THE STAGES OF THE PALEOICHNOLOGICAL STUDIES IN ROMANIA

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Abstract. The paper synthetizes the Romanian and foreign researchers contribution brought to the paleoichnological studies in Romania. These studies may be divided in the following stages: the "fucoids" stage (1910-1955), the vertebrate footprints stage (1960-1970) and the stage of the paleoichnological reviving (after 1980). One hundred and seventy-nine invertebrate and vertebrate ichnospecies belonging mostly to the Cretaceous, Paleogene and Miocene have been mentioned from the geological formations in Romania so far. Out of this figure more than 100 ichnospecies represent new forms for Romania, most of them referred to after 1980.

Key words: geological history, stages of the paleoichnological studies, Romania.

INTRODUCTION

Having been considered as curiosities for a long time, sometimes bizarre and having a mysterious origin, the biogene sedimentary structures (BSS) known as "bioglyphs" until not long ago, drew the extraordinary attention of the paleontologists and sedimentologists all over the world in the last 35-40 years. This short but particularly efficient period coincides, in fact, with the development of the paleoichnology as an independent branch of knowledge. The progress made in the study of BSS and clearing up their significance has been possible due to the accurate defining of the main concepts, of the terminology and their classification. This effort has been supported by a pleiad of famous learned geologists such as Richter (1928), Abel (1935) Lessertisseur (1955), Seilacher (1953, 1964, 1964, 1986), Häntzschel (1962, 1975), mentioning only some of them.

Ignored for a long time by paleontologists or considered as "*ludus naturae*", more and more BSS produced both by invertebrates and vertebrates are used nowadays in ***biostratigraphy*** (ichnostratigraphical marker, correlation by means of the ichnofossils index, paleogeographical and retrotectonical reconstitution), ***paleontology*** (proofs of the evolution of the metazooans and of their behaviour especially at Precambrian/Cambrian boundary), ***paleoecology*** (biotic and paleoambiental features) and ***sedimentology*** (depositional processes indicators).

Trying to review the contributions of the Romanian and foreign researchers to the paleoichnological knowledge of the different geological formations in our country one can notice that these date back in the last century, the oldest specification of this kind belonging to Capellini who, in 1868, quoted in the Eocene from Moinesti "macigne con fucoidi e *Paleodictyon*". In the same period, Coquand drew the attention of some "horizon with fucoids" at Tg.Ocna .The recording of the information on the animal activity traces in about 100 published papers, show the following stages in researching the paleoichnology in Romania: the " fucoids " stage (1910-1955); the vertebrate footprints stage (1960-1970); the stage of the paleoichnological studies reviving (after 1980) (Fig.1).

STAGES OF THE PALEOICHNOLOGICAL STUDIES

The "fucoids" stage

Most researchers who have studied the flysch formations in the East Carpathians quote frequently different types of fucoids in the Inoceramian Beds (Macovei & Atanasiu, 1923, 1926), some at the level of ichnospecies (*Chondrites intricatus, Chondrites expansus, Chondrites furcatus* - Stefănescu, 1927) and *Zoophycos* (=*Taonurus*, =*Caulerpites* - Athanasiu et al. 1927, Stefănescu, 1927). From the same formation Stefănescu (1937) quoted *Spirophyton* and *Cladichnus* (=*Muensteria*). Later on, Joja (1955) used the fucoids for separating the Senonian from the Outer Flysch in a "lower horizon with fucoids" and "upper horizons" in which these are not to be found. A "marl level with fucoids" was quoted at the basis of "Nummulitic of the Sotrile type" by Protescu (1918).

Except the Senonian deposits, fucoids have been mentioned in the Sinaia Formation (Cernea, 1952), Comarnic Formation (Murgeanu, 1934), the Black Schists Formation (Stefănescu, 1937), Tisaru Formation (Mateescu, 1930) as well as in the Eocene-Oligocene formations (Filipescu, 1934; Stefănescu, 1937; Joja, 1952, 1955; Dumitrescu, 1952; Grigoras, 1955). It is worth mentioning that Mateescu (1927) supported the certain marine origin of the marls with fucoids, and the "hieroglyphs" in the Eocene are considered as "produced by animals".

Worth mentioning are the contributions brought about by Protescu (1912) and Mrazec (1927) for explaining some hieroglyphs in the flysch, by comparing them with the present-day traces produced by some insects (*Gryllotalpa*), by gastropoda respectively (i.g. *Pirenella* noticed by Mrazec in 1915 in the mud of the Yemsah lagoon in the Red Sea). The two Romanian researchers may thus be considered as the initiators of the neoichnological studies in Romania as well as the forerunners of the "actuopaleontology", discipline whose basis was laid by Richter in 1929 when he explained the formation and preservation ways of the animal activity traces on the German coast of the North Sea and extrapolated the data obtained by studying the fossil traces in the Devonian schysts of Hunsrück.

Much in the same period, Ilie (1931) reported the first ichnospecies of *Paleodictyon* (*P. tellini, P. minimum* and *P. regulare*) in the Sotrile Facies at the East Carpathians Bend Area and the Neogene from Turda (*P.magnus*), and later on the same author, reviewing the hypotheses regarding the formation of this structure, supported its organic origin considering that this represents batrachians eggs (Ilie, 1937). This explanation will be opposed to by Joja (1952) who remarks, with good reason, that, if the hexagonal networks should represent frog eggs, then one cannot understand why they are not present in the

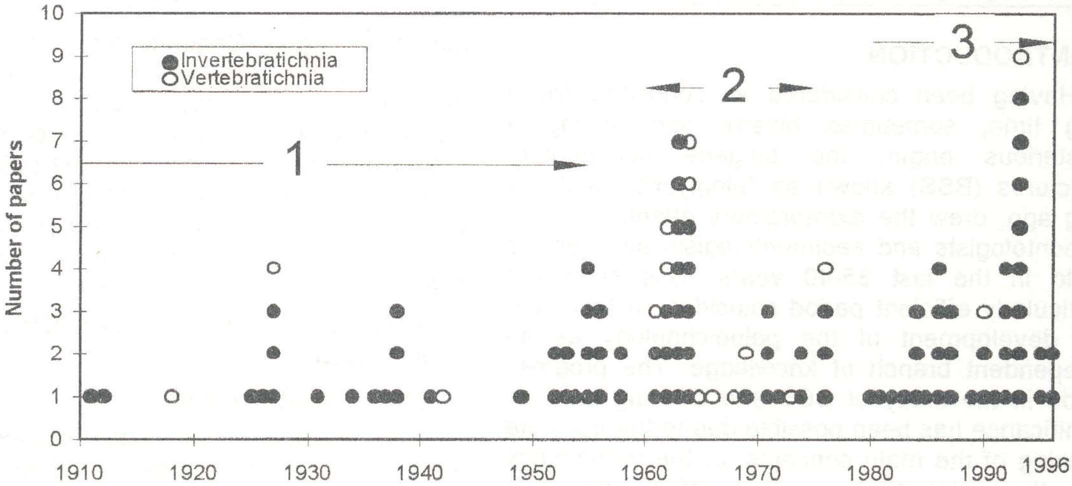


Fig.1 Papers published between 1910 - 1996, with references to BSS

Pliocene deposits. *Paleodictyon* had been quoted before in Eocene by Filipescu (1934), Stefãnescu (1937), Olteanu (1953), Joja (1955) and Ilie & Mamulea (1952) use it for separating this stage in the Hateg basin. Mention should be made that surprisingly present are the observations referring to this ichnogenus made by Filipescu (1934), who showed that its regular form excludes the hazard, and the hexagonal network represents "a burrows system belonging to a vermidian species endowed with a very pronounced directional sense". In the Miocene deposits, *Paleodictyon* has been quoted in the Dej Tuff Complex (Török, 1947; Fuchs, 1961) and in the Hida Beds in the Transylvanian basin (Fuchs, 1956).

The first footprints of the birds in the Lower Miocene in Moldavia (Grozescu, 1918) and footprints of the mammals (?*Dicrocerus*) from Ocnita (Popescu-Voitesti, 1927) were made known during the studied period, made complete later on by Paucã (1942, 1952) with numberless traces of Palmipeda and Gruida from Vrancea county.

Some other types of BSS are known from the Lower Paleozoic of the Moldavian Platform ("problematic traces" from the Atachi Sandstone and "worm traces" from the Molodova Sandstone - Vãscãutanu, 1931; "coally vermicular hieroglyphs" - Macarovici, 1956), the Permian of the Apuseni Mountains ("worm burrows" - Palfy & Rozlozsnik, 1938), considered as worm dejection by Arabu (1941), the Upper Cretaceous in the Hateg basin ("worm traces and fucoids" - Laufer, 1925), Eocene of the Getic Facies ("numerous traces of worms" and "great traces of Annelida" - Popescu-Voitesti, 1911; cylindrical burrows coming from "the digested and secreted material in the alimentary canal of some limnivorae Annelida" - Dragos, 1953; *Scolicia* (=*Palaeobullia*) traces - Murgeanu, 1941) and borings of *Teredo norvegica* in the Oligocene in the south of Rodna Mountains (Kräutner, 1938), the Borsa Sandstone in the Bârgãului Mountains (Semaka, 1955) and the Miocene in Banat (Florei, 1961).

Borings, considered by Cantuniari (1935) as being produced by *Teredo* in the fossil wood, are found in the Upper Cretaceous on the bank of the Prut River in Basarabia. From the Cenomanian glauconitic deposits in Rădăuti-Prut, the same type was quoted later on by Bâgu & Mocanu (1984). Borings in wooden substratum are also those produced by *Martesia* revealed for the first time in Romania by Suraru & Suraru (1959) in the Almasului Valley Beds. Later on, this lamelibranchiate was mentioned in the Dej Tuff (Meszaros & Clichici, 1976) and also on the Corus Beds (Givulescu, 1981). One should mention that the BSS resulting as the result of the activity carried out by *Martesia* is assigned to the *Teredolites clavatus* ichnospecies characterizing the marine Teredolites ichnofacies with *Teredolites* typical to the wooden substratum (Bromley et al., 1984).

Remaining in the same field of the traces produced by the perforating animals, it is worth mentioning the contribution brought about by Nitulescu (1936) for explaining the bioerrosion of the calcareous substratum of Stramberg Limestone type by the pholadidae and echinoderms during the Badenian, when this was making up a submarine peak situated near the surface of the water in the Petresti area (Turda).

The stage of vertebrate footprints

This stage generally corresponds to the concerns for sedimentology started in 1958 under the management and guiding of the academician G. Murgeanu. The first paleoichnological observations on the turbiditae in the Sotrile Facias (Contescu et al., 1963) were made on this occasion, and especially in the Lower Miocene molasse in the Subcarpathians, when numerous ichnospecies of bird footprints were described (Panin, 1961, 1965; Panin & Avram, 1962; Panin et al., 1966; Grujinschi, 1969; Ionită, 1964; Panin & Stefănescu, 1968). As for the birds and mammals footprints, some of which new for Romania (*Pecoripeda amalphaea, Pecoripeda gazella*) and most of which new for science (*Ardeipeda egretta, Ardeipeda gigantea, Ardeipeda incerta, Gruipeda intermedia, Gruipeda grus, Gruipeda maxima, Anatipeda anas, Charadriipeda recurvirastra, Charadriipeda minima, Charadriipeda disjuncta, Charadriipeda minor, Charadriipeda becassi, Rhinoceropeda problematica, Proboscipeda enigmatica, Canipeda longigriffa, Felipeda lynxi, Felipeda felis, Felipeda minor*) we should mention the concern for imposing a new specific research methodology and for using a proper ichnotaxonomical terminology (Panin & Avram, 1962; Panin, 1965).

Paleoichnological observations on the Cretaceous and Paleogene Flysch were made on some other occasions too, when from different formations there were mentioned ichnogenus and even ichnospecies (Săndulescu et al., 1962; Alexandrescu & Soigan, 1963; Dimian & Dimian, 1964). In that period, Pauliuc (1962) applied the terminology and the classification of the superficial structures, devised by Vassoevici, on the Paleogene sandstone in the Buzău Valley basin. The petrogenetic role of the excrements of the crustacean decapoda was discussed by Patrulius (1964), when talking about the microcoprolite (*Favreina salevensis*) in the Neocomian limestones met when borehole at Atârnati. Later on, one could notice (Drăgănescu, 1976) the wide spread of these limestones in the intertidal flats of the Lower Cretaceous in the Valahic area of the Moesic Platform. Microcoprolite as *Favreina* and boring traces produced by lithofagous Mollusca were mentioned by Dragastan (1975) too in the Bicaz Valley area, Haghimas Mountains.

In some other geological formations and areas, one mentioned *Paleodictyon* and "organic impressions of bilobated type" (which seem to belong sooner to the *Nereites* ichnogenus) in the Silurian in the Northern Dobrogea (Mutihac, 1964), and on the basis of the *Arthrophycus alleghanensis* ichnospecies, Răileanu & Năstăseanu (1963) assigned the Silurian age to the argillaceaus schists below the Ideg Limestone in Banat. In the Crystalline - Mesozoic Zone of the East Carpathians there were frequently quoted bioturbations in the Triassic Werfen Beds in the Bucegi Mountains (Patrulius, 1969) and Rarău Mountains (Turculet, 1971) as well as *Zoophycos* in the Anisian dolomites in the Hăghimas Mountains (Baltres, 1976). The borings produced by the lithofagous organisms on the indurate surface of the Tithonian limestones in the Dâmbovicioara corridor mentioned by Patrulius (1963) are interesting and terribly resemblnig the galleries of the *Ophiomorpha bornensis* in the Miocene of the Borneo Island, form indicating the coastal area.

The great fucoids were quoted from the Cretaceous Flysch and the small ones in the Convolute Flysch and the Black Schists Formation (Ionesi, 1962) and from the Transcarpathic Eocene (Petrova Beds), the same author mentioned great size fucoids (Ionesi, 1959).

In the Apuseni Mountains, the Upper Cretaceous deposits, in the Bozes Beds have a great number of *Paleodictyon, Helminthoida crassa, Spirophyton* and *Scolicia* (=*Palaeobullia*) traces mentioned by Antonescu et al. (1963), Dimian & Dimian (1963) and Mantea et al. (1971). In the Senonian deposits in Maramures there was quoted *Spirophyton* in the Puchov Marl at Poiana Botizei (Bombită, 1972), ichnogenus which had been met before at Sacel, besides *Zoophycos* (Patrulius et al., 1955). Tubes of worms are to be also found in the Badenian in the Simleu basin (Nicorici, 1972). Macarovici (1969) made some observations on some lithofagous fossil lamellibranchiate and present in the East-European Miocene and the Black Sea, and Bărbulescu (1974) mentioned borings of the *Clione* spongiae on belemnits rostrum in the Topalu area.

Finally, worth mentioning are the impresions and the footprints left by the cave bear (*Ursus spelaeus*) on the walls and the floor of some caves in the Apuseni Mountains, sometimes very numerous, as those in the Ciur-Izbuc Cave (Viehmann, 1973) and footprints of the primitive man in the same cave represented by about 400 impressions (Rusu et al., 1969; Viehmann et al., 1970), more than 200 of which being studied from an anthropologic point of view by Riscutia & Riscutia (1970). The determination of the age by radiometrical methods, carried out on a hominid footprint studied by Viehmann from the Ghetarul de la Vârtop Cave, indicates 22,400 years (Lauritzen & Onac, 1995). Unfortunately, the human footprint impression left in the cave disappeared together with a part of the floor as a result of a vandalism act ("Flagrant" newspaper, nr. 40/2-8, October 1995).

The stage of the paleoicheological studies revival

The resuming of the paleoichnological studies in Romania may be considered, on the one hand as an answer given to the need of going on an activity already begun and resulting in important results and, on the other hand as joining the common effort of many foreign researchers, nowadays, practically not being any sedimentologic study or of a basin analysis which should not contain references to the BSS associations as indicating the environmental deposition.

The paleoichnological study of the East Capathians Flysch which started about '80s resulted in continuing the BSS inventory in different geological formations as: Bistra Formation (Dinu, 1985), Siriu Sandstone in which exceptional specimens of *Zoophycos* appear (Alexandrescu & Crăciun, 1984), Hangu and Horgazu formations (Alexandrescu & Brustur, 1980, 1982, 1987), Putna (=Izvor) Formation (Alexandrescu & Brustur, 1987; Brustur & Ionesi, 1990), Cârnu-Siclau Formation (Alexandrescu & Brustur, 1993). A special attention has been paid to the Upper Eocene formations (Podu Secu, Plopu, Bisericani) rich in ichnofossils (Alexandrescu & Brustur, 1987; Micu et al., 1987) whose ichnospectrum has been recently discussed by Brustur & Stoica (1993). The Oligo-Miocene formations have furnished some new ichnospecies (i.e.*Helminthopsis filiformis* - Alexandrescu & Brustur, 1987), in the Vinetisu and Podul Morii formations of the Tarcău Unit in Bucovina and from the East Carpathians Bend Area, rendering the paleoichnocenosis with *Sabularia* (Alexandrescu & Brustur, 1984; Alexandrescu, 1986) with a special paleoecological significance and being characterised as an excelent ichnostratigraphical marker (Alexandrescu et al., 1993). This paleoichnocenosis has recently been also noticed in Vrancea Unit, to the dominant association of *Sabularia* and *Mammillichnis* being added specimens of *Rhizocorallium* and huge traces of *Zoophycos* (more than 1 m diameter) (Brustur, 1996). In the Tarcău Sandstone Formation one could identify, within the Giurgiu-Ghelinta Beds in the Trotus Valley (Alexandrescu & Brustur, 1990) and then in the Buzău Valley (Brustur, 1995), paleoichnocenosis with *Subphyllochorda*, dominated by BSS produced by spatangoida echinoids (*Subphyllochorda, Cardioichnus, Taphrhelminthopsis,* see Plate). Within the same formation on the Buzău Valley at the Siriu dam one could identify a layer keeping a lot of traces of *Taphrhelminthopsis* which were studied from an ichnotaxonomical point of view (Brustur & Alexandrescu, 1992) and an interesting association, if not unique, made up of graphoglyptides (*Paleodictyon, Cosmorhaphe*) and an extremely well preserved impression of *Asteriacites stelliforme*, a new ichnofossil for the Paleogene Flysch in Romania (Brustur, 1992).

The study of the Sotrile Facies in the Dâmbovita Valley has revealed a new biodeformating structure produced by the sea urchins (*Spatangoidichnus reinecki* - Brustur, 1993), of the ichnogenus *Ophiomorpha* and *Teichichnus* (Brustur, 1995), and from the Ialomita valley one could describe the "huge" ichnospecies *Paleodictyon gomezi*, known in the Eocene from Spain (Brustur, 1995).

An important discovery is represented by noticing a real population of the *Rhizocorallium* ichnogenus (see Plate) in the Kliwa Sandstone in Vrancea, significant for the shallow water conditions in which this deposit was accumulated (Brustur et al., 1995). The good preserving state, the accessibility and the scarcity of this occurrence have motivated the proposal of protecting by law (Brustur & Alexandrescu, 1993), especially that within the Carpathians area, this ichnogenus was known only in Poland as isolated specimens in some localities in the Magura Unit (Ksiazkiewicz, 1977; Uchman, 1992).

The research of the Lower Miocene mollase formations in Vrancea has led to the identification of some new traces of isopoda (*Oniscoidichnus miocenicus* - Alexandrescu et al., 1986) and amphipoda (*Talitrichnus panini* - Brustur &

Alexandrescu, 1993), insisting also on the need for protecting the paleoichnologic patrimony of this region (Brustur, 1992) within the paleontological protected Prisaca-Bozului Brook area (Brustur & Alexandrescu, 1991). The paleoichnological extremely high potential, of the Lower Miocene mollase in Vrancea, rendered evident recently (Brustur & Alexandrescu, 1993), is attested by the discovery of new ichnospecies of birds footprints (*Carpathipeda panini, Carpathipeda vialovi*) by the Hungarian researchers Kordos and Prakfalvi (1990), as well as mentioning some insect traces (probably coleoptera of the Dytiscidae family) and reptilian ones (Brustur, in prep.), the presence of the latter being mentioned, without any other details, by Patrulius (1976) showing that in the red beds of the upper part of the Lower Miocene there appear "bird traces, footprints of antelope, deer, horses, mastodonts and even crocodiles".

Except the East Carpathians, there have been rendered cylindrical burrows proved to be BSS according to the SEM analytical method and traces of a jellyfish type (*Nemiana simplex*) which represent elements of the Ediacara fauna in the Green Schists Series in the Central Dobrogea (Oaie, 1992), the same author describing a deep water association too (*Helminthoida, Nereites, Protopaleodictyon, Helminthopsis, Chondrites*) in the Bestepe Formation, mentioning the presence of *Planolites* in the Carapelit Formation (Oaie, 1989). Burrows of *Thalassinoides* and *Ophiomorpha* (Brustur, in prep.) have also been noticed in Dobrogea in the Cenomanian in the Babadag basin, south of the Cerna village. Two ichnospecies of *Planolites* (*Planolites beverleyensis,* and *Planolites montanus*) have been described from the Permian "Vermicular Sandstone Formation" in the Aries Valley in the Apuseni Mountains (Brustur, 1986). The same type has been distinguished in the Permian of the western part of the Codru Mountains (Istocescu, 1971). Not long ago, Bordea & Bordea (1993), due to the presence of *Planolites* and to characteristic lithology, argued the presence of the "Vermicular" Sandstone Formation in the central part of the Highis Mountains. The same ichnogenus, but as glauconitized burrows, was quoted by Catană et al. (1992-1993) in the Lower Miocene deposits in the Arges Valley.

Rădan & Brustur (1993) have recently described for the first time footprints of the bird (*Charadriipeda limosa* n.isp.) in the Upper Oligocene of the Dâlga-Uricani Formation in the Petrosani basin, where Culda (1984) quoted borings of *Cliona* and *Polydora* on *Ostrea* shells in the Sălătruc Formation (Badenian). Grigorescu et al. (1983) mentioned vertical cylindrical tunnels filled with sand, assigned to the detritus feeding worm activity from the Hateg basin, from the upper part of the fluvio-lacustrine cyclotheme of the Sânpetru Beds with dinosaurian remains. Similar structures, but with calcitic filling has been noticed in the Rona Limestone from the stratotype by Bombită & Baltres (1986). Stefănescu et al. (1986) recognized frequent traces of *Scolicia* (=*Palaeobullia*) as well as *Laminites* (Brustur, in prep.) in the Eocene deposits of the Titesti-Brezoi basin.

A special attention should be paid to the paleopathological elements on the Upper Miocene (=Bosphorian, Dacic *sense*) fossil leaves from Chiuzbaia described by Givulescu (1984). These are represented by sores due to the crysomelidae, coleopters and the gastropodes and galleries (mines) produced by hymenopteres, lepidopteres and dipteres.

FINAL REMARKS

From the Romanian geological formations 179 ichnospecies of invertebrates and vertebrates belonging mostly to the Cretaceous, Paleogene and Miocene have been pointed out so far.

Together with the ichnofauna from Chiuzbaia represented by 15 ichnospecies and without the 8 ichnospecies present in same other geological formations of different ages, there remain 171 ichnospecies of which 142 invertebrates and 29 vertebrates making up the ichnospectrum of the leaf material in the Upper Miocene from Maramures and the Outer Moldavides in the East Carpathians. More than 100 ichnospecies of this number represent new forms for Romania, most of them pointed out after 1980, 13 of them being new for science (Table 1). One described 44 ichnospecies of which 40 vertebrates and 4 invertebrates from the red and grey deposits of the Lower Miocene mollase in the Ukrainian and Romanian Subcarpathians. Worth mentioning is the fact that, of the vertebrates footprints 26 ichnospecies come from the Romanian area, 20 of them being new for science (Table 2).

This thing points out the high paleoichnological potential of the Lower Miocene molasse as well as the interest paid to the study of it by the Romanian geologists.

As to the ichnofauna of the Outer Flysch and of the Lower Miocene mollase in the East Carpathians, this has been recently synthesized in a doctor's degree thesis, when 108 ichnospecies and 4 ichnogenus were described and the significance of the ichnospectrum of same formations from Cretaceous-Lower Miocene interval was debated (Brustur, 1995).

Being entirely local, the ichnofossils are closely connected to the environmental condition change,

Table 1. Inveretebrate ichnofauna (invertebratichnia) in the Sotrile Facies, Outer Moldavide (East Carpathians) and Chiuzbaia (Maramures)

No.	Ichnospecies	CRETACEOUS			PALEOGENE			NEOGENE	
		Ne-Ap	V-Tu	Sn	Pc	E	O	M_1	M_2
1.	*Acanthorhaphe cf. incerta*					+			
2.	*Agrichnium incompositum*					+			
3.	*Agrichnium isp.*					+			
4.	*Ancorichnus horizontalis*					+			
5.	*Arthrophycus cf. strictus*					+			
6.	*Asteriacites stelliforme*					+			
7.	*Asterichnus isp.*					+			
8.	*Belorhaphe isp.*					+			
9.	*Belorhaphe zickzack*					+			
10.	*Bergaueria isp.*					+			
11.	*Caloptilia roscipenella HB fossilis*								+
12.	*Capodistria moldavica**					+			
13.	*Cardioichnus ovalis*					+			
14.	*Cardioichnus cf. planus*					+			
15.	*Chondrites aequalis*					+			
16.	*Chondrites affinis*	+	+						
17.	*Chondrites arbuscula*		+			+			
18.	*Chondrites expansus*		+	+					
19.	*Chondrites filiformis*		+						
20.	*Chondrites furcatus*		+	+		+			
21.	*Chondrites granulatus*		+						
22.	*Chondrites hoessii*			+					
23.	*Chondrites intricatus*		+	+					
24.	*Chondrites isp.1*		+						
25.	*Chondrites isp.2*		+						
26.	*Chondrites isp.3*	+							
27.	*Circulichnis montanus*					+			
28.	*Cladichnus fischeri*			+					
29.	*Cladichnus isp.*			+					
30.	*Cosmorhaphe cf. gracilis*					+			
31.	*Cosmorhaphe sinuosa*			+		+			
32.	*Cosmorhaphe helminthopsidea*					+			
33.	*Cosmorhaphe isp.*					+			
34.	*Cuniculonomus parallelus**								+
35.	*Curvolithus isp.*					+			
36.	*Cylindrichnus concentricus*					+		+	
37.	*Cylindrichnus isp.*					+			
38.	*Desmograpton cf. fuchsi*				+				
39.	*Desmograpton geometricum*					+			
40.	*Desmograpton isp.*			+					
41.	*Fenusa ulmii SD fossilis*								+
42.	*Fenusites betulacerum*								+
43.	*Fenusites caryae**								+
44.	*Fenusites fagi*								+
45.	*Fenusites zelkovae*								+
46.	*Glockerichnus aff. sparsicostata*					+			
47.	*Glockerichnus aff. disordinata*					+			
48.	*Granularia isp.*					+			
49.	*Halymenidium oraviense*					+			
50.	*Helicolithus sampelayoi*					+			
51.	*Helminthopsis abeli*			+					
52.	*Helminthopsis filiformis**						+		

Table 1 - continued

53.	*Helminthopsis aff. hieroglyphica*	+							
54.	*Helminthopsis hieroglyphica*					+			
55.	*Helminthopsis isp.1*						+		
56.	*Helminthopsis isp. 2*						+		
57.	*Helminthopsis isp. 3*						+		
58.	*Helminthoidea crassa*		+			+			
59.	*Helminthoidea aff. crassa*			+					
60.	*Helminthoidea cf. crassa*					+			
61.	*Helminthoidea labyrinthica*		+	+					
62.	*Isopodichnus isp.*					+			
63.	*Laevicyclus isp.*					+			
64.	*Laminites kaitiensis*					+			
65.	*Lorenzinia isp.*								
66.	*Mammillichnis aggeris*						+		
67.	*Mammillichnis isp.*		+				+		
68.	*Megagrapton irregulare*					+			
69.	*Oniscoidichnus miocenicus**							+	
70.	*Ophiomorpha cf. nodosa*					+			
71.	*Ophiomorpha isp.*					+			
72.	*Palaeophycus isp.*		+						
73.	*Palaeophycus striatus*					+			
74.	*Palaeophycus sulcatus*					+			
75.	*Palaeophycus tubularis*		+						
76.	*Paleodictyon carpathicum*					+			
77.	*Paleodictyon gomezi*					+			
78.	*Paleodictyon minimum*			+					
79.	*Paleodictyon miocenicum*					+			
80.	*P. miocenicum f.pleurodictyonoides*					+			
81.	*Paleodictyon regulare*					+			
82.	*Paleodictyon tellini*					+			
83.	*Paleodictyon isp.*					+			
84.	*Paleomeandron elegans*					+			
85.	*Pelecypodichnus isp.*					+			
86.	*Phagophytichnus circumsecans*								+
87.	*Phagophytichnus gastropodinus**								+
88.	*Phagophytichnus isp.1*								+
89.	*Phagophytichnus isp. 2*								+
90.	*Phagophytichnus marginis-folii*								+
91.	*Phagophytichnus nervillos-reliquens*								+
92.	*Phagophytichnus uvaeformis**								+
93.	*Phycodes dentatus**					+			
94.	*Phytomyzites querci**								+
95.	*Planolites annularis*					+			
96.	*Planolites beverleyensis*					+			
97.	*Planolites isp.*		+			+	+		
98.	*Planolites montanus*					+			
99.	*Profenusa pigmaea KL fossilis*								+
100.	*Protopaleodictyon incompositum*					+			
101.	*Psammichnites cf. gigas*					+			
102.	*Pseudogyrochorte burtani*					+			
103.	*Pseudogyrochorte imbricata*					+			
104.	*Rhabdochondrites hamatus**		+						
105.	*Rhizocorallium cf. irregulare*						+		
106.	*Rhizocorallium isp.*	+							
107.	*Sabularia isp.*						+		
108.	*Sabularia tenuis*						+		

Table 1 - continued

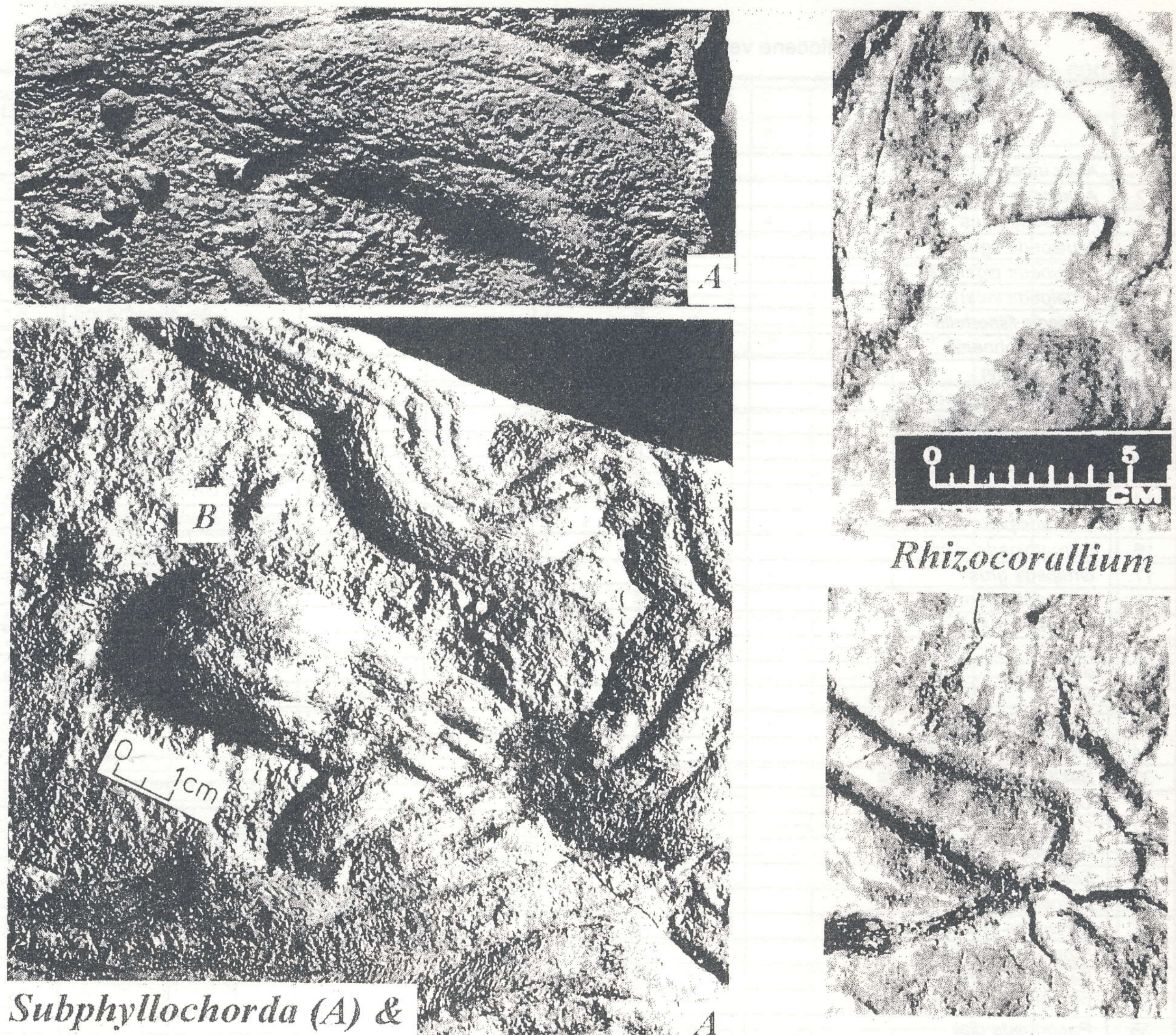
109.	*Scalarituba isp.*					+			
110.	*Scolicia isp.*			+		+			
111.	*Scolicia plana*					+			
112.	*Spatangoidichnus reinecki**					+			
113.	*Spirophyton isp.*			+		+			
114.	*Spirophycus bicornis*	+				+			
115.	*Spirorhaphe involuta*					+			
116.	*Spirorhaphe isp.*					+			
117.	*Sublorenzinia cf. nowaki*			+		+			
118.	*Sublorenzinia plana*					+			
119.	*Subphyllochorda granulata*					+			
120.	*Subphyllochorda striata*					+			
121.	*Subphyllochorda cf. laevis*		+						
122.	*Subphyllochorda isp.*			+					
123.	*Strobilorhaphe cf. clavata*					+			
124.	*Sustergichnus lenadumbratus*					+			
125.	*Taenidium isp.*			+					
126.	*Taenidium cf. satanassi*		+						
127.	*"Muensteria" planicostata*			+	+	+			
128.	*Talitrichnus panini**							+	
129.	*Taphrhelminthopsis auricularis f."auricularis"*					+			
130.	*T. auricularis f."convoluta"*			+		+			
131.	*T. auricularis f."maeandriformis"*					+			
132.	*T. auricularis f."plana"*					+			
133.	*T. auricularis f."spiralis"*					+			
134.	*Taphrhelminthopsis isp.*					+	+		
135.	*Teichichnus isp.*					+			
136.	*Thalassinoides isp.*					+			
137.	*Tuberculichnus bulbosus*					+			
138.	*Tuberculichnus punctiformis**					+			
139.	*Urohelminthoida isp.*					+			
140.	*Zapfella isp.*							+	
141.	*Zoophycos brianteus*			+	+	+			
142.	*Zoophycos isp.*		+			+			

Abreviations: Ne-Ap = Neocomian-Aptian; V-Tu = Vraconian-Turonian; Sn = Senonian; Pc = Paleocene; E = Eocene; O = Oligocene; M_1 = Lower Miocene; M_2 = Upper Miocene.
* New ichnospecies for science.

Table 2. Lower Miocene vertebrate ichnofauna (vertebratichnia) in the Subcarpathians

No.	Ichnospecies	Ukraine	Romania					
			Piatra Neamt	Tazlău	Vrancea	Teleajen	Doftana	Ocnita
1.	*Aves indet.*			+				
2.	*Anatipeda isp.*		+		+			
3.	*Anatipeda anas**				+			
4.	*Ardeipeda egretta**				+			
5.	*Ardeipeda gigantea**				+			
6.	*Ardeipeda incerta**				+			
7.	*Avipedia filiportatis*	+						
8.	*Avipedia phoenix*	+						
9.	*Avipedia sirin*	+						
10.	*Charadriipeda becassi**		+		+			
11.	*Charadriipeda disjuncta**		+		+			
12.	*Charadriipeda minima**		+		+			
13.	*Charadriipeda minor**		+		+			
14.	*Carpathipeda panini**				+			
15.	*Charadriipeda recurvirostra**		+		+			
16.	*Carpathipeda vialovi**				+			
17.	*Gruipeda grus**					+		
18.	*Gruipeda intermedia**		+					
19.	*Gruipeda maxima**				+			
20.	*Larus*				+			
21.	*? Motacilla*				+			
22.	*Sterna*				+			
23.	*Bestiopeda bestia*	+						
24.	*Bestiopeda gracilis*	+						
25.	*Bestipoeda sanguiolenta*	+						
26.	*Canipeda longigriffa**				+			
27.	*? Dicrocerus*							+
28.	*Felipeda felis**		+					
29.	*Felipeda lynxi**				+			
30.	*Felipeda minor**					+		
31.	*Hippipeda indet. (?Hipparion)*				+			
32.	*Hippipeda aurelianis*	+						
33.	*Pecoripeda amalphaea*	+	+		+	+		
34.	*Pecoripeda diaboli*	+						
35.	*Pecoripeda djali*	+						
36.	*Pecoripeda gazella*	+	+		+			
37.	*Pecoripeda isp.*	+						
38.	*Pecoripeda satyri*	+						
39.	*Proboscipeda enigmatica**				+			
40.	*Rhinoceropeda problematica**						+	

* New ichnospecies for Romania and science



Subphyllochorda (A) & Cardioichnus (B)

Rhizocorallium

Taphrhelminthopsis

the recurrence of the ichnofacies showing the recurrence of the biofacies in a given formation.

The change of the BSS distribution with the depth increase and with the coast distance has been considered a dogma of the paleoichnology materialized in the famous Seilacher's bathymetric model (1964, 1967). Nowadays the link between ichnofacies and bathymetry is considered as a *passive* connection (Frey et al., 1990), more and more researchers considering that the environment local factors are the ones controlling the distribution of the ones producing traces. Recent investigations on the present-day seas and oceans bottoms show that the shape of the trace and the ichnofacies do not depend on the depth, the morphology of the trace depending ultimately on the biological interrelation between the ravaging one and the one being ravaged, independent of the food availability.

On the long-term, one expects that the paleoichnology should bring its contribution to stating the facial diversity of the depositional systems, especially of the deltaic, lacustrian and fluvial ones which could enrich the content of *Scoyenia* ichnofacies (Bromley & Asgaard, 1979). The division into zones of this nonmarine ichnofacies, located at the interference between land and sea, has recently shown the participation of the characteristic trace fossils association of the terrestrial sediments (*Termitichnus* ichnofacies), of the transition area between the land field and the nonmarine aquatic one (*Scoyenia* ichnofacies) and of the nonmarine aquatic deposits (*Mermia* ichnofacies), dominating being the arthropoda tracks (Buatois & Mangano, 1995).

From this point of view, placing the vertebrate and invertebrate traces from Vrancea in the *Scoyenia* ichnofacies (Brustur & Alexandrescu, 1993) opens the way of continuing and deeply studying the systematic paleoichnology on the Red and Grey Formations which will certainly offer a spectaculous ichnofaunistic material.

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