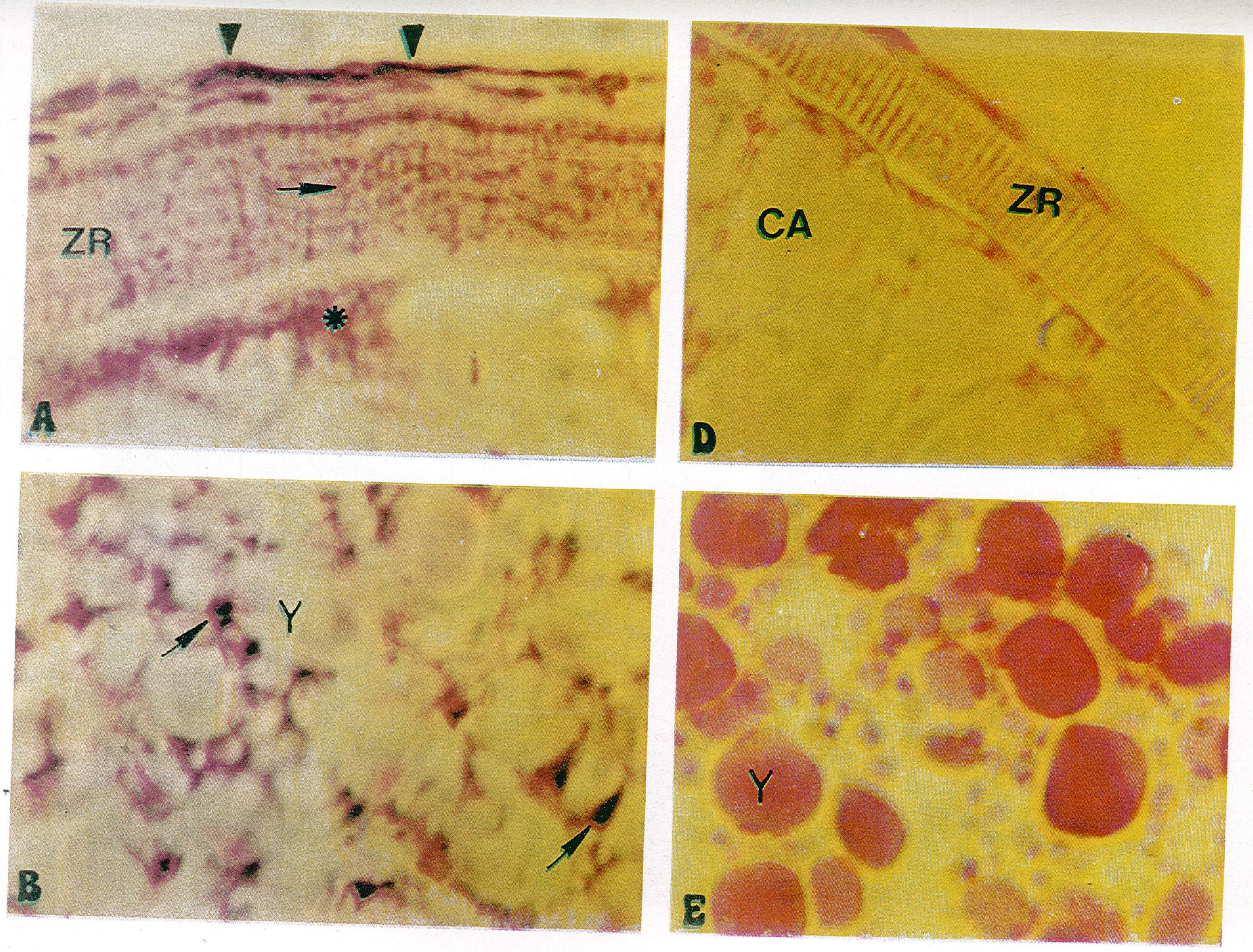

Fig. 2. A, D, B, E

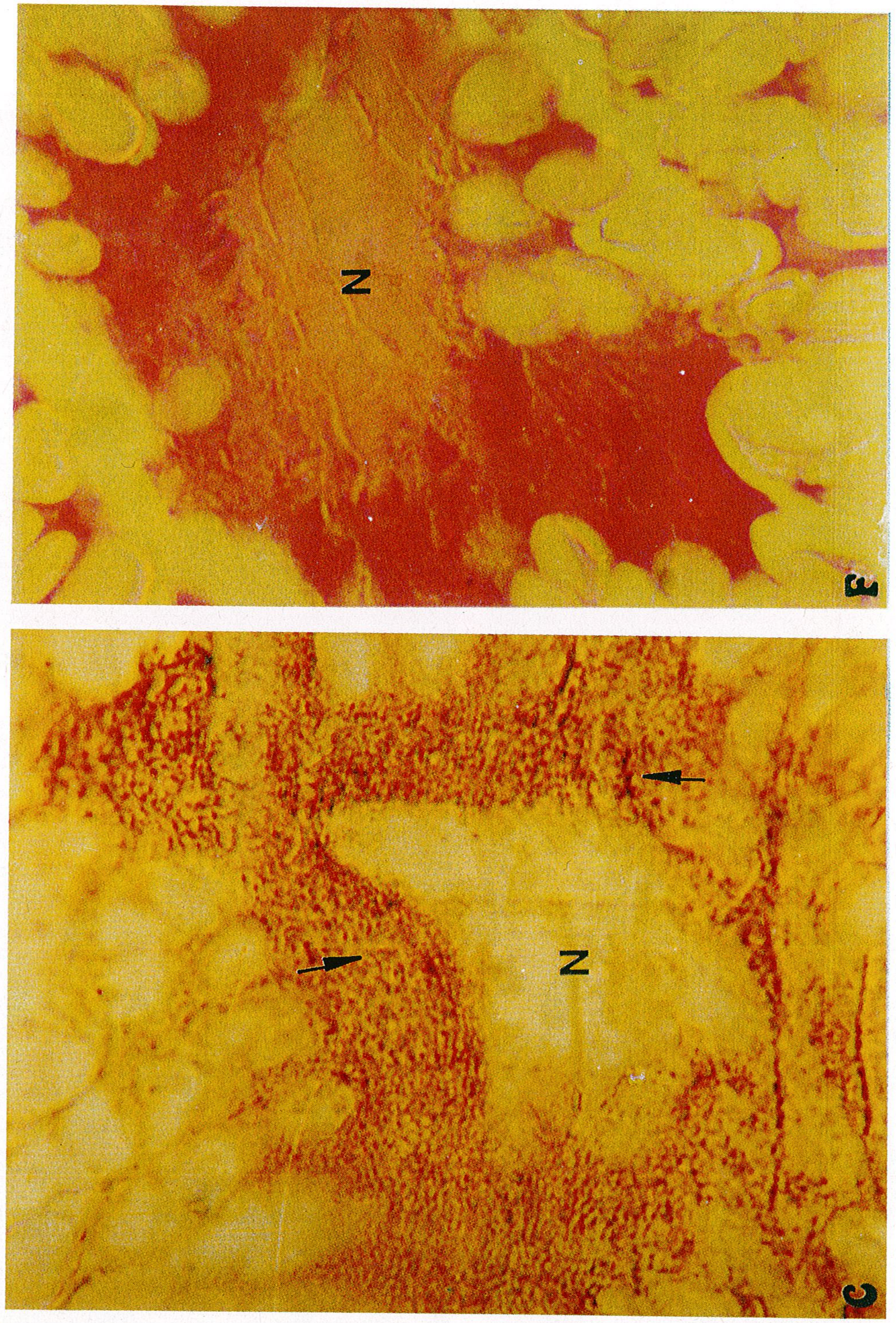

Fig. 2. C, F

The immunocytochemical studies show that during previtellogenic phase, the antibody localized the antigen in perinuclear regions and punctate in cytoplasm. Previous studies have shown that the total cellular pool of clathrin can be in either an assembled or nonassembled form (4), and punctate reaction represent clathrin assembled in pits and coated vesicles (2) meanwhile the diffuse staining was indicative of a reaction associated with an alternate, nonassembled form of the molecule (8).

It is well established that developing oocyte has a great potential for biosynthetic activities. Observations reported by Raikhel (11) provide evidence suggesting that prior to the onset of endocytosis, the previtellogenic oocyte has the capacity to accumulate an extensive amount of clathrin. Also, work reported by Merisko at *Xenopus laevis* (9) shows that in all sizes of oocytes a very fine punctate reaction was seen throughout the cytosol and was most evident in oocytes < 0.1 mm. Occasionally, an accumulation of stain was observed in the perinuclear region of the cell.

In contrast, in highly differentiated cells, including hepatocytes (4) and macrophages (15), the intracellular content of clathrin remains fairly constant and is independent of the endocytic activity of the cell. However, what varies with the state of the cell is the total cellular pool of assembled vs. unassembled clathrin.

Developing oocyte represents a cell in the process of differentiation, and cellular factor regulating clathrin synthesis and content differ more than likely (9).

In the vitellogenic oocyte the reaction was positive mainly in microvilli and cortical cytoplasm. These results are similar to those from previous investigations carried out on other cell types having a highly active plasma membrane surface (1, 6, 10, 12).

Recent findings indicate that de novo formation of clathrin-coated pits is not a prerequisite for rapid internalization or a direct response to stimulation of receptors (13) and only 20% of clathrin were present as assembled, sedimentable forms. These results agreed with our observations that revealed more unassembled than assembled clathrin in all sized oocytes.

The presence of immunoreaction in surface epithelium may suggest a clathrin-mediated endocytosis. Electron microscopy study shows that micropinocytotic vesicles are generally present at both apical and basal surfaces of these epithelial cells.

← Fig. 2. – **Immunolocalization of clathrin in the vitellogenic follicles.** Immunolabellings were associated with oocyte microvilli which were passing through the pore of zona radiata (**A**, arrows), cortical cytoplasm (**A**, ✱), around yolk globules (**B**, arrows), and perinuclearly (**C**, arrows). Also, the stain was associated with the surface epithelium (**A**, arrowheads). When parallel experiments were carried out, substituting nonimmune serum for the primary antibody, neither the punctate nor the diffuse reaction was detected (**D**, **E**, **F**). ZR – zona radiata; CA – cortical alveoli; Y – yolk globules; N – nucleus. A, B, D, E – ×640; C, F – ×320.

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ADAPTATION RESPONSE OF RATS CONTAMINATED WITH LOW DOSES OF TRITIATED WATER AND POSTIRRADIATED WITH A HIGH DOSE OF γ RAYS

ANCA BEJAN*, RODICA MORARU**, M. RADU*, GR. TURCU***

Wistar-London rats were acutely and chronically contaminated with the dose of 0.5 cSv, 5 cSv and 10 cSv of tritiated water (HTO) and subsequently postirradiated with a unique dose of 665 cGy whole body γ irradiation, survival being plotted by an analytical procedure and showing an adaptation response for all the situations tested.

INTRODUCTION

Hormesis refers to the phenomenon of induction of beneficial effects by low doses of otherwise harmful physical or chemical agents. Beneficial responses include a huge amount of end points (increased life span, decreased cancer rate, acclimation, stimulation of the immune system, etc.) which have in common the production of stress proteins.

Hormesis can be accompanied by adaptation that is:

– either the harmful response of the living system is diminished after a subsequent much higher attack of the toxic agent;

– or, a more vigorous beneficial response at the time of a subsequent, low dose attack of the toxic agent.

Concerning the hormetic and adaptation theory of biological systems to low doses of ionizing radiations, this theory is actually inconsistent and controverted, nonparadigmatic for men and animals, but always confirmed by the molecular and cellular level (Sugahara et al. (1992), Kondo (1993), Luckey (1992)).

The aim of our work is to study the adaptation response for an unreported situation in the literature of low doses acute and chronical contamination of rats with HTO, followed by postirradiation with a sublethal dose of γ-radiation.

HTO studies are important because it is a pollution byproduct of CANDU reactors even in normal conditions (occupational personnel) and become significant (population) if accidents occur.

Literature statements in the HTO field are pointed in Inaba et al. (1981), Straume (1993), Saito and Ishida (1986).

MATERIALS AND METHODS

The duration of the experiment was 60 days, divided into two 30 days periods.

We worked on 7 groups of 15 male Wistar-London rats each, 4 months age, as follows:

– group M: control group for both contamination and irradiation, composed of rats that have received tap water ad libitum.

– groups A_1, A_2, A_3: rats acutely receiving HTO, through gavage, in the first day of the experiment, so that the total dose accumulated on the 30-th day of the experiment to be 0.5 cSv (group A_1; 0.4 ml of 0.14 mCi/ml HTO), 5 cSv (group A_2; 0.4 ml of 1.4 mCi/ml HTO) and 10 cSv (group A_3; 0.4 ml of 2.8 mCi/ml HTO) per animal.

– groups C_1, C_2, C_3: rats chronically contaminated with HTO in the drinking water (23.7 mCi/l) during 2, 8 and 12 days respectively, before the 30-th day of the experiment so that the total dose accumulated at the end of the 30 days period to be 0.5 cSv (group C_1), 5 cSv (group C_2) and 10 cSv (group C_3)per animal.

The contamination conditions for the groups A_1, A_2, A_3, were calculated as shown in (Inaba et al. (1981)), and those for the groups C_1, C_2, C_3 making the approximations that: a chronical contamination is a superposition of daily acute ones and taking the muscle retention function for whole body contamination.

On the 31-th day of the experiment all the groups (M, A_1, A_2, A_3, C_1, C_2, C_3) where whole body irradiated by a γ irradiator with the dose 665 cGy, then the survival has been counted during the following 30 days.

During the whole experiment the animals were fed with standard food and were kept in standard conditions ("Principles of laboratory care" NIH publication no. 85–23, revised 1985).

RESULTS AND DISCUSSION

Experimental results in the form of survival curves (percent survival versus the number of days after irradiation) are plotted in Figs. 1 and 2 (acute and chronical HTO contamination respectively, symbols: ■, O, Δ, ▼, are for digital dependence). The shape of the survival curves is typical for such kind of curves, showing two plateau regions (initial and final number of rats) separated by a steep decreasing region (Brook *et al.* 1993).

The analytical form of the survival curves (continuous lines) has been obtained by fitting the digital dependence with a sigmoid-type function (Andrews 1974). The function used was:

$$f(t)=N_2+\frac{N_1-N_2}{1+e^{\frac{t-t_0}{\Delta t}}}$$

where the fit parameters are:

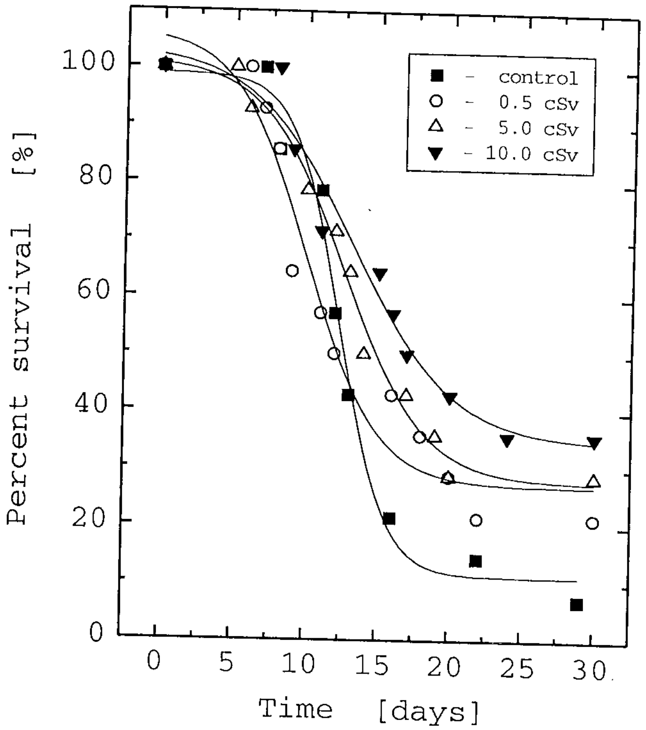
– N_1, N_2 – the percent of initial and final number of rats;

– t_0 – the value of time when the number of rats decreases with half of the difference $N_1 - N_2$;

– Δt – the time interval when the number of rats decreases from $N_1 - N_2$;

– $f(t)$ – the percent survival at time t.

Fig. 1



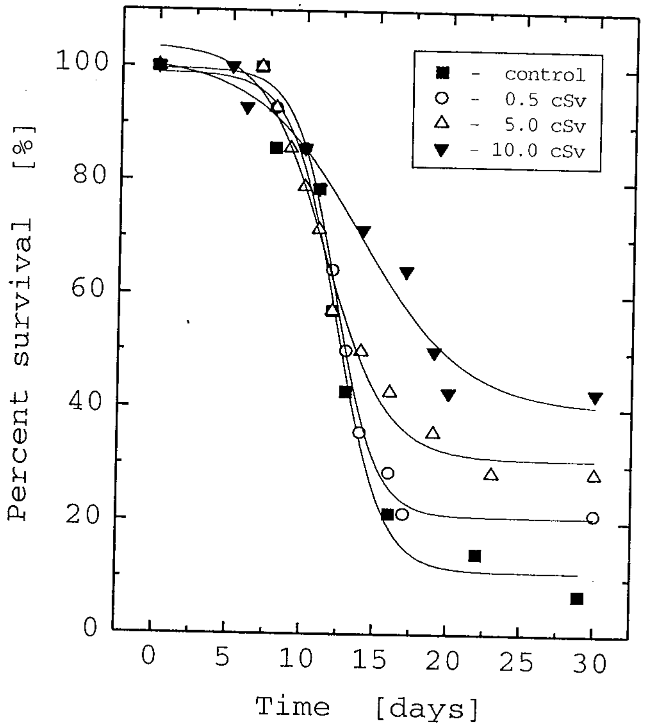


Fig. 2

The parameters N_1, N_2, t_0 and Δt could mathematically characterize the adaptation process, Δt and t_0 being correlated to the dispersion of individual responses of rats from the same group.

Values of all parameters computed with a programme relied on χ^2 fit procedure are presented in Table 1 (for acute contamination) and in Table 2 (for chronical contamination). Remarkable is the fact that in both situations two parameters (Δt and N_2) increase with the increase of HTO contamination doses, but with no rule. The maximal increase, obtained for 10 cSv – chronic contamination, is near 40% for N_2 and near 130% for Δt.

Table 1

Values of fit parameters in the case of acute contamination with HTO

Groups / Dose [cSv]	Parameters			
	N_1	N_2	t_0 [days]	Δt [days]
M / 0.0	98.9	11.1	12.31	1.59
A_1 / 0.5	106.4	27.0	9.99	2.45
A_2 / 5.0	101.3	27.5	12.60	2.76
A_3 /10.0	103.5	34.4	13.21	3.46

Table 2

Values of fit parameters in the case of chronical contamination with HTO

Groups / Dose [cSv]	Parameters			
	N_1	N_2	t_0 [days]	Δt [days]
M / 0.0	98.9	11.1	12.31	1.59
C_1 / 0.5	99.6	20.9	12.20	1.41
C_2 / 5.0	103.7	30.9	11.45	2.16
C_3 /10.0	101.4	39.8	13.81	3.59

In our opinion, the data presented above, in addition to our previous studies in HTO hormesis field (Bejan et al. (1995, 1996)), can be a relevant support set for the theory of hormesis and adaptation to low doses irradiation for animals.

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A MODEL FOR CHRONIC TRITIUM CONTAMINATION

ANCA BEJAN*, GR. TURCU**

Tritium contamination is of special interest if accidents of CANDU - PHW 600 nuclear reactors occur. Population from environmental areas can be contaminated from released tritium through ingestion, inhalation or skin penetration.

In the Journal of Radiation Research an article concerning single oral administration of tritiated water to rats (Inaba et al. 1981) has been published. It gives the retention functions for various rats tissues (blood, brain, liver, muscle, testis) and a model for dose calculation, that *can be* described mathematically by the formula:

$$D = \int_0^n fR(t)\mathrm{d}t$$

where D is the accumulated dose after a number of n consecutive days successive to an acute (single oral) contamination, f is the dose factor for tritium, t is the time and $R(t)$ is the retention function, composed of two terms, one describing the decrease in tritium concentration in tissue water and another describing the decrease in tritium concentration in tissue organic matter.

In our opinion, this model can be used as a start point for a model of oral chronic contamination, based on the approximation that a chronic contamination can be considered as a superposition of daily acute ones. Then, when a regular chronic contamination occurs, the dose calculation formula can be expressed by:

$$D = \sum_{i=1}^{n} \int_0^i fR(t)$$

where D is the chronic contamination dose for various tissues, after n days of an oral chronic contamination composed of daily identical ones, i is the current number for the day i of chronic contamination and the other terms have the same significance as above.

If the chronic contamination occurs irregularly, then the dose formula remains a sum, but divided into a certain number of terms (or domains of terms).

We modified the model for oral acute single contamination (Inaba et al. 1981) for a chronic contamination model with an oral ingestion of tritiated water to rats and applied them to studies concerning the immune response, lipoperoxidation, radioprotection with ascorbic acid and adaptation (Bejan et al., 1995; Bejan and Turcu, 1996).

We consider this kind of studies important because of the possible extrapolation to humans.

REV. ROUM. BIOL. – BIOL. ANIM., TOME 43, N^{os} 1–2, P. 147–148, BUCAREST, 1998

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HISTOLOGICAL STUDIES ON THE EFFECTS OF CYCLOPHOSPHAMIDE ON THE RAT LYMPHOCYTES

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Cyclophosphamide, an alkylating agent belonging to the family of nitrogen mustards, widely used in the chemotherapy of cancer, administered i.v. to adult male Wistar rats, in a single dose of 40 mg/kg body weight, caused obvious histopatological changes of the thymus and the spleen. The sensitivity of the lymphocytes seems to depend on their age, the most sensitive being the lymphoblasts. The serults of our histological studies raise the question whether it is a necrobiosis or an apoptosis process.

Cyclophosphamide is a cytostatic drug, an alkylating agent belonging to the family of nitrogen mustards, commonly used to treat many types of cancer in humans. At the molecular level, its cytotoxicity results from DNA double strand crosslinks and at higher concentrations from DNA strand breaks (3, 8, 10, 11). At the cellular level, cyclophosphamide may selectively affect mature lymphocytes with relative sparing of the respective precursor cells (10).

Our experiments investigated the histological effects of this drug on the lymphatic tissues and also on the lymphocytes.

MATERIAL AND METHODS

Our investigations were carried out to the following six group of adult male Wistar rats; they were maintained under laboratory conditions, with no food for 18 hours before the treatment, but they had water ad libitum.

– group M-control group;

– group T_1, T_2, T_3, T_4, T_5 – treated i.v. with a single dose of 40 mg Cyclophosphamide/kg body weight. The slaughter of these animals was effected after 24 hours, 4, 11, 18 respectively 21 days after the treatment.

Having slaughtered the animals, we took fragments from the thymus and the spleen. They were fixed in 10% neutral formol, processed by the paraffin technique, and the sections of 6 microns were stained by the hematoxylin-eosin method (9).

On the stained sections we studied, by microscope examination, the morphological aspects of the spleen lymphatic nodules and thymic lobules and the dynamics of the effect of Cyclophosphamide on the rat lymphocytes.

RESULTS

Obvious modifications already appeared 24 hours after the treatment both in the central and peripheral lymphatic tissues. Thus, in the thymic lobules, there

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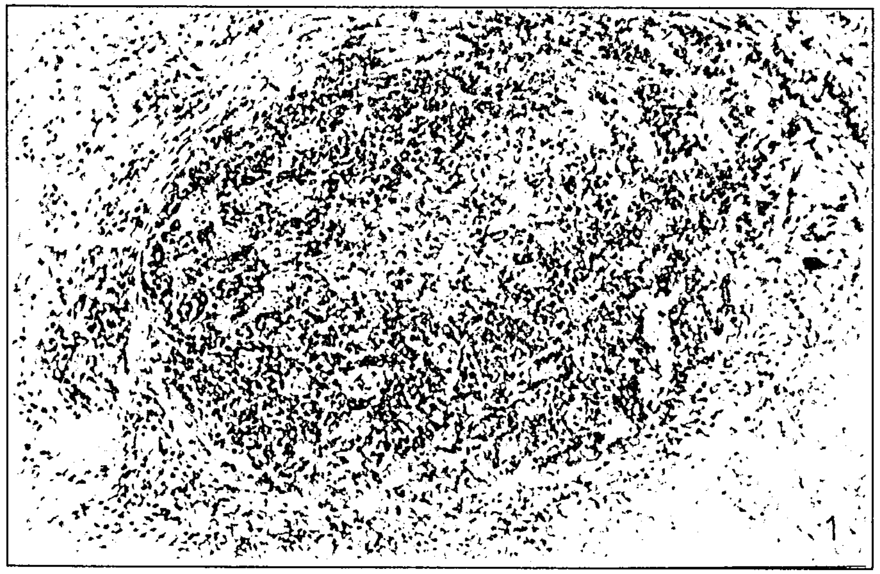

Fig. 1. – Groups of necrobiotic cells all over the lymphatic nodule surface in the spleen, conferring a particular aspects designated as "starry sky" (group T_1, slaughtered after 24 hours from the treatment).

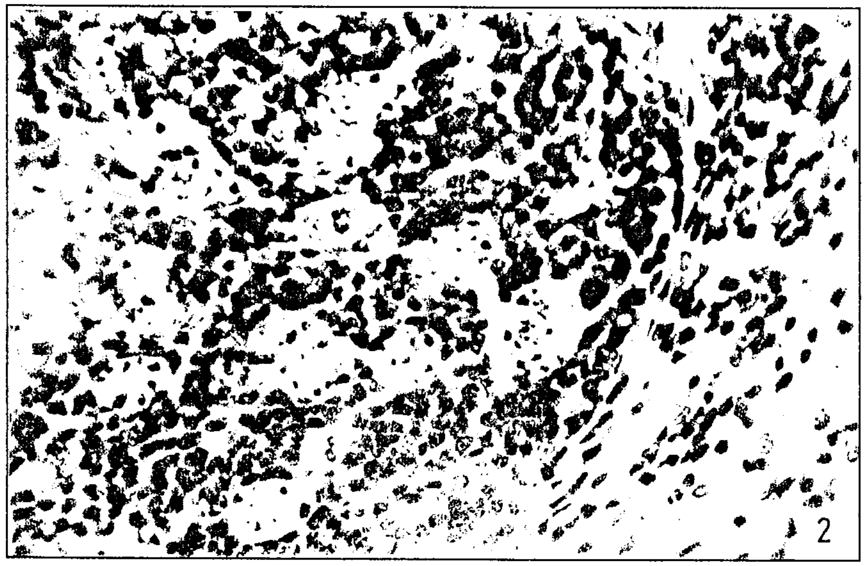

Fig. 2. – Detail of one lymphatic nodule in the spleen (group T_1).

Fig. 3. – Areas full of necrobiotic cells in the thymus of the rats slaughtered after 4 days from the treatment (group T_2).

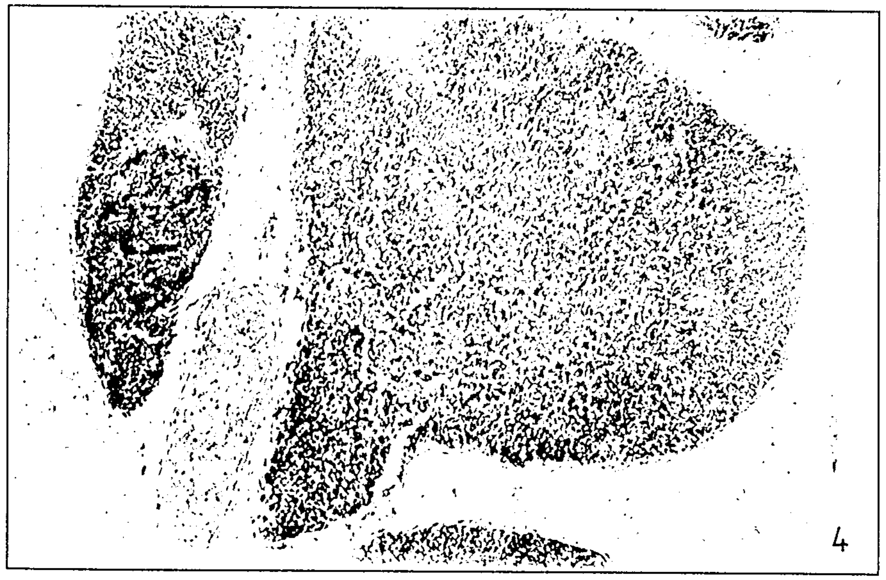

Fig. 4. – The two areas of the thymus (the cortex and the medulla) cannot be distinguished any more because of the decrease of the lymphocyte number in the cortex (group T_2, slaughtered after 4 days from the treatment).

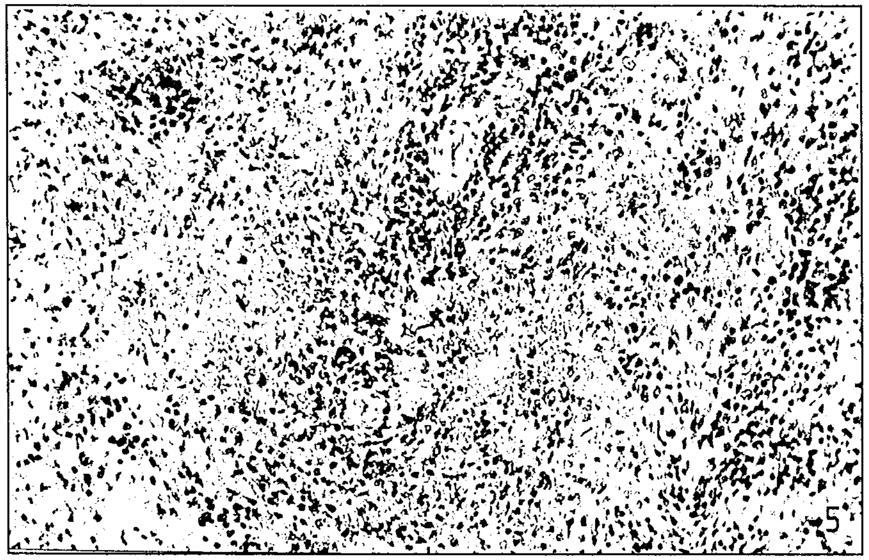

Fig. 5. – Atrophiated lymphatic nodules in the spleen of the rats slaughtered after 4 days from the treatment (group T_2).

Fig. 6. – In the lymphatic nodules of the spleen, the necrobiotic cell number is insignificant (group T_4, slaughtered after 18 days from the treatment).

were visible cortical changes, consisting in the appearance of a few groups of lymphocytes in different necrolysis stages, the phenomenon being more obvious in the peripheral cortex. The dimensions of the thymic lobules were not modified compared to the control group. Although lymphatic nodules in the spleen maintained their dimension there were some smaller or wider groups of necrobiotic cells. These groups were disposed as multiple focuses all over the lymphatic nodule surface, conferring a particular aspects, designated as "starry sky".

After 4 days from the treatment, in the thymus appeared wider and more groups of necrobiotic cells than group T_1 (slaughtered after 24 hours), and the dimensions of the thymic lobules were much smaller than the group T_1 and especially than the control group. At the same time, the two areas of the thymus (the cortex and the medulla) could not be distinguished any more, because of the decrease of the lympocytes number in the outer portion (cortex) of most of the thymic lobules. In the spleen there were necrobiotic cells all around, in groups or isolated, having different dimensions. The "starry sky" aspect of the lymphatic nodule in the spleen disappeared and the dimensions of the nodules were much smaller, a few of them being atrophiated.

After 11 days from the treatment, the thymic lobules were a little wider than the 4 days ones and the necrobiotic cell areas were smaller and so was their number. The dimension of the spleen nodules increased but just a little and the number of the necrobiotic cells were fewer. In the cords of Billroth in the red pulp of the spleen, there were many necrobiotic cells, which were disposed in lines.

After 18 days from the treatment, the necrobiotic cell number was insignificant in the thymic lobules and their dimensions were almost the same as in the control group. The same situation was noticed in the lymphatic nodules of the spleen. In the cords of Billroth too, the number of necrobiotic cells visibly decreased but not to be compared to the splenic nodules.

After 21 days the size and the histological aspects of the thymic lobules, lymphatic nodules of the spleen and cords of Billroth (in red pulp) were the same as in the control groups.

DISCUSSION

In the study we showed that this drug brutally affects the lymphocyte populations both in the central and peripheral lymphatic tissues. Its effect can be already noticed after 24 hours from the treatment, the number of the affected cells being significant. In time, the process increased, so that after 4 days there was the gravest depletion both in the thymus and the spleen.

According to the previous studies (1, 2, 4, 5, 7) the leukopenia appears immediately and it is very grave, being the limiting dose factor, the most affected cells being the lymphocytes T and B and monocytes (6). The leukopenia is maximum after 7–14 days from the treatment and it disappears in 7–10 days. The sensitivity of the lymphocytes seems to depend on their age, the most sensitive being the lymphoblasts which are normally in a high number both in the cortex of the thymus and the lymphatic nodules of the spleen. In our opinion that explains the drastic decrease of the cell number in the outer portion of the thymus and in the lymphatic nodules of the spleen after 4 days from the treatment. The mature lymphocytes were seriously affected too, but not so fast. They could be seen in the thymus even after 11 days, and in the red pulp of the spleen after 18 days from the treatment. Pette et al., (1995), noticed in vivo experiments that cyclophosphamide induces apoptosis in mature human lympocytes, the percentage of apoptotic cells depending both on drug concentration and time of exposure.

In our study the cells affected by Cyclophosphamide were in different stages of necrobiosis and apoptosis: nuclear condensation, morphological changes of the cells, nuclear fragmentation, cell fragmentation. These results confirm previous observations concerning the apoptotic effect of this anticancer drug.

CONCLUSIONS

1. Cyclophosphamide affects quickly the lymphocyte populations both in the central and peripheral lymphatic tissues.
2. The sensitivity of the lymphocytes seems to depend on their age, the most sensitive being the lymphoblasts.
3. The effect of the drug on the rat lymphocytes lasts for almost 3 weeks.
4. Our histological results corroborated with previous studies allow us to appreciate that Cyclophosphamide induces the necrobiosis and apoptosis of rat lymphocytes.

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REACTIVATION OF SOME HEMATOPOIETIC CENTERS IN THE SPLEEN AFTER A SINGLE THERAPEUTIC DOSE OF CYCLOPHOSPHAMIDE

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Although chemotherapeutic agents are widely used in the treatment of cancer, few experimental data are available on their effects on the host's hematopoiesis. Our studies established that a single intravenous (i.v.) injection of Cyclophosphamide (40 mg/kg body weight) caused immediately an excessively depletion on the lymphatic tissues especially on the red bone marrow, followed by the reactivation of some hematopoietic centers in the spleen. After 3 weeks from the treatment, the situation turned normal, so that the red bone marrow could provide the necessary blood cells.

Cyclophosphamide is a cell cycle-nonspecific alkylating agent, a prodrug activated by cytochrome P-450 isoenzymes in the liver. The therapeutic efficacy of this anticancer drug is limited by host toxicity resulting from the systemic distribution of activated drug's metabolites formed in the liver (9, 10, 11, 14, 16, 17). According to the previous studies (1, 5, 6, 7, 8, 12) the leukopenia appears immediately after the treatment and it is very grave being the limiting dose factor. That leukopenia is maximum after 7–14 days from the treatment and disappears in 7–10 days. The mature lymphocytes and the lymphoblasts are both affected. So, our experiments investigated the effect of this anticancer drug on the lymphatic tissues and also on the hematopoiesis.

MATERIAL AND METHODS

Our investigations were carried out to the following 6 groups of adult male Wistar rats; they were maintained under laboratory conditions with no food for 18 hours before the treatment, but they had water ad libitum:

- group M – control group;
- group T_1, T_2, T_3, T_4, T_5 – treated i.v. with a single dose of 40 mg Cyclophosphamide/kg body weight. These animals was slaughtered after 24 hours, 4, 11, 18 respectively 21 days from the treatment.

Having slaughtered the animals, we took fragments from the spleen. They were immediately fixed in 10% neutral formol, processed by the paraffin technique and the sections of 6 microns were stained by the hematoxylin-eosin method (13).

On the stained sections we studied, by microscope examination, the possible histological modifications induced by a single therapeutic dose of Cyclophosphamide concerning the density of the cells in the white pulp and the red pulp of the

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spleen, the morphological aspects of each cell population, the proportion of each cell type and the dynamics of the process in concordance with the moment of the slaughter and compared to the control group.

RESULTS

Clinically, the treated rats bore rather well this single therapeutic dose of Cyclophosphamide. They had an appetite as good as the control group all over the experiment. No case of illness or death occurred during the experiment either on the treated groups or on the control group. The only obvious modification was a slight drowsiness with the treated groups for 2 or 3 days after the treatment.

But, on the stained sections there were significant modifications straight after 24 hours from the treatment. These modifications consisted of a drastic decrease of the cell number especially in the lymphatic nodules in the white pulp of the spleen, where there were some smaller or wider groups of necrobiotic cells. These groups were disposed as multiple focuses all over the lymphatic nodule surface conferring a particular aspect, known as "starry sky".

After 4 days, the cell number decreased even more, the lymphatic nodules appeared much smaller compared to the control group, a few of them being atrophiated. There were necrobiotic cells all around both in the red and the white pulp, in groups or isolated, having different dimensions, but the "starry sky" aspect had disappeared. Besides, a few megakaryocytes could be seen in the rats'spleen.

After 11 days, the cell population in the spleen was in an obvious increase but quite different from the control group in density and in contents. In the spleen, besides the usual cells (lymphocytes, macrophages, erythrocytes, plasma cells and granulocytes), there were a lot of megakaryocytes all over, in groups and isolated, having a polymorphous structure. Although usually there are a large number of eosinophils and neutrophils, in this treated group (T_3), their number is larger than in the control group. All around on the spleen surface appeared many areas of granulocytes (eosinophils and neutrophils), which seem to be in different development stages.

After 18 days from the treatment, the situation was much more changed compared to the previous group (T_3). The spleen was in an obvious recovery, the size of the lymphatic nodules being almost like those in the control group and a very large number of lymphoblasts had appeared. The number of the megakaryocytes and granulocytes had obviously increased compared to the 11 days slaughtered group.

After 21 days, the number of granulocytes was almost equal to the group and the megakaryocytes were few.

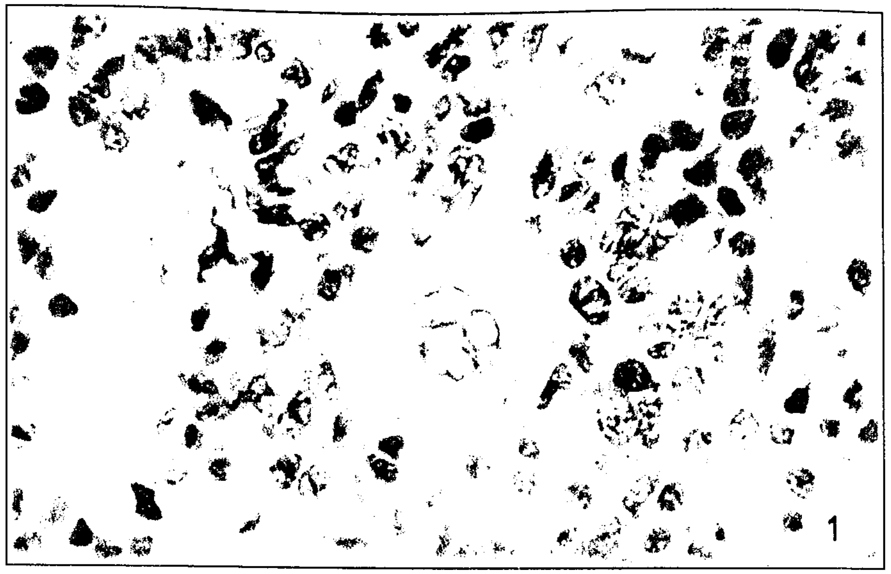

Fig. 1. – A megakaryocyte in the red pulp of the spleen in the rats slaughtered after 4 days from the treatment (group T_2).

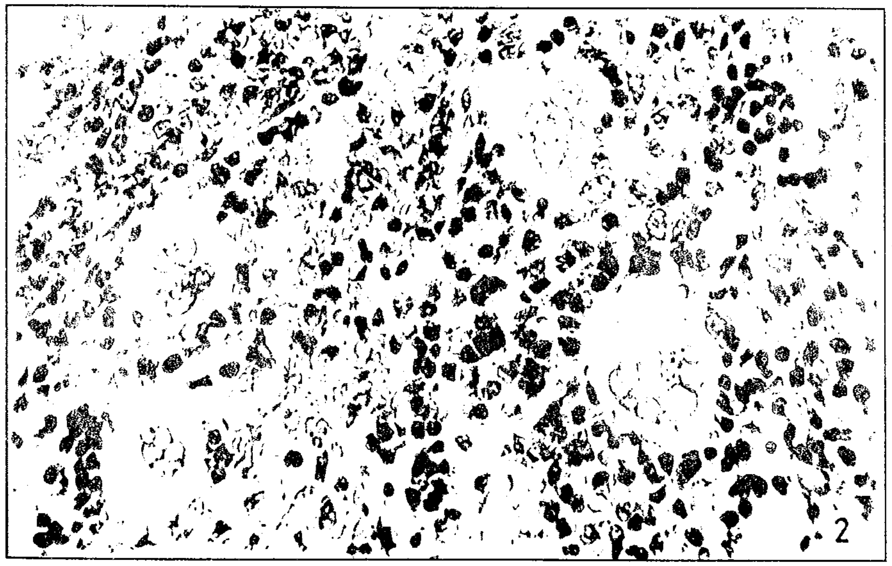

Fig. 2. – The presence of many megakaryocytes all over, having a polymorphous structure, in the red pulp of the spleen in the rats slaughtered after 11 days from the treatment (group T_3).

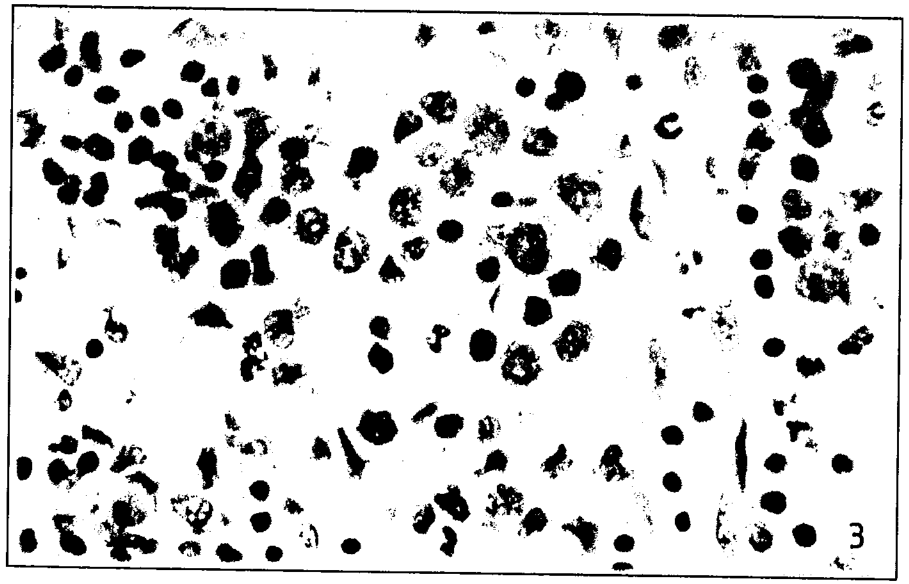

Fig. 3. – A group of eosinophils in the red pulp of the spleen in the rats slaughtered after 11 days from the treatment (group T_3).

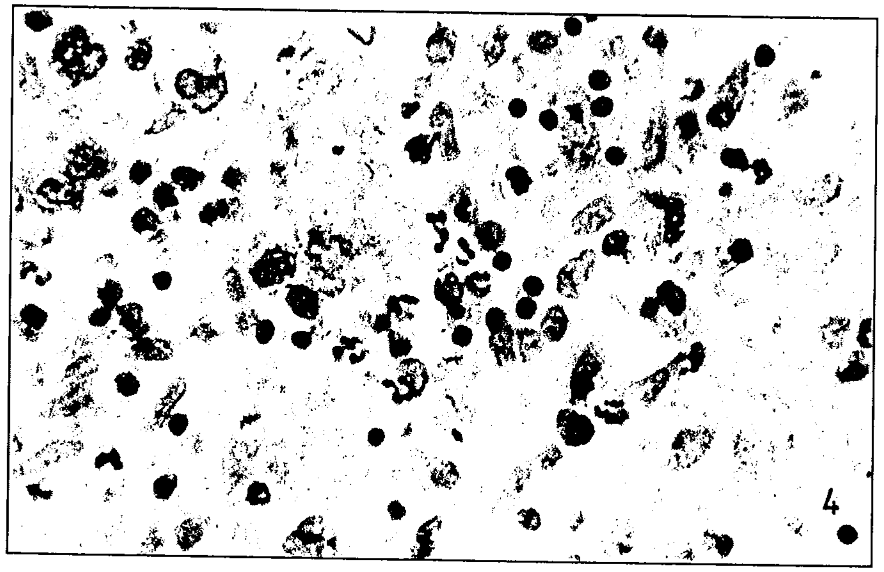

Fig. 4. – A group of neutrophils in the red pulp of the spleen in the rats slaughtered after 11 days from the treatment (group T_3).

DISCUSSION

Our results established that a single dose of 40 mg Cyclophosphamide/kg body weight affected very much the cell populations in the spleen. Thus, in 4–5 days, most of the cells in the spleen at the moment of the treatment, suffered a necrobiosis process, so the cell number decreased significantly as compared to the control group. This cell deficit induced by Cyclophosphamide couldn't be promptly recovered only by the red bone marrow. In this limit situation, the affected organism appealed for a while to the reserve mechanisms, for example spleen hematopoiesis recovery. This mechanism was very well rendered in our histological studies, at least on what concerns the formation of platelets and granulocytes. The large number of megakaryocytes in the rat spleen of the group T_3 (slaughtered after 11 days from the treatment), showed clearly that the spleen recovered its hematopoietic activity, which usually happens only before birth. Hematopoietic activity of the spleen decreased significantly after 18 days and disappeared after 21 days. These data are in concordance with previous studies which show that Cyclophosphamide has a significant hemotoxicity, materialized in leukopenia that is maximum after 7–14 days from the treatment and disappears in 7–10 days (1, 5, 6, 8, 12), and in a less grave platelets and erythrocytes decrease (4, 15). Our studies showed both the starting of the hematopoiesis in the spleen after the treatment and the period during which the red bone marrow hematopoiesis is disturbed, so that it cannot assure by itself the necessary blood cells.

Having these data, we can establish that this period lasts almost 3 weeks. After this period the spleen hematopoiesis ceases proving that the red bone marrow is completely recovered, being thus able to supply the lymphatic tissues with specific cells. Dygay et all (1995), Bravo Lina et al (1996), Chen Yuh Min et al. (1996) demonstrated that this recovery of the red bone marrow is due to the stimulating hematopoiesis factors: interleukine 1 and 3 and stem cell stimulating factors.

CONCLUSIONS

1. A single dose of Cyclophosphamide (40 mg/kg body weight) induces immediately a serious depletion in the lymphatic tissues.

2. The treated organism cannot recover promptly the cell deficit only through the red bone marrow hematopoiesis.

3. This limit situation induced by this anticancer drug makes the affected organism appeal for a while to the reserve mechanisms, in this case to the spleen hematopoiesis.

4. After 3 weeks from the treatment the red bone marrow is completely recovered, being thus able to assure the necessary blood cells: lymphocytes, granulocytes and platelets.

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