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PHYTOCOENOLOGICAL EVALUATION OF THE TROPHICITY OF GRASSLAND SOILS IN THE ROMANIAN CARPATHIANS

IOAN POP* and **ION RESMERIŢĂ**

SUMMARY. — As a result of the adaptation of plant communities to various environmental conditions, the plants reflect faithfully the ecotope and thus they are valuable ecological indicators. The study and the protection of nature require thorough phytocoenological and ecopedological researches. The quantity and quality of soluble (plant-available) mineral nutrients together with the local climatic factors contribute to the installation and evolution of phytocoenoses. Taking into consideration the base-saturation capacity of soils and their potential trophicity index, 6 categories of plants and phytocoenoses were delineated. The extremely oligotrophic phytocoenoses, made up of *Carex curvula, Juncus trifidus, Calluna vulgaris, Bruckenthalia spiculifolia, Loiseleuria procumbens, Sphagnum sp.* etc., are indicators of the very low trophicity soils. The oligotrophic phytocoenoses, indicating the low trophicity soils, are dominated by ***Agrostis rupestris, Festuca ovina, Festuca supina, Nardus stricta, Deschampsia flexuosa*** etc. The oligomesotrophic phytocoenoses, covering the soils of low to medium trophicity, are constituted of *Agrostis tenuis, Festuca rubra, Poa media, Deschampsia caespitosa* etc. The mesotrophic phytocoenoses, made up of *Calamagrostis arundinacea, Agrostis tenuis, Festuca rubra, Poa alpina, Poa pratensis* etc., are indicators of soils of medium to high trophicity. The eutrophic phytocoenoses, constituted of *Alopecurus pratensis, Arrhenatherum elatius, Dactylis glomerata, Festuca pratensis, Lolium perenne, Poa trivialis, Trisetum flavescens* etc., indicate the high trophicity soils. The megatrophic phytocoenoses, composed of *Rumex alpinus, Urtica dioica, Poa annua* etc., are indicators of the soils of very high trophicity. The authors demonstrate, based on their experiments and field observations, the interdependence between the trophicity of soils and the establishment and evolution of phytocoenoses. There are mentioned the main plant associations, the characteristics of different categories of soils of very low to very high trophicity, spread over the areas of the Romanian Carpathians.

As a result of the adaptation of plant communities to various environmental conditions, the plants reflect faithfully the ecotope and thus they constitute valuable ecological indicators. The study and the protection of nature require thorough phytocoenological researches which allow, among other things, the evaluation of the trophic degree of soils. It is known that the trophic state of soils plays a key role as far as the living conditions are concerned and also as a source of mineral nutrients whose quantity and quality contribute to the installation and evolution of the plant associations.

Trophicity of the grassland soils in the Romanian Carpathians was evaluated on the basis of the soluble (plant-available) nitrogen and phos-

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phorus in the soil solution. These two nutritive macroelements together with the local climatic factors play a decisive role in the establishment, maintenance and disappearance of a phytocoenosis in a given area. These conclusions were drawn based both on the results of our experiments [12, 14] and field observations and on literature data [1, 2, 4].

Depending on both the amount of the plant-available nitrogen and phosphorus in soil solution and the local climatic factors, the phytocoenoses are numerous. Some of them are characteristic for the Romanian Carpathians.

Taking into consideration the base-saturation capacity (V %) of soils and their potential trophicity index (Tp), 6 plant categories were delineated [2, 4]. The extremely oligotrophic plants grow on soils of very low trophicity (V = 1—20%; Tp ≦ 15). The oligotrophic plants populate the soils characterized by a low trophicity (Tp = 15—30). The oligo-mesotrophic plants prefer the soils the trophicity of which ranges between low and medium values (Tp = 30—50). The mesotrophic plants cover the soils of medium to high trophicity (Tp = 50—80). The eutrophic plants are characteristic for soils whose trophicity has high to very high values (Tp = 80—140). The megatrophic plants grow on soils of very high trophicity (V = 85—100%; Tp ≧ 140).

1. Associations of the extremely oligotrophic plants — indicators of the very low trophicity soils. Among the plants of this category we mention *Sphagnum* sp., *Eriophorum vaginatum, Juncus trifidus, Carex curvula, Calluna vulgaris, Loiseleuria procumbens,* that make up characteristic phytocoenoses spread over areas of the montane and subalpine levels [3, 5—11, 14, 15]. Of the associations belonging to this category we specify *Eriophoro vaginato—Sphagnetum* (Weber 1902) Soó (1927) 1954, *Agrostio-Juncetum trifidi* Oberd. 1959, *Primulo-Caricetum curvulae* Br.-Bl. 1926 emend. Oberd. 1959, *Calluno-Vaccinietum* Bücher 1942, *Nardo-Callunetum vulgaris* Šmarda 1953, *Violo declinatae-Nardetum strictae* Simon 1966 [5], *Loiseleurietum procumbentis* (Kerner 1863) Rübel 1931. These associations are composed of few species, able to grow on soils which are acidic and poor in mineral nutrients.

In the floristic composition of the associations *Calluno-Nardetum* and *Calluno-Vaccinietum* one can remark, besides *Calluna vulgaris,* the species *Vaccinium myrtillus, Vaccinium vitis-idaea, Nardus stricta, Deschampsia flexuosa, Bruckenthalia spiculifolia, Potentilla erecta, Sphagnum* sp. *etc.* The phytocoenoses of the associations made up of *Calluna vulgaris* are present both in the extremely oligotrophic peat swamps and on *Nardus stricta* grasslands under regress.

Following application of large amounts of farmyard manure or mineral fertilizers (N and P) for many consecutive years, the phytocoenoses made up of *Calluna vulgaris* are replaced by grasslands dominated by *Festuca rubra.* These grasslands are valuable pastures.

2. Associations of the oligotrophic plants — indicators of the low trophicity soils. The low trophicity soils are indicated by phytocoenoses made up of the oligotrophic species *Nardus stricta, Festuca supina, Fes-*

tuca ovina, Festuca rubra f. *nigrescens, Agrostis rupestris, Helictotrichon versicolor, Calamagrostis villosa, Deschampsia flexuosa, Vaccinium myrtillus* etc.

Of the oligotrophic associations indicating low trophicity soils we mention: *Nardo-Festucetum supinae* Domin 1933, *Carici-Nardetum strictae* Resmeriță 1984, 1986, *Potentillo-Nardetum strictae* Resmeriță 1984, 1986, *Campanulo abietinae-Nardetum strictae* Resmeriță 1984, 1986, *Potentillo ternatae-Festucetum supinae* Boșcaiu 1971, *Potentillo-Festucetum ovinae* Resmeriță 1970, 1984, *Helictotricho-Nardetum strictae* Resmeriță 1975, *Scorzonero roseae—Festucetum rubrae nigricantis* Coldea 1987 [5], *Calamagrostietum villosae* (Zlatnik 1925) Borza 1934, *Deschampsietum flexuosae* Issler 1942 emend. Borza 1946, *Cetrario-Vaccinietum gaulteroidis* Hadač 1956. The phytocoenoses of these associations populate the montane, subalpine and alpine levels of the Romanian Carpathians.

Of all associations dominated by oligotrophic plants, the phytocoenoses made up of *Nardus stricta* have the largest distribution. They occupy a surface of approximately 200,000 ha in the Romanian Carpathians, from 200 m altitude (in the Oaș depression) up to 2,200 m (in the Retezat Mountains). The *Nardus stricta* grasslands develop on soils which are acidic or very acidic, poor or very poor in nitrogen and phosphorus soluble in soil solution. Of the oligotrophic species present in the *Nardus stricta* association, the following will be mentioned: *Festuca supina, Deschampsia flexuosa, Agrostis rupestris, Potentilla aurea, Potentilla ternata, Vaccinium myrtillus, Veronica officinalis, Antennaria dioica.*

The *Nardus stricta* grasslands, situated at 1,600 m altitude in the Parâng Mountains [3], were fertilized with ammonium nitrate (600—900 kg/ha) and superphosphate (200—300 kg/ha). After two years, the *Nardus stricta* grasslands with no fodder value have been replaced by *Festuca rubra* phytocoenoses used as pastures.

Similar fertilization experiments were carried out also in the Micău Mountain (Western Carpathians), at 1,800 m altitude [13]. Ammonium nitrate (200—300 kg/ha) and superphosphate (100 kg/ha) were applied for 3—4 consecutive years. As a result of the fertilization, the *Nardus stricta* grasslands have developed towards *Festuca rubra* grasslands.

The *Nardus stricta* grasslands, located at 1,350 m altitude in the Vlădeasa Mountain (Western Carpathians), were treated with farmyard manure for some consecutive years. In the next 15 years, the former *Nardus stricta* grasslands were replaced successively by phytocoenoses made up of *Festuca rubra, Agrostis tenuis, Festuca pratensis* and finally of *Lolium perenne.*

In other words, after fertilizer administration, the soils of very low trophicity have passed through the stage of soils of low, medium and high trophicity. The gradual increase of mineral nutrients in soils has been indicated by oligotrophic, oligomesotrophic, mesotrophic and eutrophic plants which have succeeded each other and have made up phytocoenoses belonging to the following associations: *Campanulo abietinae-Nardetum strictae* → *Nardo-Festucetum rubrae* → *Scorzonero roseae-*

Festucetum rubrae nigricantis → *Anthoxantho-Agrostietum tenuis* → *Festucetum pratensis* → *Trifolio-Lolietum perennis*.

Potentillo ternatae-Festucetum supinae Boşcaiu 1971 and *Nardo-Festucetum supinae* Domin 1933 occupy large surfaces in the Romanian Carpathians (only the phytocoenoses made up of *Festuca rubra* and *Nardus stricta* are spread over larger areas). They grow at the montane (from 1,500 m altitude), subalpine and alpine (2,400 m altitude) levels. *Potentillo-Festucetum ovinae* Resmeriţă 1970, 1984 is spread over areas located between 1,650 and 2,150 m altitudes. The three associations mentioned above populate strongly acidic soils which are poor in soluble nitrogen and phosphorus. These associations comprise the following oligotrophic species: *Agrostis rupestris, Nardus stricta, Potentilla aurea, Potentilla ternata, Ligusticum mutellina, Vaccinium myrtillus, Antennaria dioica*.

Some authors consider that *Festuca supina* and *Festuca ovina* are indifferent in respect of the amount of nitrogen in soils.

The experiments performed in the Romanian Carpathians [3, 13] have proved that feritilization of soils with ammonium nitrate for a couple of years leads to significant increases in the phytomass. Thus, the phytomass of *Festuca supina* grasslands in the Parâng Mountains nearly doubled (more precisely, a 189% increase occurred). In the Vlădeasa Mountain, the increase in the phytomass of *Festuca ovina* grasslands reached 286%. When both ammonium nitrate and superphosphate were applied, the phytomass increase was of 307% in the first case and of 1,670% in the second case.

3. Associations of the oligomesotrophic plants — indicators of soils of low to medium trophicity. Of the plants indicating these soils we mention *Festuca rubra, Agrostis tenuis, Agrostis canina, Deschampsia caespitosa, Nardus stricta,* which contribute to the making up of oligomesotrophic associations, on areas of the montane level. The most representative are the associations in which the dominant role is played by *Festuca rubra* and *Agrostis tenuis,* occupying a surface of more than 250,000 ha, between 700 and 1,400 m altitudes.

It should be emphasized that *Festuca rubra* and *Agrostis tenuis* which have similar ecological requirements manifest a wide amplitude concerning soil trophicity, being integrated into both oligotrophic, oligomesotrophic phytocoenoses and mesotrophic and eutrophic ones, on the areas of the beech *(Fagus silvatica)* and spruce *(Picea abies)* forest levels.

Of the oligomesotrophic associations in the Romanian Carpathians the following will be quoted: *Festuco rubrae-Agrostietum tenuis* Csűrös et Resmeriţă 1960, *Agrostietum tenuis* Szafer, Pawl. et Kulcz. 1923, *Agrostietum caninae* Harg. 1942, *Poëtum mediae* Csűrös *et al.* 1956, *Deschampsietum caespitosae* Horvatič 1930. The flora of phytocoenoses belonging to these associations is composed of a mixture of oligotrophic *(Nardus stricta, Vaccinium myrtillus* etc.), oligomesotrophic *(Campanula abietina* etc.), and mesotrophic *(Poa pratensis* etc.) species.

Following fertilization of soils, the phytomass of these associations also increased. In the Southern Carpathians (Bucegi Mountains), the increase reached 300%, while in the Western Carpathians (Vlădeasa Mountain) [13] this value was a little lower (261%).

4. Associations of the mesotrophic plants — indicators of soils of medium and high trophicity. On the medium trophicity soils the phytocoenoses are made up of *Festuca rubra, Agrostis tenuis, Calamagrostis arundinacea, Poa pratensis, Poa alpina* etc.

In the case of this ecological category, too, the most representative and spread phytocoenoses are those made up of *Festuca rubra* and *Agrostis tenuis,* but they are distributed only on areas of the evergreen oak *(Quercus petraea)* forest level. The phytocoenological differentiation between the soils of low to medium trophicity and those of medium to high trophicity can be carried out also by analyzing the ratio between the oligomesotrophic and mesotrophic species taking part in the floristic constitution of the above-mentioned plant communities.

Among the mesotrophic associations we remark the following: *Festuco rubrae-Cynosuretum* Tx. 1940, *Agrostio-Festucetum rubrae* Horv. 1952, *Anthoxantho-Agrostietum tenuis* Sillinger 1933, *Calamagrostietum arundinaceae* Zlatnik 1928.

As a result of the application of mineral or organic fertilizers for many consecutive years, the mesotrophic associations are replaced by eutrophic ones, in which the dominant species are *Arrhenatherum elatius, Dactylis glomerata, Festuca pratensis, Lolium perenne, Trisetum flavescens* etc. The mesotrophic species persist in the composition of the eutrophic phytocoenoses, but they are less abundant.

5. Associations of the eutrophic plants — indicators of the high trophicity soils. Of the eutrophic species populating the soils rich in mineral nutrients the following are mentioned: *Arrhenatherum elatius, Alopecurus pratensis, Dactylis glomerata, Festuca pratensis, Lolium perenne, Poa trivialis, Trisetum flavescens* etc.

The associations made up of these species are: *Alopecuretum pratensis* Regel 1925, Nowinski 1928, *Arrhenatheretum elatioris* (Br.-Bl. 1915, 1948) Scherrer 1925, *Festucetum pratensis* Soó (1938) 1955, *Trifolio-Lolietum perennis* Krippelová 1967, Resmeriță *et al.* 1967, *Trifolio-Poëtum trivialis* Soran 1962, *Trisetetum flavescentis* Brockmann, J., 1905, *Arrhenathero-Festucetum rubrae* Resmeriță 1963.

The phytocoenoses of these associations develop preferentially in montane depressions and in wet meadows.

The most frequent and economically the most important associations (being used as hayfields) are: *Festucetum pratensis, Arrhenatheretum elatioris, Alopecuretum pratensis.* They develop on fertile and wet soils, during the whole period of vegetation.

6. Associations of the megatrophic plants — indicators of the very high trophicity soils. The megatrophic species, few in number occupy the smallest surfaces, in comparison with the other 5 plant groups described above. The megatrophic plants are represented by *Rumex alpinus, Urtica dioica, Poa annua* etc.

The phytocoenoses made up of these species are: *Poo annuae-Rumicetum alpini* Resmeriţă et Pop 1986, *Trifolio-Poëtum annuae* Todor et Culică 1967, *Taraxaco-Poëtum annuae* Beldie 1967, *Rumici obtusifoliae-Urticetum dioicae* Kornás 1968.

The phytocoenoses of these associations, encountered mostly at the montane and subalpine levels, grow on areas near sheep folds and pens, on soils rich in humus and nitrate.

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CONTRIBUTIONS TO THE STUDY OF THE ROMANIAN SYNANTHROPIC VEGETATION DEVELOPING IN CULTURES OF ORNAMENTAL PLANTS

IOAN POP[*]

SUMMARY. — The synanthropic vegetation growing in plots cultivated with ornamental plants is little known up to the present. The paper comprises the taxonomic, ecological, chorological analysis of two synanthropic associations developed in cultures of ornamental plants in Romania. *Stellario-Fumarietum schleicheri* ass. nova covers the round flower-beds and the platbands cultivated especially with the ornamental plant *Viola* × *wittrockiana* Gams under the hill relief and climate conditions of the town of Cluj-Napoca. This association made up of therophytes has a mesophilous towards xeromesophilous, eurytherm towards micromesotherm and amphitolerant towards slightly acid-neutrophilous character. The phytocoenoses of the association *Digitario-Portulacetum oleracei* (Felföldy 1942) Timár et Bodrogközy 1955 grow not only on soils cultivated with different agricultural plants, but also in platbands with ornamental plants cultivated in the town of Salonta, Bihor district, under plain relief and climate conditions. From ecological point of view, the association has a mesophilous towards xeromesophilous, micromesotherm towards moderate-thermophilic, slightly acid-neutrophilous towards amphitolerant character.

Up to the present, the flora and especially the synanthropic vegetation growing on soils cultivated with ornamental plants in gardens, parks, along the streets, etc. are very little known. În Romania, Prodan [12] was among the first to give information regarding the weeds overrunning the spaces cultivated with ornamental plants. This author describes from gardens cultivated with ornamental plants, numerous species of weeds, among which we mention the most frequent ones: *Amaranthus albus* L., *Chenopodium album* L., *Chenopodium hybridum* L., *Stellaria media* (L.) Cyr., *Fumaria schleicheri* Soyer-Will., *Portulaca oleracea* L.

The first contributions to the study of the Romanian synanthropic vegetation overrunning the soils cultivated with ornamental plants comprise the studies carried out by Pop [10]. The most frequent synanthropic phytocoenoses belong to the association *Stellario-Fumarietum schleicheri* ass. nova and *Digitario-Portulacetum oleracei* (Felföldy) Timár et Bodrogközy 1955 integrated into the following cenotaxonomic system:

Chenopodietea Br.-Bl. 1951 emend. Lohmeyer, J. et R. Tüxen 1961
  Polygono-Chenopodietalia (Tx. et Lohm. 1954) J. Tx. 1961
    Polygono-Chenopodion polyspermi Koch 1926 emend. Sissingh 1946
      1. *Stellario-Fumarietum schleicheri* ass. nova
    Eragrostietalia J. Tx. 1961 emend. Soó 1968
  Tribulo-Eragrostion pooidis Soó et Timár 1957

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2. *Digitario-Portulacetum oleracei* (Felföldy 1942) Timár et Bodrogközy 1955

On platbands cultivated with the ornamental perennial plant *Hydrangea opuloides* (Lam.) C. Koch, Pop [11] has identified the phytocoenoses of the synathropic association *Potentilletum reptantis* Eliáš 1974 emend. 1978 [4]. The rose-beds are sometimes overrun by representatives of the association *Convolvuletum arvensis* Felföldy 1942 (Syn.: *Agropyro-Convolvuletum arvensis* Felföldy 1943).

We present the analysis of the first two synanthropic associations as being the most specific and the most frequently found in plots with ornamental plants.

1. **Stellario-Fumarietum schleicheri** ass. nova. *General considerations*. Among the 7 species of *Fumaria* met on Romanian territory, the following 3 are scarce, being known only from 3—4 localities: *Fumaria kralikii* Jord., *F. parviflora* Lam. and *F. thurettii* Bois. The species identified more frequently in cereal and root-crop fields, in gardens, vineyards and other cultivated soils are *Fumaria officinalis* L. (lacking in Cluj district), *F. rostellata* Knaf, *F. schleicheri* Soyer-Willemont and *F. vaillanti* Loisel.

Of all these plants, in Cluj district, *Fumaria schleicheri* is encountered most frequently as a ruderal and segetal plant. This calcicolous, thermophilic, xeromesophilous therophyte grows on soils rich in mineral nutrients.

From a phytocoenological point of view, *Fumaria bastardi* Bor., a Mediterranean element and *Fumaria officinalis,* an Eurasian species, make up synanthropic communities mentioned by Tüxen [15] and integrated into the association *Fumarietum bastardii* Br.-Bl. 1950 and *Fumarietum officinalis* (Krusem. et Vlieger 1939) Tx. 1950 (Syn.: *Veronico-Fumarietum officinalis* (Krusem. et Vlieger 1939) Tx. apud Lohm. 1949). The last one is described in Oberdorfer's [8] synthetic work, too. Later on, there have been described some other 4 synanthropic associations made up of *Fumaria officinalis: Amarantho-Fumarietum officinalis* Tx. 1955, *Lapsano-Fumarietum officinalis* Meisel 1973, *Setario-Fumarietum officinalis* Tx. 1955 and *Thlaspio-Fumarietum officinalis* Görs 1966.

The phytocoenoses of the last 3 associations have been identified in potato crops from Czechoslovakia and analysed by Passarge and Jurkó [9]. Eliáš [5] mentions the associations *Veronico-Fumarietum officinalis* Tx. 1955 and *Amarantho-Fumarietum officinalis* Tx. 1955 in Slovak vineyards. Krippelová [6] includes all the associations made up of *Fumaria officinalis* into a cenotaxonomic system.

Borza [1] mentions, from the southern plain of Romania, the association *Fumarietum officinalis,* cited later on in the synthetic works elaborated by Morariu [7] and Sanda *et al.* [13].

Phytocoenological analysis. The phytocoenological researches have been accomplished in the Botanical Garden of the Cluj-Napoca University and also on the spaces cultivated with ornamental plants in the town of Cluj-Napoca. The town is situated on a hilly land crossed by the river Someșul Mic and surrounded by 500—680 m high hills. The temperate continental climate of these hills is characterized by an annual mean temperature of 8.3°C; the annual mean rainfall varies between 500—650 mm. For 3 consecutive years (1985—1987) we have studied the synanthropic vegetation from round flower-beds (5 m in diameter) and platbands (0.6—0.8/5—15 m) cultivated with the biannual ornamental plant *Viola* × *wittrockiana* Gams *(V. altaica* × *V. lutea* × *V. tricolor)*.

From early spring (March—April) until the weeding (May) we have registered, by means of relevés, all the species growing together with the above-mentioned ornamental plant. Some platbands were experimentally left unweeded until the development of weeds which in June have covered the whole cultivated surface.

The floristic inventory of the studied synanthropic phytocoenoses totalizes 32 species (Table 1). The number of species in a phytocoenosis

Table 1

Stellario-Fumarietum schleicheri *ass. nova*

	Altitude in metres	360—400										
	Relevé	1	2	3	4	5	6	7	8	9	10	K
	Viola × wittrockiana	3	3	3	3	3	4	4	4	4	4	
Ass	Fumaria schleicheri Soyer-Will.	+	1	2	4	3	2	2	3	3	3	V
	Stellaria media (L.) Cyr.	3	2	3	+	2	1	1	+	+	+	V
Al	Chenopodium polyspermum L.	+	+	+	—	—	+	—	+	—	—	III
	Euphorbia helioscopia L.	+	—	—	—	+	—	—	—	—	+	II
	Cerastium glomeratum Thuill	—	+	—	+	—	—	—	—	—	—	I
	Thlaspi arvense L.	—	—	—	+	+	—	—	—	—	—	I
	Veronica opaca Fries.	—	—	+	—	—	+	—	+	—	—	II
	Veronica persica Poir	+	—	—	+	—	—	—	—	—	—	I
	Sonchus arvensis L.	—	—	—	+	+	+	—	—	—	—	II
	Sonchus asper (L.) Hill.	—	—	+	—	—	—	+	—	—	—	I
Ord	Atriplex patula L.	—	+	—	+	—	—	—	—	—	—	I
	Erodium cicutarium (L.) L'Hérit	—	—	—	—	+	—	—	—	+	—	I
	Lamium amplexicaule L.	1	+	—	+	—	—	+	—	—	—	II
	Lamium purpureum L.	+	+	—	—	+	+	—	+	—	—	III
	Galinsoga parviflora Cav.	—	—	+	+	—	—	—	—	—	—	I
Cl	Chenopodium album L.	+	+	+	+	+	+	+	+	+	—	V
	Capsella bursa-pastoris (L.) Medik.	+	+	+	+	1	+	—	+	+	+	V
	Geranium pusillum Burm.	—	—	—	+	+	—	+	—	—	—	II
	Artemisia annua L.	+	—	—	—	+	—	—	—	—	—	I
	Senecio vulgaris L.	—	—	—	+	+	—	—	+	—	—	II
	Sonchus oleraceus (L.) Gou.	—	—	—	—	—	—	+	—	+	—	I
Div	Agropyron repens (L.) P.B.	—	—	—	—	—	+	—	—	—	—	I
	Poa annua L.	+	+	—	—	—	—	—	—	—	+	II
	Polygonum aviculare L.	+	+	+	+	+	+	—	—	+	—	IV
	Convolvulus arvensis L.	—	—	+	—	—	+	—	—	—	—	I
	Matricaria matricarioides (Less.) Porter	—	—	—	—	—	+	—	—	—	—	I
	Ranunculus repens L.	+	+	+	+	+	—	—	+	—	—	III
	Trifolium repens L.	+	—	+	+	—	+	—	—	—	—	II
	Taraxacum officinale Weber	+	—	+	+	—	+	—	+	+	—	III
	Holosteum umbellatum L.	+	—	—	—	—	+	—	—	—	—	I
	Myosotis sparsiflora Mikan	+	—	+	—	+	+	—	—	—	—	II
	Glechoma hirsuta W. et K.	—	—	—	—	—	+	—	—	—	—	I

within a platband is small, oscillating between 5 and 17, and averaging 12. From the total number of plants constituting the association, 21 species are characteristic for the alliance, order and class and most of the other 11 species originate from the turf surrounding the platbands and the round flower-beds of *Viola* × *wittrockiana.*

Among the species, populating with the highest constancy the analysed synanthropic communities, one can notice the following therophytes: *Fumaria schleicheri, Stellaria media, Chenopodium album, Capsella bursa-pastoris, Polygonum aviculare, Chenopodium polyspermum, Lamium purpureum* etc.

The spectrum of bioforms brings into relief the domination of therophytes (25 species — 78.2%) in the synanthropic association. The hemicryptophytes (6 species — 18.7%) and the geophytes (1 species — 3.1%) are few in number, indicating the vicinity of the turf from which they originate.

The association *Stellario-Fumarietum schleicheri* is made up of Eurasian (16 species — 50.0%) and cosmopolitan (9 species 28.1%) species. The European and adventitious phytogeographic elements each represented by 3 species (9.4%), together with the circumpolar ones (1 species — 3.1%) complete the floristic inventory of the association, determining its heterogeneous character.

The ecological groups based on the requirements of plants towards the main environmental factors (humidity, temperature and the chemical reaction of soil) have been established for Romania by Csűrös *et al.* [2, 3]. For establishing the living conditions preferred by the studied synanthropic phytocoenoses we have used the above-mentioned ecological groups (Table 2).

Table 2

Analysis of the main ecological indices

Association	E.F*	Ecological indices (number and percentage of species) 1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	0
Stellario-Fumarietum chleicheri	*U*	0	0	2	9	12	5	1	0	0	0	0	3
				6.3	28.1	37.5	15.6	3.1					9.4
	T	0	0	0	0	11	2	3	0	0	—	—	16
						34.4	6,2	9.4					50.0
	R	0	—	0	—	2	—	11	—	0	—	—	19
						6.2		34.4					59·
Cigitario-Portulacetum oleracei	*U*	0	1	1	**5**	**11**	2	3	0	0	0	0	1
			4.2	4.2	20.8	45.8	8.3	12.5					4.2
	T	0	0	0	0	10	2	6	0	0	—	—	6
						41.7	8.3	25.0					25.0
	R	0	—	0	—	3	—	9	—	0	—	—	12
						12.5		37.5					50.0

* E.F. — Ecological factors.

U — Humidity: 1—1.5 = Xerophytes. 2—2.5 = Xeromesophytes. 3—3.5 = Mesophytes. 4—4.5 = Mesohygrophytes. 5—5.5 = Hygrophytes. 6 = Hydrophytes. 0 = Amphitolerants.

T — Temperature: 1—1.5 = Hekistotherm. 2—2.5 = Microtherm. 3—3.5 = Micromesotherm. 4—4.5 = Moderate thermophilic. 5 = Thermophilic. 0 = Eurytherm (Amphitolerant).

R — Chemical reaction of the soil: 1 = Highly acidophilous. 2 = Acidophilous. 3 = Acid-neutrophilous. 4 = Slightly acid-neutrophilous. 5 = Basophilous. 0 = Euryionic (Amphitolerant).

The requirements of the phytocoenoses of the association *Stellario-Fumarietum schleicheri* towards the factor humidity, *U*, are brought into relief by the predominance of the mesophytes (*U* 3—3.5 — 17 species = 53.1%), followed by the xeromesophytes (*U* 2—2.5 — 11 species = 34.4%). The mesohygrophytes are represented only by one species (*U* 4—4.5 = 3.1%) and the amphitolerants by 3 species (*U* 0 = 9.4%).

Depending on the factor temperature, *T*, the plants of the analysed phytocoenoses are grouped into 3 ecological categories of which predominating are the eurytherm or amphitolerant species (*T* 0 — 16 species = 50.0%) and the micromesotherm ones (*T* 3—3.5 — 13 species = 40.6%). The moderate-thermophilic species (*T* 4—4.5 — 3 species = 9.4%) are few in number.

The third ecological group which concerns the chemical reaction of soil, *R*, brings into relief the large number of euryionic plants (*R* 0 — 19 species = 59.4%) followed by the slightly acid-neutrophilous ones (*R* 4 — 11 species = 34.4%). The acid-neutrophilous plants (*R* 3 — 2 species = 6.2%) are few in number and unsignificant.

In conclusion, the plant components grouped in accordance with the main ecological indices underline the mesophilous towards xeromesophilous, eurytherm towards micromesotherm and amphitolerant towards slightly acid-neutrophilous character of the association *Stellario-Fumarietum schleicheri*. The ecological requirements of the analysed synanthropic phytocoenoses are met each year, due to the fact that the man creates an optimum environment for the cultivated ornamental plants.

2. Digitario-Portulacetum oleracei (Felföldy 1942) Timár et Bodrogközy 1955.

The phytocoenoses of this synanthropic association have been first studied in Hungary, and are cited also in the synthetic work elaborated by Soó [14]. They grow not only in gardens, but also in fields with different agricultural plants. We have also identified them in platbands with ornamental plants in the town of Salonta, Bihor district. Situated in the western part of Romania, within a plain relief with an altitude of 93—95 m above sea level, the studied territory has a forest-steppe vegetation. This region is characterized by temperate continental climate, the annual mean temperature oscillating between 10.5 and 10.8°C, and the annual mean precipitations ranging between 580 and 600 mm.

In gardens and also at the border of street pavements in front of the houses we have examined many platbands cultivated with ornamental plants. More frequently cultivated are the following species: *Petunia hybrida* Hort., *Nicotiana alata* Link et Otto, *Callistephus chinensis* (L.) Nees, *Tagetes patula* L., *Zinnia elegans* Jacq., *Hosta plantaginea* (Lam.) Aschers. etc.

The soil in platbands contains little sand and gravel. The flora of the synanthropic association counts 24 species. Besides *Portulaca oleracea* and *Digitaria sanguinalis* we have also remarked *Eragrostis poioides, Chenopodium polyspermum, Euphorbia helioscopia* and *Setaria glauca* by their high constancy (Table 3).

Table 3

Digitario-Portulacetum oleracei

(Felföldi 1942) Timár et Bodrogközy 1955

Altitude: 97 m above sea level Number of relevés: 15	A + D	K
Portulaca oleracea L.	+ — 4	V
Digitaria sanguinalis (L.) Scop.	+ — 3	V
Eragrostis poioides P.B.	+	IV
Hibiscus trionum L.	+	I
Stachys annua L.	+	I
Chenopodium album L.	+ — 1	III
Chenopodium polyspermum L.	+ — 1	IV
Euphorbia helioscopia L.	+	IV
Malva neglecta Wallr.	+ — 1	III
Anagallis arvensis L.	+	I
Convolvulus arvensis L.	+	III
Solanum nigrum L.	+	III
Kickxia elatine (L.) Dumort.	+	II
Veronica persica Poir.	+	II
Galinsoga parviflora Cav.	+	III
Senecio vulgaris L.	+	I
Sonchus asper (L.) Hill.	+	II
Sonchus oleraceus (L.) Gou.	+	I
Echinochloa crus-galli (L.) P.B.	+	II
Setaria glauca (L.) P.B.	+	IV
Setaria verticillata (L.) P.B.	+	I
Amaranthus retroflexus L.	+ — 1	II
Rorippa silvestris (L.) Bess.	+	II
Calystegia sepium (L.) R.Br.	+	I

The phytocoenoses of the studied association are dominated by annual and biannual therophytes (21 species = 87.5%). The hemicryptophytes are few in number (3 species = 12.5%).

The floristic elements are characterized by the great number of cosmopolitan species (10 species = 41.6%) and of Eurasian ones (8 species = 33.3%). The adventitious plants comprise 3 species (12.5%). The European, Submediterranean and Mediterranean floristic elements consist each of one species (4.2%). The last two meridional floristic elements are favoured by the plain climate, warm in winter.

Analysis of the main ecological indices (Table 2) brings into relief the mesophilous (*U* 3—3.5 — 13 species = 54.1%) towards xeromesophilous (*U* 2—2.5 — 6 species = 25.0%), micromesotherm (*T* 3—3.5 — 12 species = 50.0%) towards moderate-thermophilic (*T* 4—4.5 — 6 species = 25.0%), slightly acid-neutrophilous (*R* 4 — 9 species = 37.5%) towards amphitolerant (*R* 0 — 12 species = 50.0%) character.

Unlike the previous association, *Digitario-Potulacetum oleracei* has a stronger xeromesophilous and moderate-thermophilic character, in concordance with the plain climate conditions.

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REFLECŢII PRELIMINARE ASUPRA ECOSISTEMELOR PRIN PRISMA LOGICII FORMALE

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SUMMARY. — Preliminary Considerations on Ecosystems in the View of Formal Logic. It is generally accepted that all ecosystems consist of two major components: a living part or biocoenosis and a non-living one — the ecotope or habitat. The ecosystem is a highly organized combination of organisms and environmental factors in permanent and mutual interrelation, in which the internal changes overcome the external ones. Each ecosystem has its own structure and dynamic equilibrium. The authors first discussed the ecosystem concept in the view of the general system theory [4]. It has been pointed out that any ecosystem may be made up of systems (units) of lower rank (biocoenosis, biotope) which, in their turn, are built up of even lower and less organized systems (synusiae, populations etc.). Whether one of the components of the biocoenosis is itself a system or only part of it is merely a question of viewpoint. Most of the phenomena occurring at the level of the ecosystem as a whole are of the fuzzy type, but those of lower rank may also be non-fuzzy. The ecosystem is a living system, therefore life defining criteria [11] can generally be applied to ecosystems as well: stability, unity, metabolism etc.

The second part of the paper deals with some general aspects of ecosystem structure, in the general view of structures, *i.e.* as consisting of elements connected by functions. It would be underlined that such highly organized complex structures, like those usually existing in ecosystems, exhibit a greater stability, resisting better to external influences. The concept of succession, as well as sudden, non-reversible changes like those produced by flood, fire, dry out etc. are discussed in the view of the catastrophe theory.

The third part of the paper is dedicated exclusively to a mathematical approach to ecosystem stability. An index of stability $I_{st} = \frac{|A - B|}{2|\bar{X} - X|} - 1$, based on the possible limits of a given feature, is proposed by the authors. When more or even all characteristics or factors are to be considered, the ecosystem stability is given by the following relation: $I = I_{st_1} \times I_{st_2} \times \ldots \times I_{st_n}$. The problem of stability may also be considered geometrically, in space, when both ecosystem and external influences are considered as (circular) areas. The intensity of the influence is directly correlated (proportional) with the size of the overlapping surfaces.

The last part exhibits the authors' contribution to the catastrophe theory modelling in ecology. Besides the relatively well-known models [23, 28, 29, 31, 32], there is a new one, proposed by the present authors. The new catastrophe model is defined by the function $f_{(x)} = \frac{|X - C| + \varepsilon}{|X - A||X - B| + \varepsilon}$ where A, B, C are given variables, ε a constant controlling the slope of the curve with more or less rounded double modes. The behaviour of the curve (model) is discussed in detail (for various values of ε, inverted $g_{(x)}$ and ne-

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gative $-f_{(x)}$ functions). This model has 5 characteristic parts, two of them (A and B), when $f'_{(x)} = 0$ showing maximal lability. When $X = 0$, the stability is maximal.

The use of the proposed index of stability and new catastrophe model for ecological investigations is not only possible but highly desirable.

Introducere. Autorii şi-au propus să reflecteze asupra modalităţilor prin care pot fi abordate ecosistemele din punctul de vedere al unor teorii care se încadrează în sfera generală a logicii formale.

Încă la sfîrşitul secolului trecut s-a arătat [12] că ecologia este ştiinţa relaţiilor organismelor faţă de lumea înconjurătoare. Aceste relaţii, privite într-un sens larg, reprezintă totalitatea condiţiilor de existenţă, în egală măsură organice şi anorganice. Esenţa acestei definiţii, acceptată în linii generale de majoritatea ecologilor o regăsim, într-o interpretare mai largă sau mai restrînsă, în funcţie de specificul autorului, în mai toate definiţiile date ecologiei.

Astfel, Eggleton [6] vorbeşte despre ştiinţa interrelaţiilor organismelor cu mediul lor de viaţă. Friedericks [8] sugerează că ecologia este mai de grabă un mod de a privi şi cerceta natura — nu numai o ramură sintetică a biologiei în care sînt implicate o serie de ştiinţe auxiliare (geologia, climatologia, pedologia, geografia, chimia, fizica etc.). Ecologia este de fapt ştiinţa complexelor supraindividuale.

Ecologia, care face parte din categoria ştiinţelor biologice complexe, are ca obiect investigarea, prin metode specifice, a complexelor supraindividuale — cunoscute în general sub denumirea de ecosisteme. Un ecosistem este alcătuit, pe baza unei prime analize, din două compartimente: unul biotic şi altul abiotic.

După Tansley [27], compartimentul biotic sau întregul complex de organisme prezente într-o unitate ecologică, numit biom, se găseşte într-un echilibru dinamic, relativ stabil, cu factorii anorganici efectivi ai mediului care, la rîndul lor, reprezintă componentul abiotic al ecosistemului. Sukacev [25] vorbeşte de biocenoză — formată dintr-o fito- şi respectiv zoocenoză —, şi de ecotop sau biotop, alcătuit la rîndul lui din edatop şi climatop. În concepţia lui Ghilearov (citat după Stugren [24]), ecologia este ştiinţa relaţiilor reciproce, a interacţiunilor vieţii pe niveluri supraorganismice. În accepţiunea lui Odum [19], ecosistemele sînt: „acele formaţii de viaţă — mediu care sînt caracterizate printr-o anumită stabilitate şi posedă o circulaţie internă a substanţei". Acceptînd caracterul de tranziţie al ecosistemelor, ne apropiem de formularea elaborată de Naumov [16], după care ecosistemul este „combinaţia viaţă — mediu, la care volumul schimbărilor interne este mai mare decît volumul schimbărilor externe de substanţă".

Autorii de faţă consideră că un ecosistem poate fi împărţit numai metodologic în cele două componente: totalitatea vieţuitoarelor (în sens de biocenoză sau biom) şi spaţiu vital — totalitatea factorilor de mediu (în sens de ecotop, biotop sau habitat), deoarece orice ecosistem se caracterizează printr-o structură specifică proprie, iar elementele sale constitutive prezintă o permanentă interdependenţă funcţională.

I. Ecosistemul şi teoria sistemelor. Cercetarea ecosistemelor se pare că are o şansă de reuşită în plus prin aplicarea teoriei sistemelor. Este cert că, în momentul de faţă sînt relativ puţini aceia care studiază ecosistemul ca sistem în adevăratul sens al cuvîntului, dacă ne gîndim la importanţa pe care ar prezenta o asemenea aproximare [9, 20, 24].

În continuare vom încerca să tratăm ecosistemul prin prisma teoriei generale a sistemelor. Se cuvine precizarea că după Bertalanffy [4], cel care a formulat teoria sistemelor, prin sistem se înţelege o mulţime la care între componenţi (elementele constitutive ale mulţimii) există cel puţin o relaţie.

În analiza noastră trebuie să pornim de la bun început acceptînd următoarele premize [26]:

— un ecosistem este sistem şi din punct de vedere al teoriei sistemelor;

— ecosistemul este un sistem viu.

Aceste afirmaţii sînt nu numai plauzibile, dar ele sînt şi deductibile. Ca să putem cerceta ecosistemele din punct de vedere sistemic sîntem nevoiţi să operăm cu modele şi trebuie să acceptăm faptul că modelele corespund numai parţial realităţii.

Ecosistemul este o mulţime în sens matematic, ca totalitatea elementelor bine definite care o alcătuiesc (plante, animale, climă, sol etc.). De menţionat că teoria sistemelor consideră sistem chiar o singură pereche de intrare/ieşire, o corelaţie sau transformarea unei perechi de intrare/ieşire. În general, ca să acceptăm ecosistemul drept sistem, cu rigurozitate matematică, acesta trebuie să răspundă la două condiţii (A, B). Aceste condiţii, postulate de Zadeh şi Polak [30], sînt general valabile pentru orice sistem, deci în mod implicit şi pentru ecosistem.

Astfel, *un ecosistem constă din mai multe subsisteme (A).* Se pare că această afirmaţie este valabilă nu numai pentru ecosistem în ansamblu, ci şi pentru părţile — subsistemele — sale constitutive (biocenoză şi biotop).

Orice subsistem poate fi considerat sistem (unitate) în momentul în care pot fi decelate în cadrul lui subsisteme de rang inferior. Astfel, orice subsistem poate fi şi sistem dacă îl raportăm la subsistemele sale inferioare, dar rămîne sistem dacă-l privim prin prisma unităţii din care face parte. Este evident că fiecare sistem, respectiv subsistem are o infrastructură proprie.

Biocenoza, unul dintre subsistemele imediat inferioare ecosistemului, este alcătuită din comunităţi vegetale, animale, bacteriene, fungice etc., subsisteme care la rîndul lor sînt constituite din subsisteme şi mai mici, subordonate (sinuzii, populaţii). În acest fel, subsistemul comunităţilor vegetale este alcătuit din sinuzii de alge, briofite, antofite etc. Sinuzia algală este formată din subsistemele populaţionale ale speciilor componente.

Dacă analizăm componentul abiotic al ecosistemului ca sistem, solul, cu rang de subsistem, este alcătuit la rîndul său din mai multe orizonturi care, pot primi (intrare) şi ceda (ieşire) substanţe constitutive — astfel încît pot fi concepute drept subsisteme.

Raportul intrare/ieşire este acea funcţie care reflectă schimbările care au avut loc la nivelul unui sistem sau subsistem. Decelarea funcţiilor (intrare/ieşire) în cazul ecosistemului în ansamblu este deocamdată mai dificilă, mult mai uşor fiind acest lucru în cazul subsistemelor.

Ecosistemul este supus unei serii de influenţe (B) (intrări), dintre care fac parte influenţele climatice, geologice, edafice, biotice, antropice etc.

Pentru ca o colecţie din mulţimea de intrări/ieşiri să constituie subsistem, trebuie să satisfacă 4 condiţii de consistenţă.

Condiţia de acoperire. Fiecare pereche intrare/ieşire din ecosistem aparţine cel puţin la o colecţie de mulţimi. Orice individ intrat în ecosistem şi care îşi manifestă efectul asupra ecosistemului aparţine cel puţin la o colecţie de mulţimi a unui segment (biocenoză, asociaţie, populaţie, orizont de sol etc.).

Condiţia de închidere prin trunchiere. Dacă o pereche de intrare/ieşire reprezintă un segment, atunci toate perechile de intrare/ieşire, care se găsesc în segment, au aceeaşi proprietate: reprezintă segmentul respectiv. Sfagnetele de trecere adăpostesc desmidiacee şi diatomee acidofile, prin urmare, prezenţa acestora caracterizează turbăriile mezotrofe acide.

Condiţia de unicitate. Fiecărei influenţe (intrare) îi corespunde un răspuns (ieşire). La orice influenţă, biocenoza (populaţia, asociaţia, orizontul de sol etc.) trebuie să răspundă printr-o schimbare. Este evident că influenţele devin sesizabile investigatorului doar în cazul în care acestea depăşesc un anumit nivel sau prag de mărime, intensitate sau durată.

Condiţia de prelungire. Mulţimea prelungirilor tuturor perechilor de intrare/ieşire din colecţia de submulţimi corespunde perechii de intrare/ieşire a mulţimii. Înlănţurea influenţelor şi răspunsurilor din biocenoză, populaţie, asociaţie, sol etc. se reduce, în final, la o singură pereche, aceea de efect/schimbare a ecosistemului.

Un ecosistem este un sistem dinamic; mărimea ieşirii sistemului, în general, depinde atît de starea actuală a mărimii intrării în sistem cît şi de „istoria sistemului" [13]. Conceptul de timp trebuie introdus în studiul ecosistemului cel puţin în două cazuri bine distincte: la variaţii ciclice (circadian şi sezonier) şi la cele aciclice, respectiv cele implicate în evoluţia ecosistemului (climax, postclimax).

Este evident că fenomenele în realitate sînt mult mai complicate. În cazul ecosistemelor avem de a face cu fenomene stochastice, care nu apar categoric, deci sînt vagi sau de tip „fuzzy". La asociaţii de plante, unde prezenţa sau absenţa plantei în asociaţie nu este exclusivă, apartenenţa nu are o limită clară, existînd posibilitatea să apară şi o stare de trecere. În acest caz, precum şi în toate cazurile cînd avem de a face cu o mulţime vagă, trebuie să ţinem cont de următoarele afirmaţii [17, 18]:

— fiecare relaţie de organizare de tip „fuzzy" (apartenenţa sau nu a populaţiilor la asociaţii) poate fi descompusă în relaţii (sau nivele) mai simple;

— dacă relaţia de apartenenţă la asociaţii este de tip „fuzzy", cea referitoare la o subasociaţie poate fi şi de tip „non-fuzzy".

În altă ordine de idei, principiul vieţii, — problema de bază a biologiei şi a disciplinelor legate de ea — a constituit o temă mult disputată la diferite foruri, dar se pare că, în cele din urmă, nici pînă în prezent nu a fost pe deplin rezolvată. Gánti [11] încearcă să formuleze criteriile absolute şi potenţiale care definesc viaţa. În cele ce urmează vom analiza în ce măsură criteriile preconizate îşi găsesc o valabilitate în cazul ecosistemelor. Criteriile enumerate de Gánti [11] sînt de două categorii — absolute şi potenţiale.

1. Criterii absolute sau reale

1.1. Un sistem viu, în mod inerent, trebuie să fie o unitate. Cercetările ecologice au condus la recunoaşterea adevărului că un ecosistem nu este o simplă şi întîmplătoare unire (aglomerare) de elemente constitutive, ci reprezintă o entitate cu particularităţi calitative specifice.

1.2. Un sistem viu se caracterizează prin metabolism. Acceptînd condiţia de prelungire [30], metabolismul unui ecosistem poate fi conceput ca fiind asigurat cantitativ de către metabolismul tuturor elementelor constitutive (subsisteme, populaţii, indivizi etc.).

1.3. Un sistem viu trebuie să prezinte stabilitate inerentă. Ecosistemul răspunde la schimbările parametrilor externi prin modificări dinamice interne în aşa fel încît să-şi menţină neschimbată unitatea (homeostazia ecosistemelor).

1.4. Sistemul viu trebuie să dispună de subsisteme, care sînt purtătoare de structuri informaţionale pentru întregul sistem. Informaţia codificată devine într-adevăr informaţie numai atunci cînd există un subsistem care o descifrează. Evident că un ecosistem este compus din mai multe subsisteme. De exemplu, clima este decodificată de sol şi de vegetaţie, solul la rîndul său de biocenoză; clima, solul, vegetaţia sînt decodificate de faună etc. Se pare că seturile de informaţie ale ecosistemelor nu trebuie să se suprapună integral. Un subsistem minimal poate să conţină informaţii pe care un alt subsistem aparţinător la acelaşi sistem nu le conţine, presupunînd că lipsa informaţiei nu contrazice informaţia generală. Se poate presupune că un astfel de subsistem, cum este, de exemplu, solul sau orizonturile diagnostice ale acestuia, poate conţine informaţii pentru întregul ecosistem.

1.5. Procesele care au loc într-un sistem viu trebuie să fie reglate şi dirijate. Condiţia fiecărui sistem biodinamic persistent este existenţa reglajului la nivelul proceselor sale, care se realizează, în primul rînd, prin mecanismele chimice de bază. Dar reglajul asigură doar existenţa sistemului; condiţia de bază necesară diferenţierii şi dezvoltării calitative a sistemului este dirijarea (legea toleranţei).

2. Criterii potenţiale

2.1. Un sistem viu trebuie să aibă capacitatea de creştere şi de înmulţire. Gánti [11] consideră acest criteriu drept unul dintre criteriile potenţiale ale existenţei lumii vii, dar în mod necesar şi a individului. Un ecosistem, în condiţii normale, poate să crească şi să se înmulţească în detrimentul unui alt ecosistem (dacă nu se dezvoltă pe substrat abiotic ca de exemplu după activităţi vulcanice). Această idee va fi reluată în contextul ecosistemelor (climax, catastrofe), în capitolul respectiv.

2.2. Un sistem viu trebuie să aibă valabilitate intrinsecă şi respectiv capacitatea transmiterii „ereditare" a schimbărilor. Acest criteriu, perfect valabil la nivel populaţional, în cazul ecosistemelor nu se realizează prin dedublarea ADN-ului. Genofondul ecosistemului rezultă din asocierea genofondurilor populaţiilor (subsistemelor) care îl constituie. Astfel, valabilitatea la nivelul ecosistemelor se materializează prin variaţii de compoziţie şi structură, un proces care cu timpul evoluează spre o avansată specializare (subasociaţie, facies etc.) sau spre o nouă fază succesională. Transmiterea caracterelor unui ecosistem în ansamblu se realizează prin transmiterea ereditară a caracterelor indivizilor şi populaţiilor care îl alcătuiesc.

2.3. Un sistem viu trebuie să fie şi „muritor". În cazul ecosistemelor, moartea poate interveni cel puţin în două feluri: prin dispariţia însăşi a vieţii în ansamblu sau prin reînnoirea periodică a elementelor componente (moarte parţială). Dispariţia brutală (catastrofală) poate interveni în cazul unor calamităţi naturale (erupţii vulcanice, inundaţii, incendii, răcirea sau încălzirea climei generale etc.) sau prin impact uman (defrişări, intervenţii agrotehnice, poluare etc.). Unele dintre aceste forme produc doar distrugerea parţială, reversibilă a ecosistemelor, altele în schimb pot produce modificări profunde, care duc la transformarea sau chiar dispariţia acestora — deci la o moarte propriu-zisă. O moarte „înceată", care de fapt este reînnoirea ecosistemelor, se realizează prin înlocuirea indivizilor din populaţiile componente; ea se realizează periodic în funcţie de ciclurile ontogenetice ale speciilor. Reînnoirea se poate produce în cîteva ore sau în sute de ani.

Avînd în vedere cele de mai sus este evident că:

— ecosistemele sînt sisteme şi în înţelesul matematic al cuvîntului; ele pot fi şi trebuie să fie tratate ca atare (sistemic);

— ecosistemele sînt sisteme dinamice, iar abordarea lor statică nu poate fi decît metodologică, reflectînd doar starea lor într-un moment dat;

— ecosistemele sînt sisteme „fuzzy" la care fenomenele nu au un mers univoc şi nu au o delimitare exclusivă, ceea ce presupune aplicarea unei metodologii adecvate;

— aplicînd criteriile absolute şi potenţiale postulate de Gánti [11] la nivelul ecosistemelor reiese cu claritate că orice ecosistem este un sistem viu în care biotopul (habitat) şi respectiv biocenoza (biom) sînt subsisteme minimale imediat inferioare.

II. Consideraţii asupra structurii ecosistemelor. La prima aproximare un sistem este un obiect sau o mulţime de obiecte care primesc influenţe şi răspund la influenţele primite. În comparaţie cu un sistem, o structură este mulţimea elementelor legate printr-o funcţie [14], ea putînd fi ceva mai statică. În acord cu Drăgănescu [5] şi Soran [22] putem admite, prin definiţie, că structura sau arhitectura este acel set de funcţiuni pe care un sistem îl poate realiza în timp şi într-un spaţiu dat şi care determină forma şi comportarea sa la o anumită interfaţă sau palier de acces (de exemplu mediu). Referindu-ne la sol de exemplu, organizarea în orizonturi dovedeşte că acesta are o structură în înţeles informaţional. În acelaşi context, solificarea, respectiv procesele de humificare pot fi considerate structuri informaţionale, chiar decizionale în unele privinţe. Dacă omul de ştiinţă, în general, caută să răspundă la întrebarea cum se schimbă sistemele în diferitele condiţii, avînd în vedere teoria dinamicii sistemelor, pedologul-practician este interesat în special să cunoască cum să ridice fertilitatea solului sau cum să o menţină la un nivel înalt.

Organizarea ierarhică a sistemelor face ca ruperea unui circuit local să afecteze numai o mică porţiune a structurii, să nu ducă la paralizarea întregului pînă cînd funcţiile circuitului rupt sînt preluate de către celelalte circuite rămase. O structură superior organizată poate suporta influenţe din afară, mai multe şi mai diverse, pe care le selectează şi le prelucrează în mod propriu [7]. Sistemele numite sisteme mari sau complexe, înalt organizate [1], cum sînt ecosistemele, caracterizate prin numărul mare de variabile ce trebuie menţinute la valori impuse, ar putea să înfrunte greu multitudinea perturbaţiilor ce se propagă asupra variabilelor sistemului, dacă ele nu ar fi organizate după anumite legităţi. Sarcina atenuării perturbaţiilor nu revine sistemului în ansamblu, ci, datorită unei forme specifice de organizare, diferitelor niveluri ale acestuia. Să ne referim acum la ecosisteme. Pe lîngă schimbările reversibile ce au loc în mod normal între anumite limite — cunoscute sub denumirea de fluctuaţii — ecosistemul se dezvoltă trecînd prin schimbări succesive (secvenţe de faze), care de regulă sînt continue unele cu altele [27]. Fazele succesionale apar sub acţiunea concertată a unor factori autogeni şi alogeni [27]. În cazul în care domină factorii care depind direct de activitatea vieţuitoarelor (plante, animale, ciuperci etc.), putem vorbi de succesiune autogenică; în caz contrar, succesiunea este alogenică. Dacă schimbările survenite în structura ecosistemului, fie ele lente, fie bruşte, trec peste pragurile critice, la care ecosistemul nu mai are capacitate de autoreglare, alterările structurale şi funcţionale devin ireversibile (nu mai sînt de categoria fluctuaţiilor), asemănătoare unor „catastrofe“ în sens matematic.

Catastrofele în sens utilizat includ nu numai impacturile drastice, brutale ale ecosistemelor cu unele fenomene naturale sau activităţi umane (incendii, desecări, inundaţii, alunecări de teren, defrişări, arături etc.) care distrug parţial sau total ecosistemele ori subsistemele acestora. Asemenea impacturi, deci, constituie doar o categorie particulară a catastrofelor în sensul utilizat de noi, care întrerup succesiunea normală, producînd brusc schimbări drastice în ecosistem. Cu cît un ecosistem posedă o structură mai complexă, cu atît capacitatea sa de a înfrunta perturbări (capacitatea de rezilienţă) este mai mare. În ecologie, interesul deosebit faţă de teoria sistemelor, dar şi faţă de cea a structurilor se datoreşte, printre altele, nevoii de a modela situaţiile existente şi de a decela tendinţele posibile viitoare de evoluţie la nivelul ecosistemelor, cu scopul de a promova acele structuri, respectiv sisteme, care sînt cele mai favorabile progresului societăţii.

În ceea ce priveşte modelarea matematică a structurilor [3] avem două posibilităţi de aproximare: senzorială-experimentală, la care se are în vedere esenţializarea structurilor (sistemelor) şi cognitivă, care se bazează pe considerarea tuturor structurilor posibile. În continuare, spre exemplificare, vom analiza succint solul ca ecosistem, prin prisma teoriei structurilor. Ne vom referi la un sol cu mai multe orizonturi (elemente). Structura acestuia este dată, la prima aproximare, de mulţimea elementelor orizonturilor şi conexiunile care îl alcătuiesc.

Acceptînd ideea lui Racoveanu [21], solul poate fi definit ca o structură ierarhizată, avînd între orizonturile sale constitutive, atît relaţii de supraordonare cît şi de subordonare. În consecinţă, bunăoară, fenomenele de la nivelul solurilor pot şi trebuie să fie abordate cel puţin sub două aspecte. Structura solului trebuie privită, pe de o parte, ca macrosistem, sistem alcătuit din orizonturi genetice. Orizonturile solului, pe de altă parte, sînt complexe de compuşi anorganici, organici şi organominerali, fiecare dintre acestea reprezentînd elemente ale microsistemului (orizontului). Lumea vie, fie în totalitate, fie pe părţi, poate şi chiar trebuie să fie abordată în acest fel.

Solul poate fi considerat un sistem închis, deoarece îndeplineşte anumite funcţiuni, care la rîndul lor operează în timp şi în prezenţa/absenţa elementului uman. În absenţa elementului uman, procesele din sol decurg în general conform stărilor climax în direcţia negentropiei minime. Omul intervine mai ales în procesele de decizie. În vederea evaluării strategiilor de conducere şi de elaborare a metodelor de decizie calitative şi cantitative este nevoie de o mare cantitate de informaţie.

Dacă urmărim de exemplu procesele de humificare prin calcule structurale şi notăm cu S_1 submulţimea compuşilor reali sau ipotetici implicaţi în proces, iar cu S_2 submulţimea legilor care guvernează combinarea acestor compuşi, structura procesului de humificare poate fi reprezentată ca reuniunea celor două submulţimi $(S = S_1 \cup S_2)$ unde atît S_1 cît şi S_2 aparţin lui S. Trebuie să admitem că între S_1 şi S_2 pot exista două feluri de relaţii: de subordonare şi de supraordonare. În cazul nostru aceste expresii pot fi înlocuite prin calitate (supraordonare) şi cantitate (subordonare). La o structură ierarhizată se poate introduce semnul $\updownarrow$ pentru relaţii verticale şi semnul $\longleftrightarrow$ pentru relaţii orizontale.

Cele de mai sus, desigur, sînt doar referiri generale, detaliile urmează să fie elaborate pentru fiecare tip de structură în parte.

III. Consideraţii asupra stabilităţii ecosistemelor. Despre stabilitatea sistemelor, ca funcţii matematice, găsim ample relatări şi în literatura noastră de specialitate. Este suficient, credem, să ne gîndim la lucrarea lui Morozan [15]. Cu toate acestea, de regulă, problemele au fost tratate la nivelul ecuaţiilor diferenţiale, atît în cazul parametrilor aleatori cît şi în cazul celor stochastici. Doar rareori s-a încercat rezolvarea adecvată a unor probleme particulare. În cele ce urmează prezentăm o încercare în acest sens cu privire specială asupra ecosistemelor.

Cercetarea stabilităţii ecosistemelor (în cazul discutat şi al solurilor) este o problemă prin excelenţă de ecologie care, în viitor, va căpăta din ce în ce mai mult valenţe de inginerie ecologică mai ales în perspectiva unor schimbări imprevizibile datorate impactelor umane.

Evaluarea stabilităţii ecosistemelor este, în primul rînd, o problemă de alegere a caracterizanţilor generatori de grupuri. Caracterizanţii trebuie grupaţi în ordine descrescîndă, în funcţie de gradul lor de complexitate (principali, secundari etc.) [10]. Este important în alegerea caracterizanţilor ca aceştia să fie cuantificabili şi să nu se repete.

Să presupunem că avem *n* ecosisteme (sau soluri) cît de cît similare la care, pe baza unor măsurători, stabilim un număr de parametri (X_i) de tip aleator (caracterizanţi). În urma analizei caracterizanţilor unui grup cercetat putem determina limitele de existenţă (AB) sau laticele pentru fiecare caracterizant, precum şi media acestora $(\bar{X})$. Media caracterizanţilor $(\bar{X})$, în mod particular, poate să coincidă cu mediana. Dacă acelaşi parametru (X) al unui alt ecosistem din afara grupului analizat se încadrează în limitele stabilite pentru grup şi în extremis coincide cu media $(\bar{X})$, ecosistemul cercetat prezintă o stabilitate apropiată sau identică cu cea a grupului, natural, numai în privinţa caracterizantului respectiv. Limitele intervalului de existenţă a valorilor (AB) reprezintă limitele de stabilitate; în afara limitelor de stabilitate se găsesc zonele subminimale de stabilitate, respectiv zonele de instabilitate (Fig. 1).

Propoziţia 1. Valoarea caracterizantului cercetat (X) poate să cadă atît în interiorul intervalului de existenţă (în latice) cît şi în afara acestuia (Fig. 1 a, d).

Propoziţia 2. Stabilitatea unui ecosistem particular (X) este invers proporţională cu distanţa $\bar{X}$—X.

Propoziţia 3. Stabilitatea este direct proporţională cu mărimea intervalului de existenţă a caracterizantului, A—B.

Lema 1. Cînd stabilitatea depinde de un singur factor divergent, indicele de stabilitate parţială (I_{st}) al unui ecosistem este:

$$I_{st} = \frac{|A - B|}{2|\bar{X} - X|} - 1$$

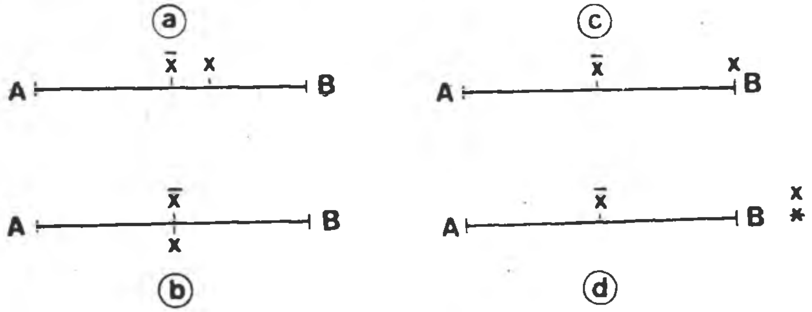

Fig. 1. *Schemă ilustrînd stările de stabilitate sau instabilitate ale ecosistemelor pe baza unui caracterizant* (X) *în funcţie de limitele de existenţă* (AB) *şi media* $(\bar{X})$.

a, b — Stări de stabilitate. c, d — Stări de instabilitate. Explicaţii suplimentare în text.

de exemplu $B = 30$ $A = 40$ $\bar{X} = 35$

1. $X_1 = 37$ $I_{st} = 1{,}5$
2. $X_2 = 35$ $I_{st} = 9$
3. $X_3 = 40$ $I_{st} = 0$
4. $X_4 = 42$ $I_{st} = -0{,}29$

Lema 2. Presupunem că între indicii de stabilitate parţială ai ecosistemului (I_{st}) există o relaţie de înmulţire, deoarece, dacă există chiar numai un singur factor determinant cu indice de stabilitate 0 (tinde către 0), atunci şi coeficientul de stabilitate totală, respectiv stabilitatea ecosistemului studiat este 0 (tinde către 0).

$$I = I_{st_1} \times I_{st_2} \times \ldots\ldots \times I_{st_n}$$

În cazul cînd un ecosistem se dovedeşte a fi instabil, dar indicele de stabilitate calculat arată că ar fi stabil, sau invers, înseamnă că alegerea caracterizanţilor nu este adecvată.

Din cele relatate mai sus se desprinde posibilitatea obţinerii unor schimbări dirijate în funcţie de scopurile practice urmărite. Astfel, se poate stabili cu cît este necesar să modificăm valoarea caracterizantului X (sau a caracterizanţilor) pentru ca sistemul să rămînă sau să devină stabil. Se deschide de asemenea posibilitatea evitării unor schimbări ireversibile (instabilităţi catastrofale).

Problema stabilităţii poate fi privită şi din punct de vedere geometric. Să presupunem că avem un ecosistem oarecare, care se încadrează în limitele unui cerc cu raza r_1, şi mai avem undeva un agent perturbator cu rază de acţiune r_2. Am luat un caz idealizat, cînd amîndouă ariile sînt circulare. Mai trebuie să presupunem că cele două cercuri de existenţă sînt apropiate, distanţa dintre cele două centre (origo) fiind 1. Pot exista 3 cazuri:

1. Dacă $1 - r_2 > r_1$, atunci cele două raze de acţiuni nu se ating; agentul dăunător nu afectează starea ecosistemului cercetat:

$$\frac{1 - r_2}{r_1} > 1$$

2. Dacă $1 - r_2 = r_1$, atunci cercurile sînt tangente; acţiunea agentului dăunător se manifestă doar la marginea ecosistemului cercetat care se menţine în echilibru prin acţiunea de regenerare:

$$\frac{1 - r_2}{r_1} = 1$$

3. Dacă $1 - r_2 < r_1$, atunci cercurile se întretaie; acţiunea agentului dăunător perturbă ecosistemul cercetat:

$$\frac{1 - r_2}{r_1} < 1$$

Nu este greu de imaginat un sistem în care acţiunile de mai sus se petrec în spaţii vitale în formă de sferă (în apă sau în aer). În acest caz cercurile vor fi înlocuite cu sfere; mărimea primei sfere va fi $4/3\pi r_1^3$, iar celei de a doua $4/3\pi r_2^3$. La calculare ţinem cont de poziţia sferelor, adică de două cercuri ale căror centre coincid cu centrele sferelor.

IV. **Ecosisteme privite prin prisma teoriei matematice a catastrofelor.** Teoria matematică a catastrofelor este relativ nouă, primele lucrări semnate de Thom — cel care a formulat-o — au apărut după anii '60 [28]. La scurt timp au apărut o serie de lucrări prezentînd cercetări orientate spre aplicarea teoriei catastrofelor în cele mai variate domenii de cercetare: geografie, psihologie, economie, biologie etc. [2, 23].

Teoria matematică a catastrofelor constituie un instrument pentru cercetarea fenomenelor la care schimbările cantitative treptate trec, la un moment dat, în schimbări calitative. În acest fel teoria matematică a catastrofelor pare a fi în consens cu concepţia generală a dialecticii şi încearcă să modeleze matematic (prin formule şi grafice) schimbările lumii materiale.

Dintre reprezentările grafice (şi acestea sînt mai generale) de remarcat sînt 4 modele: modelul în formă de V răsturnat, modelul lui Zeeman [31, 32], modelul lui **Thom** [28] şi modelul lui **Rieman-Huginot** (graf de G) [23, 29] (Fig. 2).

În cele ce urmează propunem şi prezentăm un model nou, inedit (Fig. 3) care ar putea să-şi găsească aplicabilitate în ecologie, ne poate arăta cît de mare trebuie să fie schimbarea cantitativă la nivelul unui ecosistem ca aceasta să fie urmată de o schimbare calitativă, prin care ecosistemul nu va mai rămîne el însuşi, deoarece se va produce prăbuşirea structurii acestuia. Graficul propus redă modul în care se petrece o „catastrofă" în sens matematic, prezentînd în coordonate carteziene o funcţie monovariabilă $f_{(x)}$ (de exemplu stabilitatea unui fenomen sau unui ecosistem), şi avînd daţi parametrii fixaţi iniţial A, B, C şi ε. Funcţia de bază este:

$$f_{(x)} = \frac{|X - C| + \varepsilon}{|X - A|\,|X - B| + \varepsilon}$$

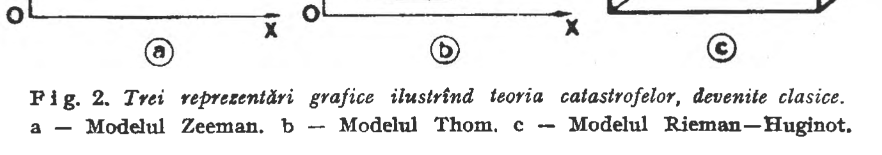

Fig. 2. *Trei reprezentări grafice ilustrînd teoria catastrofelor, devenite clasice.* a — Modelul Zeeman. b — Modelul Thom. c — Modelul Rieman—Huginot.

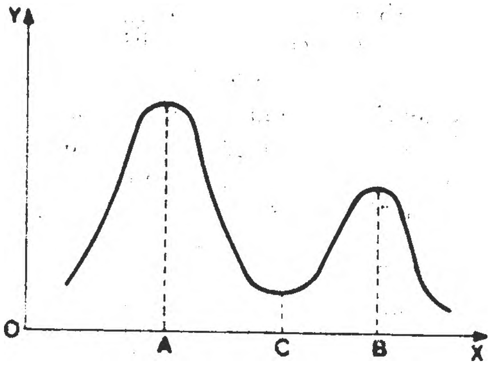

Fig. 3. *Noul model propus pentru reprezentarea grafică a teoriei catastrofelor în aproximarea modificărilor ce au loc la nivelul ecosistemelor.*

Dacă măsurăm în trei cazuri valorile lui X (variabilă independentă) şi $f_{(x)}$ (variabilă dependentă), atunci constantele A, B, C pot fi calculate fie prin metoda Euler, fie prin metoda determinantelor, fie prin metoda iteraţiei după care, cu al patrulea caz se poate deja controla curba, avînd ε fixat iniţial. În graficul funcţiei (Fig. 3) axa OX reprezintă o variabilă în funcţie de care se cercetează comportamentul unui ecosistem, iar axa OY, starea de stabilitate a funcţiei cu o singură variabilă. Pentru a înţelege problema stabilităţii, trebuie să studiem funcţia din punct de vedere al derivatelor de gradul I. Deoarece derivarea unor funcţii poate prezenta greutăţi din punct de vedere matematic, o metodă mai expeditivă ar fi determinarea grafică a derivatelor. Derivata de grad I, $f'_{(x)}$ este 0 în acele puncte în care tangenta dusă la curbă este paralelă cu axa OX. Este evident că pentru a obţine reprezentarea unor funcţii mai complicate ne putem adresa calculatoarelor. Pentru a analiza starea de stabilitate a unei funcţii ajunge să analizăm variaţia derivatelor de ordin I, prezentînd interes doar punctele la care $f'_{(x)} = 0$ şi eventual $f'_{(x)} = \pm\infty$. Derivatele de gradul II influenţează numai starea de curbură a graficului.

Interpretarea graficului. În interval finit graficul cuprinde 5 intervale caracteristice:

— $X \in (-\infty\,;\ A)$; funcţia este monoton crescătoare, la $-\infty$ tinde asimptotic către 0, iar la valoarea sa extremă, A, funcţia ajunge la valoarea $f_{(x)A}$.

— $X = A$; funcţia are valoare maximă $f_{(x)A}$; punctul A reprezintă un interes deosebit pentru noi, deoarece în acest punct se surprinde fenomenul de catastrofă, natural în sens matematic. În acest punct, unde derivata funcţiei $f'_{(x)} = 0$, avem maximă labilitate, deci stabilitate minimă. Pentru ilustrarea acestui lucru să ne imaginăm o bilă aşezată tocmai în acest vîrf virtual.

— $X \in (A\,;\ C)$; funcţia este monoton descrescătoare pînă la valoarea ei minimă $f_{(x)C}$ de unde ea devine monoton crescătoare pînă la valoarea $f_{(x)B}$.

Funcţia admite două puncte de inflexiune, locuri unde derivata a doua a funcţiei $f''_{(x)}$ se anulează (=0). Aceste valori deocamdată nu prezintă interes, deoarece locul punctelor de inflexiune nu influenţează foarte mult starea funcţiei. În punctul caracteristic $X = 0$, avem punctul de maximă stabilitate. Din nou să ne gîndim la bila imaginară, de această dată situată însă în punctul C. În orice direcţie am mişca-o, ea se întoarce la locul iniţial (C). Prin extrapolare, puterea de tamponare a ecosistemelor (homeostazia) poate fi echivalată cu starea bilei noastre imaginare din punctul C.

— $X = B$; o situaţie similară cu cea prezentată la punctul al doilea.

— $X \in (B\,;\ \infty)$; idem primul punct, exceptînd faptul că funcţia este monoton descrescătoare.

Caracteristica comună a intervalelor 1 şi 5 o constituie faptul că la ambele, funcţia admite cîte un punct de inflexiune $f''_{(x)} = 0$.

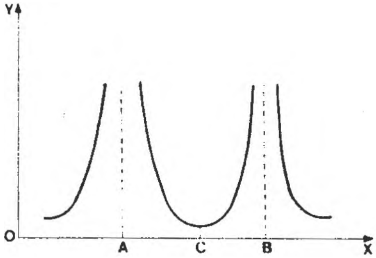

Fig. 4. *Aspectul curbei din modelul propus, în cazul în care* $\varepsilon = 0$.

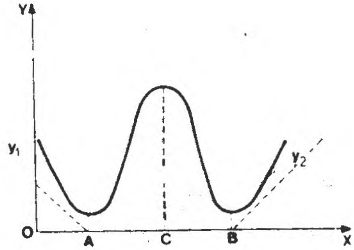

Fig. 5. *Reprezentarea grafică a funcţiei inverse:* $g_{(x)}$.

Parametrii $A < C < B$ sînt parametrii experimentali obţinuţi prin analiza factorilor. es te un factor de ameliorare, o constantă foarte mică. $\varepsilon = A/n$, $n \in (50, 1000)$, $\varepsilon > 0$; rolul ei este să rotunjească curba care aproximează funcţia, bunăoară ca funcţia să nu „scape" spre infinit. Dacă ε ar fi 0, am obţine funcţia: $f_{(x)} = \dfrac{|X - C|}{|X - A|\,|X - B|}$; corespunzător graficului din Fig. 4.

Rolul valorilor absolute este de a împiedica pendularea funcţiei între valori pozitive şi negative, făcînd posibilă obţinerea unei funcţii strict pozitive. Funcţia este cu atît mai alungită în sensul axei OY cu cît valoarea ε este mai mică. Dacă $\varepsilon = 0$ nu avem un punct care să permită trecerea funcţiei dintr-o stare în alta.

Plecînd de la modelul original, putem obţine şi alte funcţii care ar putea prezenta interes din punctul nostru de vedere, de exemplu o funcţie inversă (Fig. 5): $g_{(x)} = \dfrac{|X - A|\,|X - B| + \varepsilon}{|X - C| + \varepsilon}$. Funcţia admite două asimptote oblice, y_1 şi y_2, pe care se sprijină curba studiată; $y_1 = -X + A + B - C - \varepsilon$; $y_2 = X - A - B + C - \varepsilon$. Rolul parametrilor A, B, C se schimbă radical ca şi configuraţia generală a curbei, ea prezentînd trei zone caracteristice de interes ($a - c$).

— $(-\infty; C)$. Din starea de maximă stabilitate (punctul A) trecerea în cealaltă stare de stabilitate (punctul B) se realizează prin punctul C.

— $X = C$; în punctul C funcţia derivată este egală cu 0, $f'_{(x)} = 0$, deci avem stabilitatea minimă, reprezentînd un punct de tranziţie.

—$X \in (C; \infty)$; reprezintă a doua zonă de stabilitate maximă care se realizează în punctul $X = B$.

Graficul poate fi reprezentat cu ajutorul a două asimptote oblice, care sînt paralele cu primul (y_1) respectiv al doilea (y_2) bisector. Neglijînd factorul ε, obţinem un grafic (Fig. 6), care derivă din curba reprezentată în Fig. 5 şi este analoagă cu cea din Fig. 4. Funcţia în acest caz are următoarea formă: $g_{1_{(x)}} = \dfrac{|X-A|\,|X-B|}{|X - C|}$.

Această funcţie are tot două stări de stabilitate.

Dacă considerăm $h_{(x)} = -f_{(x)}$, obţinem ecuaţia:

$$h_{(x)} = -\frac{|X - C| + \varepsilon}{|X - A|\,|X - B| + \varepsilon} \text{ (Fig. 7).}$$

Adăugînd un factor suplimentar (H), obţinem funcţia: $h_{1_{(x)}} = H - \dfrac{|X - C| + \varepsilon}{|X - A|\,|X - B| + \varepsilon}$, redată grafic în Fig. 8. Ca să ajungem în situaţia în care curba se sprijină pe axa OX, se scrie: $H = \max \cdot \{|f_{(x)_A}|; |f_{(x)_B}|\}$. Valoarea lui H se poate calcula din relaţia matematică:

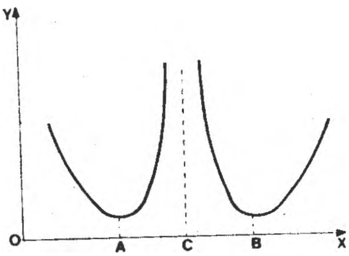

Fig. 6. *Reprezentarea grafică a funcţiei inverse cînd* $\varepsilon = 0$.

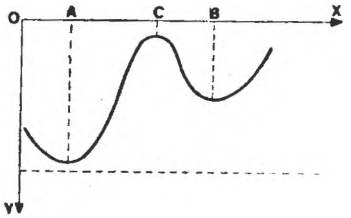

Fig. 7. *Reprezentarea grafică a funcţiei negative :* $h_{(x)} = -f_{(x)}$.

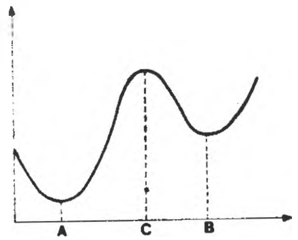

Fig. 8. *Graficul funcţiei negative* $h_{(x)}$, *în cazul introducerii unui factor suplimentar* (H).

$H = \dfrac{|f_{(x)_A} + f_{(x)_B}| + |f_{(x)_B} - f_{(y)_B}|}{2}$. Explicaţia graficului este analoagă cu cea dată în Fig. 4, deoarece cele două curbe nu se deosebesc între ele din punct de vedere al stărilor de stabilitate. Deosebiri remarcabile apar doar la analiza derivatelor de ordin I şi II.

— $g_{(x)}$ nu admite derivată în punctul C, iar la $h_{1(x)}$ derivata devine 0;

— la $g_{(x)}$ funcţia se prăbuşeşte în starea de echilibru, datorită asimptotei oblice, iar la $h_{1(x)}$, pînă la o limită, putem avea stări succesive de echilibru pasiv (cazul bilei rostogolite pe o masă), care devine însă din ce în ce mai instabil. Începînd cu o valoare dată funcţia se prăbuşeşte într-o stare de echilibru mai stabil, pînă ce atinge valoarea $f_{(x)_A}$, respectiv $f_{(x)_B}$.

Problemele de mai sus au fost prezentate la un mod general, căutînd să sugerăm posibilităţile de aplicare a unor idei matematice, atît în cercetarea ecosistemelor în ansamblu (de ex. inginerie ecologică), cît şi în analizarea părţilor constitutive ale acestora. Răspîndirea crescîndă a calculatoarelor, cu care sînt dotate mai toate instituţiile de cercetare, va permite cît de curînd ca aceste instrumente matematice să fie accesibile tuturor cercetătorilor din domeniul biologiei în rezolvarea inclusiv a problemelor practice.

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TESTING THE POSSIBLE MUTAGENIC EFFECTS OF CAPTAN IN *DROSOPHILA MELANOGASTER*

NICOLAE COMAN* and **MANUELA DORDEA***

SUMMARY. — The mutagenic activity of the fungicide captan was studied. The DL_{50} concentration for *Drosophila melanogaster* was established as corresponding to 1% fungicide included into the medium. This concentration as well at that utilized in agriculture (0.25%) were used to estimate the mutagenic effects of captan. Using the *CyLPm* test, our paper reveals a low frequency of deleterious mutations at both doses of captan, without exceeding significantly the values of the control. The frequency of the lethal recessive mutations is 2.78% for the agricultural dose of captan, and 3.66% for the DL_{50}, as compared to 0.99% for the untreated control. The increase of the frequency of lethal recessive mutations suggests that the pesticide might break the arms of the chromosomes, causing great deletions, incompatible with survival.

Chemical mutagenesis is a biological phenomenon, during which chemical agents interact with the genetic material of the living cell. The induced alterations lead to immediate and inherited modifications (mutations, chromosomal alterations) of the genotype and phenotype.

A mutagenic chemical agent may thus be identified by its property of inducing mutations, either directly or through some metabolites, or increasing significantly the mutation rate above the spontaneous background level.

The production of synthetic organic chemicals has doubled in the last 7—8 years. Since these chemicals are present in products involved in human use, the toxic effects will be mainly on the human body.

Exposure of humans to these man-made chemicals may be: — direct, during manufacturing of these chemicals, or — indirect, either through using the products containing these chemicals or through their inhalation, ingestion or absorption from contaminated air, water or food.

Only a very low percentage of the known chemicals were so far tested for their mutagenicity [14].

Nowadays, the large utilization of pesticides implies a precise knowledge of their mutagenic action.

Thus, the captan (N-trichloro-methylthio-3a, 4, 7, 7a-tetrahydrophthalimide) is a fungicide against the pathogenic fungi which affect the fruit trees, vegetables, ornamental plants, as well as against parasitic fungi of animals.

Beside the fungicide qualities of captan [1, 3, 4, 8—10], a lot of papers reveal its negative effects, such as: damage to cellular structure

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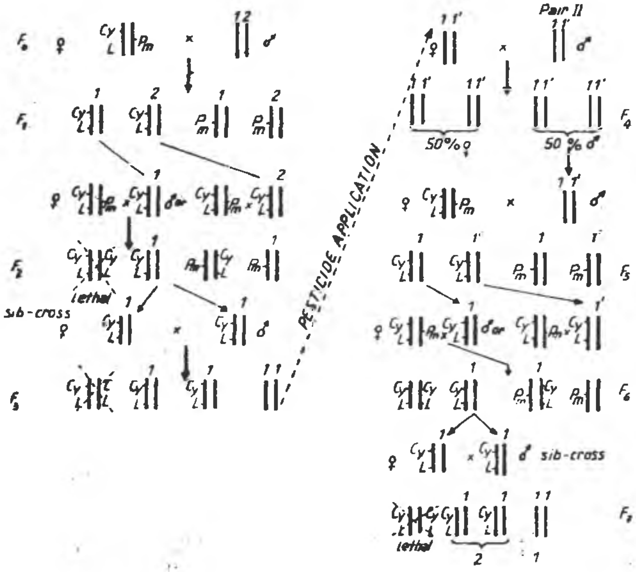


Fig. 1. *Diagram of the crossing for the* CyLPm *test.*

[11, 12], teratogenic effects [6, 10, 15], decrease of viability and development [1, 5, 18], mutagenic action [2, 7, 13].

Based on literature data concerning the effects of captan, we decided to undertake a study of its mutagenic action in order to establish to what extent it might depend on the dose.

We used *Drosophila melanogaster*, whose tester lines allow to estimate the frequency of induced mutations.

Two concentrations were tested: one was that of DL_{50} for *Drosophila*, and the other was lower, equal to the dose usually applied in the agricultural practice.

Material and methods. We used a wild strain of *Drosophila melanogaster*, from Riverside, California, reared on a „white medium" with semolina, at 25°C.

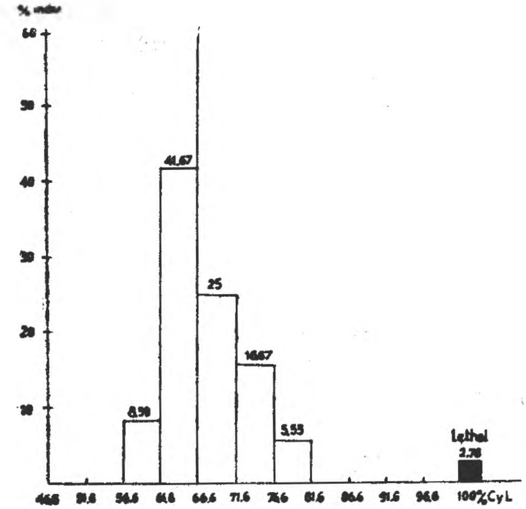
At the beginning we established the DL_{50} as corresponding to 1% captan, dissolved in ethyl alcohol and included into the medium.

In order to estimate the level of mutagenic effects of captan, the *CyLPm* test was used. The method was imagined by Wallace [17] for the study of mutagenic effect of radiations. It consists in homozygotizing a *Drosophila* strain for the second pair of chromosomes and the rearing of the homozygotized individuals on the medium with captan. Afterwards, the chromosomes resulted from the individuals submitted to the action of pesticide were re-homozygotized. The diagram of the crossings is presented in Fig. 1. If a lethal recessive mutation is induced on one or both chromosomes of the second pair, then the homozygote offspring for that mutation is not viable. Vogel [16] has estimated that the test of the lethal recessive mutations represents one of the most precise methods for establishing the induced mutations by various environmental agents.

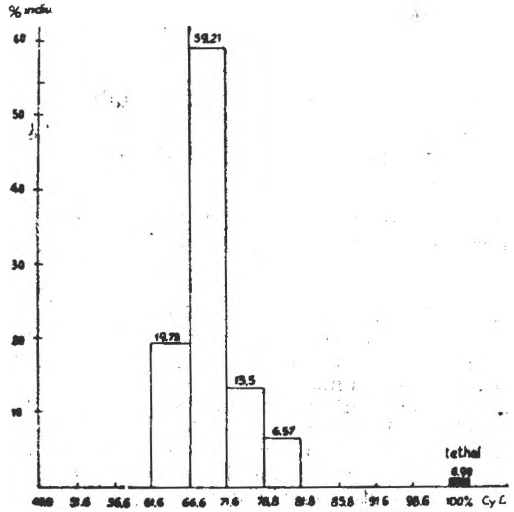
Results and discussions. In the control (Fig. 2), 0.99% of the individuals have lethal recessive mutations on the second pair of chromosomes. Our results are in agreement with those of Wallace [17] and

Vogel [16] who, using also this method, found values of 1% for the same mutations.

Examination of the deviation from the 2 : 1 ratio *(i.e.* 66.66% CyL/+ : 33.33% +/+) reveals that 78.94% of the descendants distribute around the mean with an insignificant deviation of ± 5%. In the control, beside lethal mutations we have also revealed some deleterious ones. Thus, 13.5% of the analyzed individuals have in F_7 an offspring which deviates with 5—10% from the 2 : 1 ratio, while 6.57% of them have a deviation of 10—15% in the favour of *CyL* flies. This means that 20.07% of the control individuals are carrying deleterious mutations which affect the viability of the offspring in various degrees. Therefore, this natural mutagenesis represents a standing selection factor and, implicitly, one of the causes of variations in the genofond of the population.



F i g. 2. *Frequency of deleterinus and lethal recessive mutations in control, after the use of the* CyLPm *test.*



F i g. 3. *Frequency of deleterious and lethal recessive mutations after treatment with captan at agricultural dose (0.25%).*

The agricultural dose (0.25% captan), as we can observe from Fig. 3, induced 2.78% lethal mutations as compared with the 0.99% of the control. From the total individuals that we analyzed, 66.67% have the F_7-offspring in the 2 : 1 ratio, which means that they have no deleterious mutations on the second pair of chromosomes. 16.67% from the F_7-individuals have, however, a deviation of 5—10%, while 5.55% of these individuals show a deviation of 10—15%, as compared to the control.

Referring to the control, we conclude that the process of inducing deleterious mutations is practically negligible.

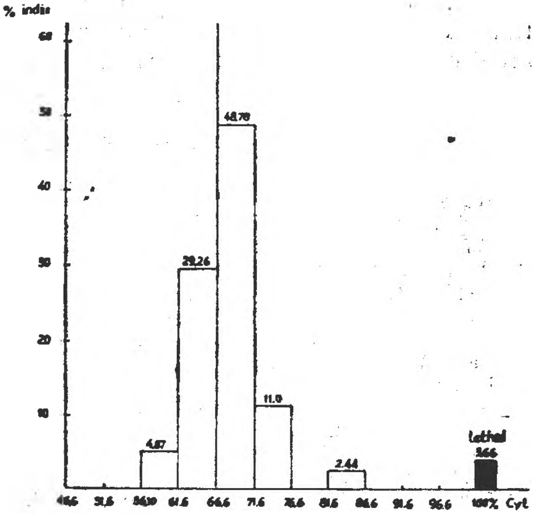


Fig. 4. *Frequency of deleterious and lethal recessive mutations after treatment with captan at* DL_{50}.

The results obtained for the DL_{50} concentration, which is 4 times higher than the agricultural dose, reveal an increase in the frequency of lethal recessive mutations from 0.99% (in control) to 3.66% (Fig. 4). From the total individuals, 78.04% have in F_7 the normal ratio of 2 : 1, *i.e.* whithout deleterious mutations on the second pair of chromosomes. A smaller part of the individuals (11%) have an offspring with a deviation of 5—10%, while 2.74% have a deviation of 15—20%, as compared to the control.

Our results prove that the frequency of the deleterious mutations increases insignificantly as compared to the control even at the concentration of DL_{50}, which is, as we mentioned, about 4 times higher than the agricultural dose.

Significant differences, however, appear concerning the lethal recessive mutations.

Although we did not find any linear relationship between the two captan doses and the mutation frequency, we can assert that the lethal recessive mutations are about three times as higher for the agricultural dose and 4 times as higher for DL_{50} than in the untreated control.

These results are in agreement with those of Legaton *et al.* [7] and Arlett *et al.* [2], who mentioned also a mutagenic effect of captan. A lack of linear correlation between the concentration and the teratogenic effect of captan was noticed by Martin *et al.* [10].

Our results emphasized the same lack of linear relationship, this time between the captan concentration and the lethal recessive mutations.

The low frequency of the deleterious mutations at both doses of captan tested, as compared with that of the lethal mutations, can be explained probably through the break of chromosome arms (noticed also by Legaton *et al.* [7]), which causes great deletions, incompatible with life.

Conclusions. Both doses of captan tested induce a low frequency of deleterious mutations, which do not exceed significantly the control values.

The frequency of the lethal recessive mutations is 2.78% for the agricultural dose of captan, and 3.66% for DL_{50}, as compared to 0.99% for the untreated control.

The increase of the frequency of lethal recessive mutations suggests that the pesticide might break the arms of the chromosomes, causing great deletions, incompatible with survival.

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EPIGÄISCHE SPINNEN UND INSEKTEN EINER BINNENSANDFLÄCHE AUS OLTENIEN

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SUMMARY. — Epigeic Spiders and Insects from an Inland Sand Area in Oltenia. A typical desert-like landscape in the heart of grasslands and agricultural fields, the sand area Obedeanu, at the north of Craiova, is geomorphologically structured in 4 habitats: 1. sand hills, *i. e.* the proper dunes; 2. interdune area; 3. dried bottom of a temporary pond; 4. black locust grove. Each habitat is occupied by a specific community of epigeic spiders and insects. The communities are discriminated significantly by different abundances of certain insect orders, as it was shown by the chi-square test. In the whole investigated area there is a parallelism between the variation of individual numbers in *Heteroptera* and *Homoptera*, and between those of *Heteroptera* and *Diptera*, too. To the contrary, there is an inverse variation between individual numbers of spiders and wasps. In October, the sands are overpopulated with spiders. Species area curves for *Orthoptera* and *Heteroptera* (28 and 87 species, respectively) are well fitted into the Arrhenius equation. The sand area comprises a high total number of individuals (22,090) and a reduced species number, as far as they are identified (672). Individuals are distributed at random, following the Poisson law. The Monard rule does not apply here. The whole sand area is an ecosystem composed of 4 subsystems (habitat + biotic community).

Einleitung. Klimatisch und edaphisch sind Binnensandflächen typisch wüstenartige Lebensstätten [35]. Binnensandflächen kommen im südwestlichen Oltenien, aber auch in der Senke des Jiu-Flusses, an dessen linkem Ufer vor, wobei sich der Sandstreifen aus der Umgebung von Craiova südwärts bis an die Donau erstreckt (Abb. 1). Der nördlichste Ausläufer des Sandgebietes am linken Ufer des Jiu erreicht nördlich von Craiova das Flüßchen Amaradia, ein linker Zufluß des Jiu. Die von uns zoozönologisch untersuchte Binnensandfläche Obedeanu liegt zwischen Craiova und Amaradia. Es ist eine 3—4 km lange, sich in westöstlicher Richtung erstreckende Dünenkette. Die Dünen sind nicht bebaut, aber spontan von Steppenpflanzen bewachsen und von Robinienbeständen umzingelt, welche den Flugsand der Mulden aufhalten. Physiographisch entsprechen die Dünen von Obedeanu dem Dünentyp „Ciupercenii Vechi", einer Sandfläche im Südwesten von Oltenien. Die Sandoberfläche von Obedeanu und Ciupercenii Vechi ist wellenartig, von Rippelmarken geprägt; der Sand ist grobkörnig, die Bodenschicht dünn oder sogar bloß fleckenartig. Manche Dünen sind bogenförmig, als Barchane emporgehoben [10]. Nach einem allgemeinen Gesetz der Sandwüstenbildung zu urteilen [27],

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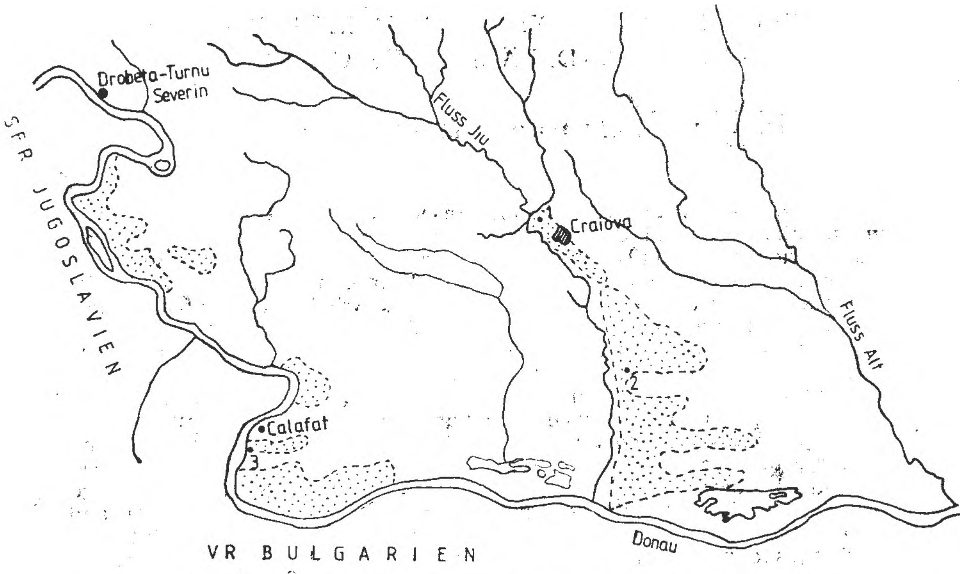


Abb. 1. *Ausdehnung der Sandgebiete in Oltenien* [8].
Punktierte Fläche — Sandgebiet. 1—3 — im Text angeführte Binnendünenlandschaften: 1 — Obedeanu, 2 — Tîmburești, 3 — Ciupercenii Vechi.

entstehen analoge Dünenformgestaltungen in Abhängigkeit von der Windrichtung, wobei demselben Windregime dieselben Dünenformen entsprechen. Die Hauptrichtung des Windes „Austru“, welcher in Oltenien den Sand bewegt, geht vom Südwesten aus.

Das trockenwarme **Eigenklima** der Sandfläche Obedeanu weist bedeutende Jahrestemperaturschwankungen auf. Nach unveröffentlichten Daten der Wetterwarte Craiova für das Jahr 1975 umfassen Unterschiede der Lufttemperaturen in Obedeanu eine Schwingungsweite von 55—70°C, Temperaturen an der Sandoberfläche sogar 55—85°C. Für Tîmburești, einer weiter südlich gelegenen Binnensandfläche in der Jiu-Senke, wurden breitere Schwingungsweiten der Jahrestemperaturen in der Atmosphäre und an der Sandoberfläche festgestellt [38, 39].

Die **Topographie** der Sandfläche ist durch ihre Gliederung in 4 geomorphologisch umrissene Biotope geprägt (Abb. 2): 1. Sandhügel, d. h. die eigentliche Düne; 2. Windmulde (Dünenzwischenraum mit Rippelmarken); 3. Feuchte Mulde (ausgetrockneter Sandboden eines vorübergehenden Tümpels); 4. Robinienbestand. Diese 4 Lebensstätten unterscheiden sich voneinander nicht bloß durch Formgestaltung, sondern auch mineralogisch und pflanzensoziologisch. So ist der Sand von Windmulden und feuchten Mulden feinkörniger und verhältnismäßig humusreicher als der Dünensand [25]. Der Sandboden ist in allen 4 Lebensstätten nahrungsarm.

Die Pflanzendecke nimmt auf Sandhügeln mehr als 50% der Fläche ein, und ist durch das Vorkommen von Weichkraut *(Mollugo cerviana)* gekennzeichnet [8]. Diese, auf dem ganzen Sandgebiet der Jiu-Senke weit verbreitete Pflanze, soll aber in Obedeanu schon verschwunden sein [28].

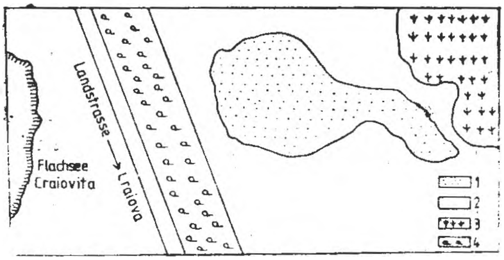


Abb. 2. *Topographie der unterscheidbaren Lebensstätten der epigäischen Arthropoden in der Binnendünenlandschaft Obedeanu bei Craiova.*

1 — Sandhügel (Düne). 2 — Windmulde (Dünenzwischenraum). 3 — Feuchte Mulde (ausgetrockneter Sandboden eines vorübergehenden Tümpels). 4 — Robinienbestand.

Die Arthropoden der Sandfläche Obedeanu wurden bisher nur vorübergehend beachtet [1, 5—7, 9, 20, 23, 32, 33]. Die vorliegende Arbeit stellt einen Versuch dar, die epigäische Arthropodenbevölkerung dieser Sandfläche synökologisch zu schildern.

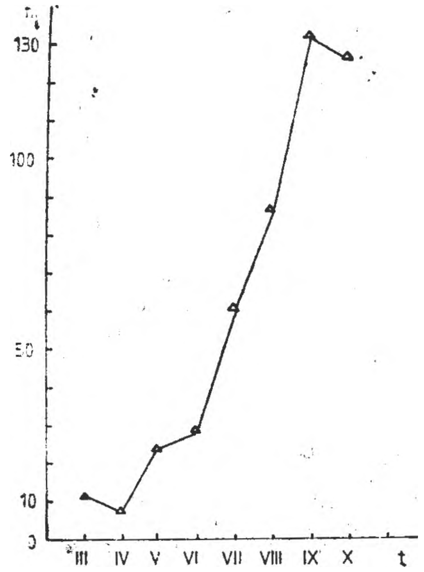
Die Arbeit basiert vor allem auf den Felduntersuchungen des 1. Autors während der Jahren 1963—1977. Der 1. Autor sammelte auch das riesengroße Material von Spinnen und Insekten, teilte es auf Ordnungen und Familien ein, und identifizierte auch einige Arten von Heteropteren und Coleopteren, sowie teilweise auch Arten aus anderen Ordnungen. Der 2. Autor nahm ebenfalls teil an den Felduntersuchungen und identifizierte, bzw. überprüfte die Bestimmungen von Orthopteren, Heteropteren und Neuropteren, die vom 1. Autor durchgeführt wurden, wobei er auch für das Nachprüfen sämtlicher entomologischen Angaben und Artennamen zuständig ist. Der 3. Autor ist für die statistische Verwertung des Materials und für die hier vorgelegte synökologische Schilderung des Epigaions verantwortlich. Das Grundwerk aus dem die hier bearbeiteten Daten entlehnt wurden ist die Doktor-Dissertation des 1. Autors, die von Prof. Dr. Z. Matic als wissenschaftlicher Leiter durchgesehen und am 4.12.1982 der Universität in Cluj-Napoca vorgelegt wurde.

Unser Dank gebührt für Bestimmungen der Arten aus verschiedenen Insektenordnungen mehreren Fachspezialisten: Dr. Lucia Duşa *(Diptera: Bombyliidae)*, Prof. Dr. M. A. Ieniştea *(Coleoptera)*, Dr. Xenia Palade *(Hymenoptera)*, Dipl.-Biol. Carmen Stănescu *(Diptera: Syrphidae)*, Dr. I. Stănoiu *(Lepidoptera)*, Dr. Medeea Weinberg *(Diptera außer Bombyliidae und Syrphidae)*. Für Beisteuerung seltener Literatur sind wir Herrn Prof. Dr. W. Tischler (Kiel, BRD) zu Dank verpflichtet. Für Verfertigung von Strichzeichnungen sind wir Dipl.-Biol. Corina Roşioru und für sprachliche Verbesserung des Textes der Germanistin Dr. Hanni Markel nicht zuletzt dankbar.

Material und Methode. Das Material umfaßt 22 090 Arthropoden, darunter 480 Spinnen und 21 610 Insekten, gesammelt von März bis Oktober 1975. Asseln, Myriapoden und Weberknechte wurden nicht berücksichtigt. Das Material wird z. Zt. im Landesmuseum von Oltenien aufbewahrt.

In jeder der 4 Lebensstätten wurden je 10 zufallsbedingte Aufnahmeflächen, jede von 1 m² Größe erforscht. Das Material wurde hauptsächlich mit Barberfallen und Jermyschen Lichtfallen nach der in der Zoozönologie üblichen Technik [3] gesammelt. Darüber hinaus wurden auch andere Fangtechniken verwendet, z.B. Streifenaufnahmen mit entomologischen Netzen, oder aber auch das Ansammeln mit der Pinzette. Gelegentlich wurden auch Sandproben durch eine feines Netz gesiebt.

Ergebnisse. Ein Vergleich der Individuenzahlen aus den Proben die in verschiedenen Monaten gesammelt waren, zeigte, daß die *Häufigkei-*



A b b. 3. *Häufigkeitsschwankungen der Araneen von März bis Oktober 1975 auf der gesamten Sandfläche Obedeanu.*
t — Zeit (Monate). n_i — Individuenzahlen.

ten verschiedener Ordnungen ungleich auf Monate verteilt sind. **Spinnen** (Araneen) sind beispielsweise im September-Oktober besonders zahlreich (128 Individuen im Oktober, gesammelt auf der gesamten Sandfläche), in anderen Monaten jedoch spärlicher vertreten (Abb. 3). Der Anteil der Araneen an der gesamten Arthropodenbevölkerung, auf das ganze Jahr 1975 berechnet, beträgt jedoch nur 2,17%. Werden die Individuendichten der Araneen im Verhältnis zur Fläche von 1 m^2 berechnet (Tabelle 1), so ergeben sich relativ hohe Werte. Im Oktober erreicht die Individuendichte der Araneen, auf die gesamte Aufnahmefläche von 40 m^2 in allen 4 Lebensstätten bezogen, rund $3{,}20 \cdot m^{-2}$.

Die **Insektenbevölkerung** weist im September höchste Individuenzahlen bezüglich der gesamten Sandfläche auf (Tabelle 2). In der Windmulde erreicht die Variationskurve der Individuenzahlen den Gipfel im Oktober, in anderen Biotopen aber schon im September. Die niedrigsten Individuenzahlen kommen auf der Düne vor, da hier die Windverhältnisse als rauher Selektionsfaktor wirken. Nur im Mai ergaben sich auf der Düne höhere Individuenzahlen als in der Windmulde. Der Robinienbestand, wo mildere Windverhältnisse herrschen, wird schon in März dicht von Insekten besiedelt, ebenfalls die Feuchte Mulde. Im Oktober wird die Häufigkeit der Insekten in der Windmulde 3mal höher als auf der Düne.

Tabelle 1

Individuenzahlen und Individuendichten der Araneen im Oktober 1975

Biotop	Größe der Aufnahmefläche	Individuenzahl	Individuendichte
Düne	10 m^2	11	$1{,}10 \cdot m^{-2}$
Windmulde	10 m^2	16	$1{,}60 \cdot m^{-2}$
Feuchte Mulde	10 m^2	56	$5{,}60 \cdot m^{-2}$
Robinienbestand	10 m^2	45	$4{,}50 \cdot m^{-2}$
Gesamte Sandfläche	40 m^2	128	$3{,}20 \cdot m^{-2}$

Tabelle 2

Häufigkeitsverteilungen des Epigaions von März bis Oktober 1975

Biotop	Monat								
	März	April	Mai	Juni	Juli	August	Sept.	Okt.	Summe
Düne	158	236	391	316	253	520	1261	516	3651
Windmulde	350	332	320	511	817	1220	1207	1754	6511
Feuchte Mulde	569	600	557	516	930	736	1400	975	6283
Robinienbestand	638	315	531	556	624	791	1486	704	5645
Summen	1715	1483	1799	1899	2624	3267	8354	3949	22090

Tabelle 3

Häufigkeitsverteilungen der Insektenordnungen auf den 4 Biotopen der Sandfläche Obedeanu bei Craiova, nach den Aufnahmen während des Jahres 1975

Col. — Coleopteren. Coll. — Collembolen. Dipt. — Dipteren. Het. — Heteropteren. Hom. — Homopteren. Hym. — Hymenopteren. Lep. — Lepidopteren. Od. — Odonaten. Orth. — Orthopteren. Pl. — Planipennia. Thys. — Thysanopteren.

Biotop	Insektenordnung										
	Coll.	Od.	Orth.	Thys.	Het.	Hom.	Hym.	Col.	Pl.	Lep.	Dipt.	Summe
Düne	5	0	131	63	833	1554	186	127	0	9	715	3619
Windmulde	15	0	142	190	1617	2598	222	214	1	23	1418	6440
Feuchte Mulde	8	5	231	295	1106	2061	326	349	6	31	1727	6145
Robinienbestand	0	6	116	170	1141	1581	483	407	12	62	1418	5406
Summen	28	11	620	718	4699	7994	1221	1097	19	125	5278	21610

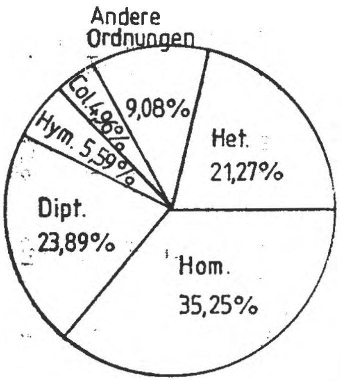


Abb. 4. *Prozentanteil verschiedener Arthropodenordnungen an dem Aufbau des Epigaions auf der gesamten Sandfläche Obedeanu, nach den Aufnahmen im Jahre 1975.*

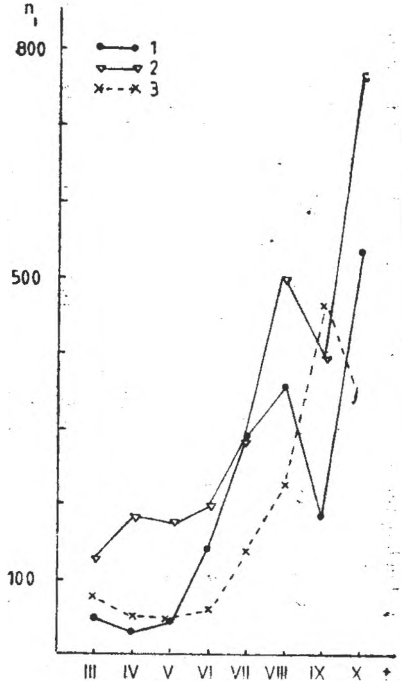


Abb. 5. *Häufigkeitsschwankungen von Heteropteren (1), Homopteren (2) und Dipteren (3) von März bis Oktober 1975 in der Windmulde.*

t — Zeit (Monate). n_i — Individuenzahlen.

Einige Insektenordnungen sind in der Binnendünenlandschaft spärlich vertreten. So wurden Collembolen im August und September auf Dünen, in der Windmulde und Feuchten Mulde gefunden, nicht aber im Robinienbestand. Odonaten sind ebenfalls nicht häufig vertreten. Im Juli und August sind sie in der Feuchten Mulde, im August und September im Robinienbestand durch geringe Individuenzahlen vertreten.

Orthopteren, Heteropteren, Homopteren, Hymenopteren, Coleopteren und Dipteren sind von März bis Oktober in allen 4 Biotopen reichhaltig vertreten (Abb. 4). Die Individuendominanz gehört den Homopteren mit 35,28%, von Dipteren mit 23,89% und Heteropteren mit 21,27% gefolgt. Hymenopteren und Coleopteren weisen geringere Prozentzahlen auf (5,52% und bzw. 4,96%). Der Rest von 9,08% ist auf Orthopteren, Thysanopteren, Lepidopteren, Collembolen, Odonaten und Planipennia verteilt.

Aus Abb. 5 wird ersichtlich, daß in der Windmulde, einem Biotop der am reichsten von Heteropteren und Homopteren besiedelt ist, die Schwankungen der Individuenzahlen beider Ordnungen parallel verlaufen. Beide Variationskurven zeigen 2 Gipfel, einen im August und den anderen im Oktober. In jedem Monat erreichen aber Homopteren höhere Individuenzahlen als Heteropteren. Die Kurve der Individuenfluktuationen von Dipteren weist einen ähnlichen Verlauf auf, ist aber eingipfelig.

Ferner konnten wir ein umgekehrtes Verhältnis zwischen den Häufigkeiten der Araneen und Hymenopteren feststellen (Abb. 6), wobei die niedrigsten Häufigkeiten der Spinnen zeitlich mit den höchsten Häufigkeiten der Hymenopteren übereinstimmen.

Die **Zusammensetzung der Fauna** wurde hier unvollständig ermittelt, da manche Arten unbestimmbar waren und ein Teil des Materials unbearbeitet blieb. Aus dem bearbeiteten Material geht hervor, daß die Sandfläche Obedeanu insgesamt von 672 Insektenarten bewohnt wird. Die Verteilung der hier festgestellten Arten auf Ordnungen zeigt, daß die 1. Stelle den Lepidopteren mit 205 Arten, die 2. den Coleopteren mit 183 Arten gebührt. Es folgen Heteropteren mit 87 Arten, Dipteren mit 66 Arten, Hymenopteren mit 56 und Orthopteren mit 28 Arten. Odonaten sind durch 13 Arten vertreten, Homopteren und Neuropteren von je 8 Arten, Dermapteren von 2 Arten, Ephemopteren, Mantodea, Mecopteren und Trichopteren bloß durch je 1 Art.

Die **ökologische Diversität** wurde für Orthopteren (Tabellen 4—7) und Heteropteren (Tabellen 8—11) berechnet, da nur diese Insektenordnungen in allen Proben bis auf das Artniveau bearbeitet wurden. Mittels der Anwendung der Shannon-Weaver-Formel nach Margalef [24] wurde gezeigt, daß die ökologische Diversität niedrig ist, wobei hohe Individuenzahlen (21 610) mit geringen Artenzahlen (672) vereinigt sind. Die Arten sind durch wenige Individuen vertreten. *Es gibt keine dominante Arten auf der Sandfläche.* Die höchste Individuenzahl (125) erreicht unter den Heteropteren *Trigonotylus pulchellus* in der Windmulde.

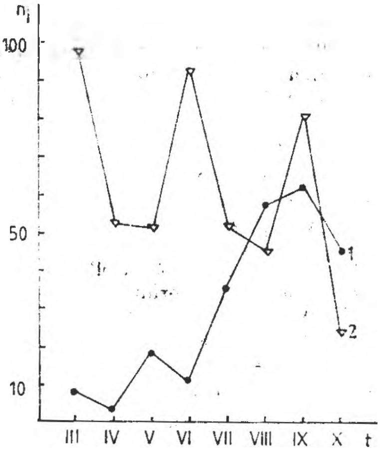


Abb. 6. *Umgekehrtes Verhältnis der Häufigkeitsschwankungen von Hymenopteren (1) und Araneen (2) von März bis Oktober 1975 im Robinienbestand.*

t — Zeit (Monate). n_i — Individuenzahlen.

Tabelle 4

Artenliste der Orthopteren mit Individuenzahlen (n_i) und den dazugehörenden Wahrscheinlichkeiten ($p_i = n_i/N$) mit den Werten der Funktion $p_i \log_2 p_i$ zur Berechnung der ökologischen Diversität $H = \Sigma p_i \log_2 p_i$ auf dem Biotop Düne, nach den Aufnahmen im August 1975

Nr.	Spezies	n_i	p_i	$p_i \log_2 p_i$
1	Acrida hungarica (Herbst)	5	0,185	0,4504
2	Omocestus minutus (Brullé)	2	0,074	0,2780
3	Calliptamus barbarus (Costa)	3	0,111	0,3520
4	Chorthippus loratus (Fisch. W.)	3	0,111	0,3520
5	Acrotylus insubricus (Scop.)	9	0,333	0,5283
6	A. longipes (Charp.)	4	0,148	0,3971
	Summen	$N=27$		$H=2,3578$

Tabelle 5

Artenliste der Orthopteren mit Individuenzahlen (n_i) und den dazugehörenden Wahrscheinlichkeiten ($p_i = n_i/N$) mit den Werten der Funktion $p_i \, log_2 \, p_i$ zur Berechnung der ökologischen Diversität $H = \Sigma \, p_i \, log_2 \, p_i$ auf dem Biotop Windmulde, nach den Aufnahmen im August 1975

Nr.	Spezies	n_i	p_i	$p_i \log_2 p_i$
1	Calliptamus italicus (L.)	1	0,071	0,2709
2	C. barbarus (Costa)	3	0,214	0,4760
3	Dociostaurus brevicollis (Ev.)	1	0,071	0,2709
4	Chorthippus brunneus (Thunb.)	4	0,285	0,5161
5	Acrotylus insubricus (Scop.)	3	0,214	0,4760
6	A. longipes (Charp.)	2	0,142	0,3999
	Summen	$N=14$		$H=2,4098$

Tabelle 6

Artenliste der Orthopteren mit Individuenzahlen (n_i) und den dazugehörenden Wahrscheinlichkeiten ($p_i = n_i/N$) mit den Werten der Funktion $p_i \, log_2 \, p_i$ zur Berechnung der ökologischen Diversität $H = \Sigma \, p_i \, log_2 \, p_i$ auf dem Biotop Feuchte Mulde, nach den Aufnahmen im August 1975

Nr.	Spezies	n_i	p_i	$p_i \log_2 p_i$
1	Tridactylus variegatus (Latr.)	4	0,285	0,5161
2	Tr. pfaendleri Harz	8	0,421	0,5255
3	Tetrix tuerki (Krauss)	1	0,071	0,2709
4	T. bolivari (Saul.)	1	0,071	0,2709
5	T. ceperoi (Bol.)	2	0,142	0,3999
6	Chorthippus albomarginatus (De G.)	1	0,071	0,2709
7	Ch. parallelus (Zett.)	1	0,071	0,2709
8	Pteronemobius concolor Walk.	1	0,071	0,2709
	Summen	$N=19$		$H=2,7960$

Tabelle 7

Artenliste der Orthopteren mit Individuenzahlen (n_i) und den dazugehörenden Wahrscheinlichkeiten ($p_i = n_i/N$) mit den Werten der Funktion $p_i \, log_2 \, p_i$ zur Berechnung der ökologischen Diversität $H = \Sigma \, p_i \, log_2 \, p_i$ auf dem Biotop Robinienbestand, nach den Aufnahmen im Mai 1975

Nr.	Spezies	n_i	p_i	$p_i \log_2 p_i$
1	Calliptamus italicus (L.)	1	0,062	0,2487
2	C. barbarus (Costa)	3	0,187	0,4523
3	Acrida ungarica (Herbst)	2	0,125	0,3750
4	Chorthippus brunneus (Thunb.)	2	0,125	0,3750
5	Ch. albomarginatus (De G.)	2	0,125	0,3750
6	Ch. loratus (Fisch. W.)	5	0,132	0,2487
7	Oedipoda coerulescens (L.)	1	0,062	0,2487
	Summen	$N=16$		$H=2,5990$

Tabelle 8

Artenliste der Heteropteren mit Individuenzahlen (n_i) und den dazugehörenden Wahrscheinlichkeiten ($p_i = n_i/N$) mit den Werten der Funktion $p_i \log_2 p_i$ zur Berechnung der ökologischen Diversität H = $\Sigma\, p_i \log_2 p_i$ auf dem Biotop Düne, nach den Aufnahmen im August 1975

Nr.	Spezies	n_i	p_i	$p_i \log_2 p_i$
1	Exolygus rugulipennis Popp.	4	0,072	0,2733
2	Trigonotylus pulchellus (Hahn.)	10	0,181	0,4463
3	Tr. ruficornis (Geoffr.)	10	0,181	0,4463
4	Deraeocoris punctulatus Fall.	1	0,018	0,1043
5	Chlamydatus pullus Reut.	2	0,036	0,1727
6	Stenodema calcaratum (Fall.)	2	0,036	0,1727
7	Notostira elongata (Geoffr.)	3	0,054	0,2774
8	Polymerus cognatus (Fieb.)	2	0,036	0,1727
9	Nabis pseudoferus Rem.	2	0,036	0,1727
10	Nysius ericae (Schill.)	1	0,018	0,1043
11	Cymus melanocephalus Fieb.	2	0,036	0,1727
12	Geocoris pubescens (Jak.)	2	0,036	0,1727
13	Oxycarenus pallens (H.—Sch.)	4	0,072	0,2733
14	Brachycarenus tigrinus (Schill.)	2	0,036	0,1727
15	Chorosoma schillingi (Schill.)	7	0,127	0,3781
16	Eurydema ornata (L.)	1	0,018	0,1043
	Summen	$N = 55$		$H = 3,4421$

Tabelle 9

Artenliste der Heteropteren mit Individuenzahlen (n_i) und den dazugehörenden Wahrscheinlichkeiten ($p_i = n_i/N$) mit den Werten der Funktion $p_i \log_2 p_i$ zur Berechnung der ökologischen Diversität H = $\Sigma\, p_i \log_2 p_i$ auf dem Biotop Windmulde, nach den Aufnahmen im August 1975

Nr.	Spezies	n_i	p_i	$p_i \log_2 p_i$
1	Adelphocoris lineolatus (Goeze)	1	0,003	0,0251
2	Exolygus rugulipennis Popp.	25	0,075	0,2803
3	Trigonotylus pulchellus (Hahn.)	125	0,382	0,5303
4	Tr. ruficornis (Geoffr.)	55	0,168	0,4323
5	Deraeocoris punctulatus Fall.	22	0,067	0,2613
6	Campylomma verbasci Mey.—D.	2	0,006	0,0443
7	Chlamydatus pullus Reut.	12	0,036	0,1727
8	Stenodema calcaratum (Fall.)	9	0,027	0,1407
9	Notostira elongata (Geoffr.)	31	0,094	0,3207
10	Nabis punctatus Costa	12	0,036	0,1727
11	N. pseudoferus Rem.	20	0,061	0,2461
12	Pyrrhocoris apterus (L.)	1	0,003	0,0251
13	Nysius senecionis (Schill.)	2	0,006	0,0443
14	Cymus melanocephalus Fieb.	3	0,009	0,0612
15	Geocoris megacephalus (Rossi)	2	0,006	0,0443
16	Chorosoma schillingi (Schill.)	3	0,009	0,0612
17	Holcostethus vernalis (Wolff)	1	0,003	0,0251
18	Dolycoris baccarum (L.)	1	0,003	0,0251
	Summen	$N = 327$		$H = 2,9128$

Tabelle 10

Artenliste der Heteropteren mit Individuenzahlen (n_i) und den dazugehörenden Wahrscheinlichkeiten ($p_i = n_i/N$) mit den Werten der Funktion $p_i \log_2 p_i$ zur Berechnung der ökologischen Diversität $H = \Sigma\, p_i \log_2 p_i$, auf dem Biotop Feuchte Mulde, nach den Aufnahmen im August 1975

Nr.	Spezies	n_i	p_i	$p_i \log_2 p_i$
1	Saldula pallipes (F.)	2	0,018	0,1043
2	Orius niger Wolff	1	0,009	0,0612
3	Adelphocoris lineolatus (Goeze)	3	0,028	0,1444
4	Exolygus rugulipennis Popp.	34	0,317	0,5254
5	Trigonotylus pulchellus (Hahn.)	7	0,065	0,2563
6	Tr. ruficornis (Geoffr.)	10	0,093	0,3187
7	Halticus apterus (L.)	5	0,046	0,2043
8	Chlamydatus pullus Reut.	4	0,037	0,1760
9	Notostira elongata (Geoffr.)	12	0,112	0,3537
10	Stenodema calcaratum (Fall.)	5	0,046	0,2043
11	Polymerus cognatus (Fieb.)	2	0,018	0,1043
12	Prostemma guttula (F.)	2	0,018	0,1043
13	Nabis punctatus Costa	5	0,046	0,2043
14	N. pseudoferus Rem.	6	0,056	0,2329
15	Cymus melanocephalus Fieb.	4	0,037	0,1760
16	Geocoris megacephalus (Rossi)	1	0,009	0,0612
17	Chorosoma schillingi (Schill.)	2	0,018	0,1043
18	Codophila varia (F.)	2	0,018	0,1043
	Summen	$N = 107$		$H = 3{,}4402$

Tabelle 11

Artenliste der Heteropteren mit Individuenzahlen (n_i) und den dazugehörenden Wahrscheinlichkeiten ($p_i = n_i/N$) mit den Werten der Funktion $p_i \log_2 p_i$ zur Berechnung der ökologischen Diversität $H = \Sigma\, p_i \log_2 p_i$ auf dem Biotop Robinienbestand, nach den Aufnahmen im August 1975

Nr.	Spezies	n_i	p_i	$p_i \log_2 p_i$
1	Adelphocoris lineolatus (Goeze)	6	0,019	0,1086
2	Exolygus rugulipennis Popp.	74	0,245	0,4971
3	Trigonotylus pulchellus (Hahn.)	33	0,109	0,3485
4	Tr. ruficornis (Geoffr.)	20	0,066	0,2588
5	Campylomma verbasci Mey.—D.	15	0,049	0,2132
6	Chlamydatus pullus Reut.	3	0,009	0,0612
7	Stenodema calcaratum (Fall.)	9	0,029	0,1481
8	Notostira elongata (Geoffr.)	31	0,102	0,3359
9	Polymerus cognatus (Fieb.)	6	0,019	0,1086
10	P. vulneratus (Panz.)	19	0,063	0,2513
11	Nabis pseudoferus Rem.	63	0,209	0,4720
12	Pyrrhocoris apterus (L.)	3	0,009	0,0612
13	Cymus melanocephalus Fieb.	2	0,006	0,0443
14	Brachycarenus tigrinus (Schill.)	2	0,006	0,0443
15	Corizus hyoscyami (L.)	1	0,003	0,0251
16	Chorosoma schillingi (Schill.)	2	0,006	0,0443
17	Aelia acuminata (L.)	1	0,003	0,0251
18	Eusarcoris aeneus (Scop.)	1	0,003	0,0251
19	Holcostethus vernalis (Wolff)	2	0,006	0,0443
20	Dolycoris baccarum (L.)	3	0,009	0,0612
21	Eurydema ornata (L.)	5	0,016	0,0955
	Summen	$N = 301$		$H = 3{,}2737$

Das **Verteilungsmuster** der Heteropteren wurde für den Biotop Düne nach der üblichen statistischen Technik [40] berechnet. Dieses fügt sich (Tabelle 12 und Abb. 7) in das Poisson-Modell ein, wobei sich ergibt, daß es eine zufallsbedingte, nicht-ansteckende Verteilung ist.

Die Verschiedenheit der Zoozönosen aus den 4 topographisch klar umgrenzten Biotopen der Dünenlandschaft, wurde durch die Verwertung der statistischen Daten in der χ^2 — Verteilung [40] geprüft, wobei es sich herausstellte, daß die beobachteten Unterschiede der Häufigkeiten der Insektenordnungen für diese 4 Biotope signifikant sind, da dem berechneten Wert von $\chi^2 = 2\,943{,}48$ vereinbart mit 30 Freiheitsgraden bloß eine Wahrscheinlichkeit von $P<0{,}001$ bzw. $P<0{,}1\%$ entspricht (Tabelle 13). Daraus ergibt sich, daß jeder Biotop seine eigene, spezifische Zoozönose innehat.

Das **Verhältnis der Individuenzahlen zur Flächenzunahme** wird hier für Orthopteren und Heteropteren der Windmulde durch empirische Arealkurven dargestellt (Abb. 8 und 9). Es ergibt sich, daß die Zunahme der Individuenzahlen linear im Verhältnis zur Flächenzunahme verläuft. Dagegen befolgt die Zunahme der Artenzahlen von Orthopteren und Heteropteren (Abb. 10 und 11) die Form einer Parabel, wobei sich die Artenarealkurve in die Arrheniuskurve [2, 18] einfügt.

Tabelle 12

Statistische Unterlagen für das Verteilungsmuster der Heteropteren auf dem Biotop Düne im August 1975

x_i — Individuenzahl auf einer Probefläche. f_i — entsprechende Häufigkeit der Probeflächen mit 0, 1, 2, ..., 13 Individuen. P_i — berechnete Häufigkeit nach Poisson [40].

x_i	f_i	$f_i x_i$	P_i
0	0	0	0,0370
1	0	0	0,2072
2	3	6	0,58015
3	1	3	1,08294
4	2	8	1,51606
5	1	5	1,69798
6	0	0	1,58470
7	0	0	1,2677
8	1	8	0,88739
9	0	0	0,5521
10	0	0	0,3091
11	0	0	0,1573
12	1	12	0,0734
13	1	13	0,0316
Summe	10	55	

Parameter der Verteilung:

$\bar{x} = \lambda = 5{,}5$ = Mittelwert der Poisson—Verteilung

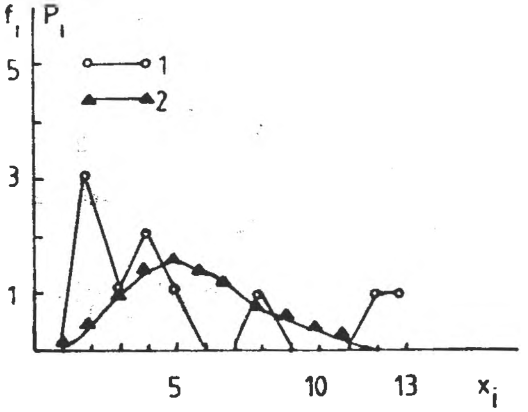


Abb. 7. *Verteilungsmuster der Heteropteren auf dem Biotop Düne, nach den Aufnahmen im August 1975.*

1 — empirische Verteilung. 2 — Poisson—Verteilung.

Tabelle 13

χ^2 — Verteilung der Insekten auf den 4 Biotopen der Sandfläche Obedeanu bei Craiova, während des Jahres 1975

Col. — Coleopteren. Coll. — Collembolen. Dipt. — Dipteren. Het. — Heteropteren. Hom. — Homopteren. Hym. — Hymenopteren. Lep. — Lepidopteren. Od. — Odonaten. Orth. — Orthopteren. Pl. — Planipennia. Thys. — Thysanopteren. f_i — beobachtete Verteilung. φ_i — berechnete Verteilung (in Klammern) nach dem χ^2 — Verfahren.

Biotop		Insektenordnung											
		Coll.	Od.	Orth.	Thys.	Het.	Hom.	Hym.	Col.	Pl.	Lep.	Dipt.	Summe
Düne	f_i	5	0	131	63	835	1551	180	127	0	9	715	3619
	φ_i	(4,68)	(1,85)	(103,83)	(120,24)	(786,93)	(1305,25)	(204,43)	(183,71)	(3,18)	(20,93)	(887,44)	
Windmulde	f_i	15	0	142	190	1617	2598	222	214	1	23	1418	6440
	φ_i	(8,34)	(3,27)	(184,76)	(213,97)	(1400,34)	(2382,29)	(363,87)	(326,91)	(5,66)	(37,25)	(2415,34)	
Feuchte Mulde	f_i	8	5	231	295	1106	2061	326	349	6	31	1727	6145
	φ_i	(7,96)	(3,12)	(176,30)	(204,16)	(1336,20)	(2216,29)	(347,20)	(311,94)	(5,40)	(35,54)	(1500,89)	
Robinienbestand	f_i	0	6	116	170	1141	1581	493	407	12	62	1418	5406
	φ_i	(7,02)	(2,77)	(155,11)	(179,69)	(1176,03)	(2090,17)	(305,46)	(276,44)	(4,76)	(30,28)	(1879,40)	
Teilsummen		28	11	620	718	4699	7994	1221	1097	19	125	5278	21610

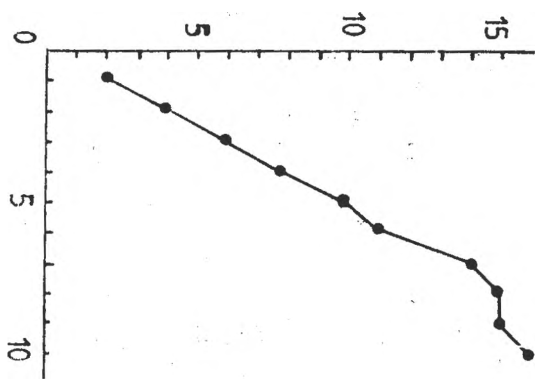


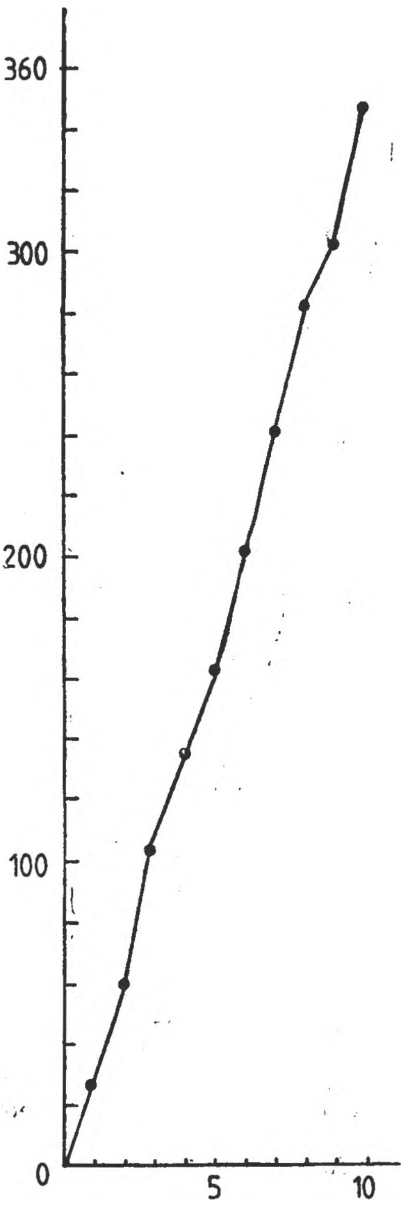
Abb. 8. *Arealkurve der Individuenzunahme der Orthopteren im Biotop Windmulde, nach den Aufnahmen im August 1975.*

Abszisse — Fläche in m². Ordinate — Abundanz.

Diskussion. Die angeführten Ergebnisse leiten zu einigen Fragen weiter: Warum stellen die Spinnen nur 2,17% der Gesamtbevölkerung von epigäischen Arthropoden dar? Wie erklärt sich das umgekehrte Individuenzahlenverhältnis von Araneen und Hymenopteren sowie die Übervölkerung an Spinnen im Oktober? Welche biozönotische Gestaltung ist der Sandfläche Obedeanu im Vergleich zu anderen Dünenlandschaften eigen?

Die geringen **Individuenzahlen der Spinnen** auf der nahrungsreichen Sandfläche sind womöglich durch spinnenfressende Amphibien und Reptilien verursacht, welche im Dünengelände nicht spärlich sind.

Auf der Sandfläche Obedeanu haben wir folgende Arten von Amphibien und Reptilien beobachtet: Rotbauchunke *(Bombina bombina* (L.)), Wechselkröte *(Bufo viridis* Laur.), Laubfrosch *(Hyla arborea* (L.)), Seefrosch *(Rana ridibunda* Pall.) und Taurische Eidechse *(Podarcis taurica* (Pall.)). Alle diese Arten sind Insekten- und Spinnenverzehrer. Am häufigsten sind hier Wechselkröte und Taurische Eidechse vertreten. *P. taurica* kommt in Obedeanu mit einer Individuendichte von 1 Exemplar auf 100 m Strecke vor [11] wobei sie hier ein ständiges Faunenelement ist [12]. Ihre Biomasse erreicht eine Größe von 0,003628 g.m^{-2}, während das Epigaion von Arthropoden 1,80 g.m^{-2} Biomasse erlangt [14]. Nach unseren Angaben ist im Juni die Individuendichte des Epigaions 2 109/40=52,47. m^{-2}. Im Nahrungsspektrum der Taurischen Eidechse aus Obedeanu stellen Araneen mit 21,4% den größten Anteil dar [13]. Diese Eidechsenart ernährt sich auch anderswo, z.B. auf der Krim, hauptsächlich von Spinnen [31]. Da Spinnen eine leicht greifbare Beute sind, bilden sie in der Regel einen wichtigen Nahrungsbestandteil der Taurischen Eidechse [19], welche demgemäß als Spinnenvertilger angesehen werden kann. Spinnen können außergewöhnliche Individuendichten dort erreichen, wo spinnenvertligende Gipfelräuber fehlen, so z. B. auf winzigen Inseln der Bahamas wo zufälligerweise Echsen abwesend sind [30]. Ferner erlangen Spinnen hohe Individuendichten auch auf alpinen Matten des Altai, wo es keinen Nahrungsüberfluß gibt [4], aber wohl auch keine spinnenfressende Echsen. Auch an der Ostsee, auf den Küstendünen der Kieler Förde erreichen Spinnen verhältnismäßig hohe Individuenzahlen, obwohl dort auch Spinnenvertilger anwesend sind, beispielsweise Kreuzkröte *(Bufo calamita* Laur.), Erdkröte *(B. bufo* (L.)), Moor-



A b b. 9. *Arealkurve der Individuenzunahme der Heteropteren im Biotop Windmulde, nach den Aufnahmen im August 1975.*

Abszisse — Fläche in m². Ordinate — Abundanz.

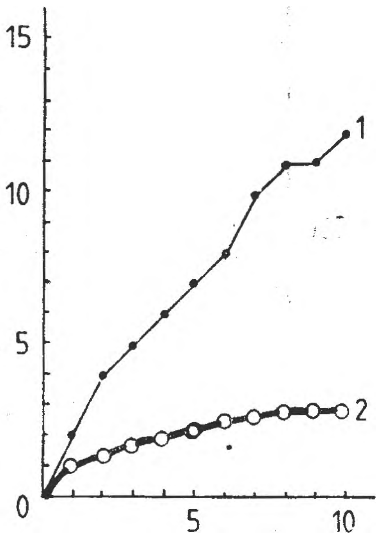


Abb. 10. *Artenarealkurve der Orthopteren im Biotop Windmulde, nach den Aufnahmen im August 1975.*

Abszisse — Fläche in m². Ordinate — Artenzahl.

1 — empirische Kurve. 2 — Arrheniuskurve.

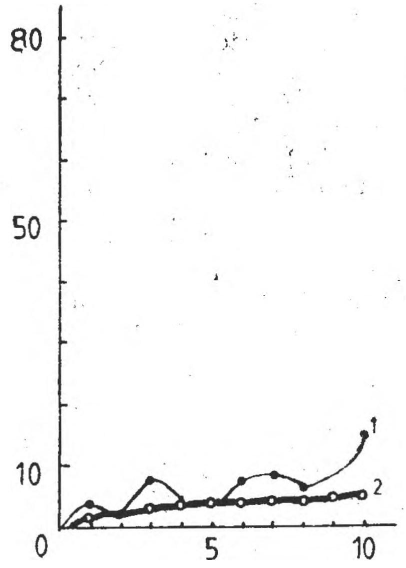


Abb. 11. *Artenarealkurve der Heteropteren im Biotop Windmulde, nach den Aufnahmen im August 1975.*

Abszisse — Fläche in m². Ordinate — Artenzahl.

1 — empirische Kurve. 2 — Arrheniuskurve.

frosch *(Rana arvalis* (Nilss.) und Mooreidechse *(Lacerta vivipara* Jacquin) [29].

Außer dem Druck von Gipfelräubern, kommt auf der Sandfläche Obedeanu auch das *umgekehrte Verhältnis von Araneen und Hymenopteren* als mitwirkender Hemmungsfaktor der Individuenzunahme von Spinnen in Frage. Einige Wespen, z.B. Pompiliden und Spheciden greifen oft Spinnen an, was möglicherweise zur Herabsetzung der Individuenzahlen von Spinnen führt.

Die Übervölkerung an Spinnen im Oktober wird wahrscheinlich von dem Auftritt einer neuen Generation und von der Zuwanderung aus benachbarten Kulturfeldern verursacht, wo im Oktober Gras- und Krautschicht schon entfernt werden, während auf der Düne und in Mulden die Vegetation noch Unterschlüpfe und Nahrung gewährt. Die Population der Taurischen Eidechse wirkt dann nicht mehr als Hemmungsfaktor für Araneen, da sie sich schon größtenteils Ende September in Winterquartiere zurückzieht [11]. Die Individuendichte der Spinnen auf 1 m^2 Sandfläche bezogen erreicht 3,20, eine Zahl die höher als die Individuendichte von Spinnen, $1{,}2 . m^{-2}$ auf einem Grasland in England [15] ist.

Die Gestaltung des Epigaions, wie diese oben auf Grund der Prozentanteile verschiedener Insektenordnungen geschildert wurde, zeigt einige Ähnlichkeiten und Unterschiede gegenüber Insektenbevölkerungen aus anderen Binnendünenlandschaften Olteniens. So erlangen auf der Sandfläche Obedeanu Heteropteren eine hohe Artenzahl (87), was für diese auf eine optimale Lebensstätte daselbst deutet. Dasselbe ist auch für die weiter südlich gelegene Sandfläche Tîmbureşti bekannt [5]. Was die Artenzahl verschiedener Ordnungen anbelangt, so unterscheidet sich die Sandfläche Obedeanu von der Sandfläche Tîmbureşti. Während in Obedeanu die höchste Artenzahl den Lepidopteren gehört, stehen in Tîmbureşti Coleopteren mit 99 Arten (rund 58% der Gesamtzahl der Arten) an erster Stelle [7].

Ein Vergleich mit anderen Binnendünenlandschaften und Küstendünen Europas zeigt, daß die Mehrheit der Insektenarten innerhalb der Sandflächen bloß einen engen Verbreitungsraum einnehmen. So ist beispielsweise *Acrotylus insubricus* nicht auf der ganzen Sandfläche zu finden, sondern nur in gewissen Punkten, bzw. in der Feuchten Mulde und im Robinienbestand. Die Wanderheuschrecke *(Calliptamus barbarus)* und *A. longipes* kommen ebenfalls nur auf Dünen vor. Das Vorkommen von *Chorthippus albomarginatus* ist nur auf den Robinienbestand beschränkt, jenes von *Tetrix pfaendleri, T. ceperoi* und *Pteronemobius concolor* nur auf feuchte Mulden. Auf Küstendünen der Halbinsel Hel (Polen) an der Ostsee wurde für einige Insektenarten ebenfalls eine enge, kleinräumige Verbreitung festgestellt [16]. In Obodeanu gehören zur der echten eremischen Fauna außer *Calliptamus barbarus* und *Acrotylus longipes* noch *Acrida ungarica* und *Omocestus minutus* an. Auf Küstendünen in Südfinnland ermittelte Krogerus [22] zahlreiche Arten mit begrenzten ökologischen Verteilung, also stenotope Arten. Die meisten Arten gehören jedoch in Südfinnland den Dipteren (418) an, wonach Hymenopteren mit 388 Arten, Lepidopteren mit 216 und „Hemipteren" (Heteropteren+Homopteren) mit 147 Arten folgen. Auf einer Binnendüne unweit Cedynia, am rechten Ufer der Oder (Polen, Woiwodschaft Szczecin (= Stettin)), ergaben sich Coleopteren mit 251 Arten als dominante Gruppe [17].

Die Binnendünenlandschaft aus der Umgebung von Craiova stellt eine „Insel auf dem Kontinent" dar, welche aber mit Arten aus nahe liegenden trockenwarmen Grasfluren besiedelt wird. Die extremen Lebensbedingungen der Binnendünenlandschaft verhindern das Ansiedeln von Ubiquisten, begünstigen aber eremische und xerophile Arten. Deren Anzahl ist aber nicht groß, die Gesamtanzahl der Individuen jedoch hoch. Eine Einwanderung aus anderen Wüstengebieten bringt nur wenige Arten bei, da Oltenien weit entfernt von dem ausgedehnten Wüstengürtel der Paläarktis liegt. Die geringe Artenzahl in Obedeanu gegenüber der hohen Individuenzahl wird dadurch teilweise erklärt. Wir vermuten jedoch, daß diese Binnendünenlandschaft mehr als 672 Insektenarten beherbergt, da, wie oben schon gesagt, nicht das sämtliche Material bearbeitet wurde.

Das von Thienemann [34] hervorgehobene umgekehrte Zahlenverhältnis zwischen Arten- und Individuenmenge für extreme Biotopen, wurde auch für epigäische Arthropoden der Binnendünenlandschaft westlich von Neumünster (Schleswig-Holstein) festgestellt [37]. Ansonsten weisen Binnendünen in Mitteleuropa reichhaltigere Lebensgemeinschaften als Küstendünen auf [17, 36, 37]. Es ist ferner eine allgemeine Erscheinung, daß extreme Lebensstätten die ökologische Diversität herabsetzen [41]. Nach der Monard-Regel [26] soll in einförmigen, engbegrenzten Lebensstätten nur je eine Art aus einer Gattung vorhanden sein*. Demgemäß sollen auf Binnensandflächen keine synpatrische Arten derselben Gattung vorkommen. Die Monard-Regel trifft auf den Küstendünen von Südfinnland zu [22]. Das ist aber auf der Sandfläche Obedeanu nicht der Fall. So kommen unter den 28 Orthopterenarten einige Paare von synpatrischen Arten vor, z.B. *Tridactylus variegatus* und *Tr. pfaendleri; Tetrix subulata* und *T. bolivari; Chorthippus albomarginatus* und *Ch. loratus.* Die trockenwärmeliebende Gattung *Acrotylus* ist hier durch 2 Arten vertreten: *A longipes* und *A. insubricus.*

Die **Physiognomie** der Arthropoden ist auf der Sandfläche von den extremen Lebensbedingungen geprägt. Genau so wie in Sandwüsten suchen auch auf Binnendünen zahlreiche Arthropoden vor der Wärme zur Mittagszeit im Sandinneren Schutz. Im feinkörnigen Sand (Körner von 0,2 mm Diameter) graben sich Wespen *(Sphex, Bembix)* und Larven von Cicindelen ein. Im grobkörnigen Sand senken sich vorübergehend Orthopteren *(Acrotylus),* Larven von Myrmeleoniden, sowie Blatthornkäfer *(Lamellicornia)* ein.

Von den 672 hier sicher bestimmten Arten sind bloß 72 (=10,56%) echte Wüstentiere. Einige davon wurden oben schon angeführt. Hierher gehören noch der Apide *Nomioides minutissima* und einige Grabwespen *(Sphex maxillosus, Bembix oculata)* sowie Großfalter *(Dysauxes flammula* und *Cochliatheca crenullela)* an. Solche wärmeliebende, sandgebundene (eremische) Formen kommen nur in Wüsten vor. Die hier erwähnten eremische Grabwespen gehören auch in anderen Binnendünenlandschaften Mitteleuropas zu echten Dünentieren an [17].

Wir haben bei wenigen eremischen Insekten verschiedene Färbungen und Zeichnungen gefunden, welche vor räuberischen Kröten und Eidechsen Tarnung gewähren. So sind manche Orthopteren gelb- bis braunfärbig *(Chorthippus brunneus).* Tischler [35, 36] hat hervorgehoben, daß in Sandwüsten manche Insekten, dank ihrer Streichhölzerform fast unbemerkbar sind, da sie sich an Grashalmen und -blättern heften. Dasselbe haben wir hier bei einigen Heteropteren *(Chorosoma, Neides, Stenodema)* beobachtet.

Die Physiognomie der Insektenbevölkerung der Sandfläche Obedeanu ist folglich jener der Insektenwelt aus Sandwüsten ähnlich. Das erklärt sich teilweise aus der Ähnlichkeit der abiotischen Lebensbedingungen. Das Vorhandensein einiger eremischen Arten, z. B. *Acrotylus longipes* ist aber nicht durch Konvergenz bei der Lebensformenausbildung erklärbar, sondern ist aus der rezenten Faunengeschichte ableitbar. *A. lon-*

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* Der französische Originaltext lautet: „Dans un milieu uniforme, restreint dans le temps et l'espace, ne tend à subsister qu'une seule espèce par genre." [26, p. 222].

gipes und *A. insubricus* stammen zweifelsohne aus der eremischen Fauna des Nordafrikanischen Wüstenbereiches, da sie streng an Sandflächen gebunden sind [21]. Es läßt sich aber schwer entscheiden, ob diese Orthopteren im Sandgebiet von Oltenien als Relikte einer wärmeren, postglazialen Trockenzeit zu betrachten sind, oder erheblich jüngere, von dem Südwesten aus Nordwestafrika durch den Austrul-Wind hergewehten Zuwanderer darstellen. Der Bläuliche Grashüpfer *(Oedipoda coerulescens)* ist aber keine eremische, sondern im Allgemeinen an trockenwarme Grasfluren gebundene Form. Auf der Sandfläche Obedeanu ist es eine seltene Art. Die Spezies wurde im Sandgebiet links des Jiu—Flusses, aber auch in der Gebirgslandschaft Parîng (Südkarpaten), bei 1 500 m ü. M. nachgewiesen [5].

Schließlich bleibt noch zu ermitteln, ob die gesamte Sandfläche Obedeanu ein einziges, einheitliches Ökosystem darstellt. Die 4 topographisch umgrenzten Biotope beherbergen, wie wir es oben schon erwähnt haben, jeder eine besondere Zoozönose, bzw. Artenkombination im Epigaion. Die Düne mit ihren Entomofauna oder die Windmulde zwischen den Dünen bilden aber keine gesonderte Ökosysteme. Die gesamte Sandfläche ist durch die Tätigkeit der räuberischen Wechselkröten und Taurischen Eidechsen in einen einheitlichen Stoff- und Energiefluß vereinigt. Es gibt keine Ausbreitungsschranken für Insekten zwischen den 4 Biotopen der Sandfläche. Deswegen wird hier die Meinung geäußert, daß die Sandfläche Obedeanu ein einheitliches Ökosystem darstellt, das aus 4 Teilsystemen (Biotop+Biozönose) gebaut ist. Somit erfaßt das Ökosystem Sandfläche nicht bloß eine Biozönose, sondern 4 Biozönosen. Das Ökosystem „Sandfläche Obedeanu" ist in eine höhere Einheit, das Geosystem „Sandgebiet Olteniens links des Jiu—Flusses" integriert.

Schlußfolgerungen. Die Sandfläche Obedeanu aus der Umgebung von Craiova besteht aus 4 geomorphologisch umrissenen Lebenssätten (Biotopen): Düne, Windmulde, Feuchte Mulde, Robinienbestand. In der gesamten Arthropodenbevölkerung des Epigaions stellen Araneen bloß 2,17% dar, was sich aus dem Vorhandensein von spinnenvertilgenden Wechselkröten *(Bufo viridis)* und Taurischen Eidechsen *(Podarcis taurica)*, sowie durch räuberische Tätigkeit von Grabwespen erklären läßt. Im Oktober gelangen Spinnen zur Übervölkerung, da dann *P. taurica* schon größenteils die Winterruhe angetreten hat und auch Spinnen aus den benachbarten Kulturfeldern die Sandfläche überschwemmen.

Die Zusammensetzung der Entomofauna weist auf der Individuenebene die Dominanz von Homopteren (35,28%) auf, gefolgt von Dipteren (23,89%) und Heteropteren (21,27%). Auf der Spezies-Ebene sind Lepidopteren mit 205 Arten auf der 1. Stelle. Die Variationskurven der Individuenzahlen von Heteropteren und Homopteren, sowie von Heteropteren und Dipteren verlaufen parallel. Die Variationskurven von Heteropteren und Homopteren sind zweigipfelig, jene von Dipteren aber eingipfelig. Arealkurven von Individuenzahlen der Orthopteren und Heteropteren verlaufen linear. Artenarealkurven sind aber von der Form einer Parabel und fügen sich in die Arrheniuskurve ein.

Durch die Anwendung der χ^2-Verteilung wurde gezeigt, daß die 4 Lebensstätten ihre eigene Zoozönose innehaben. Das Verteilungsmuster befolgt ein Poisson-Modell. Die ökologische Diversität ist niedrig. Die Gesamtzahl der Insekten (21 610 Individuen) ist hoch, die Artenzahl, soweit ermittelt (672), dagegen gering. Die meisten Arten weisen enge, kleinräumige Areale auf. Dominante Arten gibt es nicht. Die Monard-Regel trifft hier nicht zu. Die Physiognomie der Insektenwelt hat ein typisch wüstenartiges Gepräge. Auf der Sandfläche kommen auch einige echte Wüstenbewohner vor. Die gesamte Sandfläche stellt ein einheitliches Ökosystem dar, das aus 4 Teilsystemen (4 Einheiten Biotop+Biozönose) besteht.

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HEPATIC ULTRASTRUCTURAL ASPECTS OF ETHIONINE-INTOXICATED RATS TREATED WITH Mg^{2+} AND Ca^{2+} ORGANIC COMPLEXES

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SUMMARY. — Hepatocyte ultrastructure from ethionine-intoxicated rats shows a certain degree of recovery after a treatment with various Mg organic salts. Intoxication with ethionine usually produces lipid accumulation in the cells, strong glycogen depletion, deformation and decrease in the number of mitochondria and in the quantity of the rough endoplasmic reticulum, appearance of intracellular lysis foci, slight swelling of the nucleus and a state of biliary stasis. All these negative phenomena are almost completely removed if after ethionine intoxication the rats are treated with a solution of Mg-glutamogluconate. Other two salts, Ca-Mg-gluconolactate and Mg-glutamolactate also have favourable effects, but to a smaller extent than Mg-glutamogluconate.

Although not perfectly elucidated, Ca^{2+} and Mg^{2+} play an essential role in the cellular energetic processes as well as other fundamental functions of the cell. Thus, the importance of the Ca^{2+} as an intracellular messenger, which was first recognized in the functioning of the nerve and muscle has now been extended to many other processes, including hormonal secretion and effects, anion transport, regulation of various enzymatic reactions etc. (see, for exemple [3, 4, 11, 17, 19]). Mg^{2+}, on the other hand, is involved in protein and nucleic acid synthesis, lipogenesis, glycolysis and respiration [9, 10, 15, 16], as well as in the regulation of ion transport in mitochondria. Mg^{2+} participates not only in the regulation of the monovalent cation fluxes, such as those of the K^+ and H^+ [7, 13] but also those of the Ca^{2+} ion itself [1, 3, 14].

These effects and the complex interrelationships between Ca^{2+} and Mg^{+2} may explain the importance of these ions in the bioenergetic processes of the cell and constitute the rationale behind their utilization, in the form of organic salts, for the treatment of liver injury, following experimenal intoxications in laboratory animals [5, 6, 20, 22—25] or several forms of hepatitis in man [8, 18, 25, 26].

In previous papers we have reported beneficial effects of the treatment with Ca-Mg-gluconolactate and/or Trofopar (a peptidie extract also containing Ca^{2+} and Mg^{2+}) on several bioenergetic indices of liver mitochondria isolated from allyl alcohol-intoxicated rats [22, 23] or on the hepatocyte ultrastructure [6]. More recently, we have undertaken a more extensive study of the effects of several organic complexes containing Mg^{2+} or Mg^{2+} plus Ca^{2+} on both the functions and ultrastructure of isolated mitochondria and on the hepatocyte ultrastructure of ethio-

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nine-intoxicated rats. The results obtained with isolated mitochondria have already been published [21], whereas the present paper is dedicated to the problem of hepatocyte ultrastructure. However, since the same animals served for both mitochondrial preparations and hepatic sections for electron microscopy, frequent correlations will be attempted between the results obtained on the two types of preparations and also between the ultrastructural and functional aspects.

Materials and methods. The experiments were performed on male Wistar rats of about 130 g, kept on a normal diet. The following groups of animals were established:

1. Control group, in which each animal received daily 0.5 ml distilled water for three consecutive days. The water was given through gavage, a method also used for the administration of the ethionine and the Mg^{2+} complexes in the other groups;
2. Group intoxicated with ethionine (10 mg/100 g body weight of each animal) for three consecutive days;
3. Group intoxicated with ethionine (as 2) and treated with a 5% solution of Ca-Mg-gluconolactate (0.5 ml/100 g body weight) at 0, 6, 24 and 30 hours from the moment of the administration of the last ethionine dose;
4. Group intoxicated with ethionine and treated with a 5% solution of Mg-glutamolactate, in a way similar to 3;
5. Group intoxicated with ethionine and treated with a 5% solution of Mg-glutamogluconate, in a way similar to 3 and 4.

The rats were decapitated after stunning and bled under cold running water. The liver was immediately removed and fragments of the hepatic tissue were taken and prefixed for 2 hours, at +4°C, in a 2.5% glutaraldehyde solution in 0.1 M phosphate buffer, pH 7.2, then washed in 4 successive 1-hour baths containing 0.15 M phosphate buffer, pH 7.2. The tissue fragments were then postfixed for 1 hour at +4°C, in a 1% osmic acid solution and 0.15 M phosphate buffer, pH 7.2. Dehydration was made in acetone and infiltration and embedding in vestopal W. Ultrathin sections were performed with a LKB-III ultramicrotome, contrasted with uranyl acetate and lead citrate and later examined in a TESLA BS-500 electron microscope.

All the chemicals used were of analytical grade. The Mg^{2+} organic complexes were produced by Biofarm (Bucharest).

Results and discussions. 1. *Control group* (Figs. 1—3). The normal hepatocyte possesses a spherical nucleus of approximately 7—8 µm in diameter, containing 2—3 nucleoli in its karyolymph. Often, the nucleoli are disposed near the nuclear membrane, suggesting an intense cellular activity.

Mitochondria are numerous, sligthly elongated and normally structured (Figs. 1 and 2). Those from the perilobular hepatocytes are smaller and electron denser whereas those from the centrolobular hepatocytes are somewhat larger and less electron dense. These are usual conformational aspects for mitochondria of normal liver [2].

Endoplasmic reticulum is represented mainly by narrow profiles of rough endoplasmic reticulum (RER), disposed both in packages of parallel profiles and in profiles surrounding the mitochondria (Figs. 1 and 2). Numerous ribosomes are attached to it, indicating an intense activity of protein synthesis. The smooth endoplasmic reticulum (SER) is very discretely represented by vesicles spread in the cytoplasm.

Golgi apparatus also has a discrete appearance, being observed in connection with the perilobular bodies and around the biliary canaliculi (Fig. 2).

Cytoplasmic matrix has an increased electron density, due to its richness in glycogen particles (Figs. 1 and 3). The lipid droplets are relatively rare, because they are not accumulated in hepatocytes, but transported and retained at the level of the fat-storing cells (Fig. 3) [12].

Biliary canaliculi have a narrow lumen, full of microvilli (Fig. 2). Disse perisinusoidal space is narrow and filled with the microvilli of the limitant hepatocytes, indicating an intense absorption process at this level, an activity also suggested by the multitude of the endocytotic microvesicles (Fig. 3). There are no agglomerations of collagen in the Disse space. The lumina of the blood capillary are normal, narrow and containing many red blood cells.

2. *Ethionine-intoxicated group* (Figs. 4—6). As compared to the control group, several morphofunctional alterations can be observed:

— Lipid accumulation in the cells, due to the transit blockage toward the sinusoidal spaces (Fig. 4), within the context of a reduced lipid synthesis;

— Strong glycogen depletion, especially in the perilobular hepatocytes (Figs. 5 and 6);

— Deformations of the mitochondria and a decrease of their number per cell (Figs. 5 and 6);

— A decrease of the RER quantity, the lack of its organization in synthesis complexes (parallel profiles), dilatation of the reticular space (Figs. 5 and 6), all of these indicating a very low activity of protein synthesis;

— Appearance of little foci of intracellular lysis (Fig. 5);

— Slight swelling of the nucleus (9—10 μm in diameter) and a decrease in the quantity of heterochromatin (Fig. 4). Only one nucleolus is observed in the karyolymph, slightly swollen and relatively centrally disposed, with the nuclear pores not always distinctly visible. All these suggest a weak nucleo-cytoplasmic relationship;

— Biliary canaliculi are dilated (Fig. 5), a situation characteristic to the state of biliary stasis.

However, one can observe that the parenchymal organization of the hepatic tissue is generally preserved, although small accumulations of collagen take place in the perisinusoidal spaces. It can be appreciated that the hepatic tissue has a deficient metabolic activity, but the situation is not so grave as observed in the case of the allyl alcohol intoxication [6].

3. *Group intoxicated with ethionine and treated with Ca-Mg-gluconolactate* (Figs. 7 and 8). As compared to the control and the ethionine-intoxicated groups, one can observe the following ultrastructural changes:

— A massive accumulation of lipids in the cells (Fig. 7), which can be explained by the blocking effect of the ethionine intoxication on the lipid transit to the perisinusoidal spaces, coupled with the stimulating effect of Mg^{2+} on lipogenesis, an activity marked by the occasional presence of little centres rich in SER;

— An increased glycogen quantity (Fig. 7), as compared to the intoxicated group. Although other investigators have reported glycogenolysis at 30 minutes after the administration of the Ca-Mg-gluconolactate [5], we consider hat this is to short an interval for assessing the final effect. In agreement with our observations, histoenzymological investigations performed under similar conditions have also indicated an activation of the glycogenogenesis [20];

— Mitochondria have generally a normal conformation, but they are slightly swollen, with a somewhat rarefied matrix, a moderate electron density and evident cristae (Fig. 8). In general, the authors of the histoenzymological study cited above [20] consider that the beneficial effects of Ca^{2+} and Mg^{2+} are due, in the first place, to the stimulation of the mitochondrial functions and of the energogenetic processes, since the administration of the Ca-Mg-gluconolactate prevents the depresssion of the activity of several important mitochondrial enzymes (succinate dehydrogenase, cytochrome oxidase, Mg-ATPase) as well as of the enzymes involved directly in the carbohydrate metabolism (lactate dehydrogenase and glucose-6-phosphatase);

— RER is slightly hypertrophied, richly upholstered with ribosomes and in close relation with mitochondria (Fig. 8). This indicates an increased protein synthesis, most likely due to the beneficial effect of Mg^{2+};

— Numerous ribosomes, organized in polysomes appear in the cytoplasmic matrix (Fig. 8), also indicating an intensification of the protein synthesis;

— Although the nuclei and the nucleoli are still slightly swollen, the latter are disposed close to the nuclear membrane (Fig. 7), suggesting an enhancement of the nucleo-cytoplasmic activity;

— Biliary canaliculi are relatively normal, nondilated, but with few microvilli (Fig. 7). A slight accumulation of collagen fibres can be observed in the perisinusoidal spaces (Fig. 7).

The general aspect of the hepatocyte ultrastructure and especially that of the *in situ* mitochondria are in agreement with both the functional and ultrastructural results obtained on isolated mitochondria [21].

4. *Group intoxicated with ethionine and treated with Mg-glutamolactate.* From Figs. 9 and 10 we can make the following observations:

— The blocking effect of ethionine on lipid transport and the lipid accumulation in hepatocytes are also maintained in this group, although the number and the dimensions of lipid droplets are smaller (Figs. 9—10);

— As compared to the intoxicated group, the glycogen quantity is increased. The presence of SER in the glycogen zones is an indication of a slight increase in the glyconeogenetic activity of this group (Fig. 10);

— Mitochondria are usually more elongated than normal, with a medium electron density of the matrix (Fig. 10);

— RER is present in normal quantity, usually around the mitochondria, with tendencies to organize into parallel profiles (Fig. 10);

— Nuclei and nucleoli are slightly dilated and have an irregular contour (Fig. 10);

— In certain cells, biliary canaliculi are normal, with narrow lumina and microvilli, whereas in others the lumen is broad and lacking the microvilli (Fig. 10);

— There are no visibile cellular lesions or glycogen accumulations, the general situation of the hepatocyte being intermediate between the intoxicated and the control group. As compared to the previous group, the situation can be considered as close, although the state of the mitochondria may not be so good as in that case. Functional results with isolated mitochondria have proven to be better than in the case of the intoxicated group, but slightly worse than for the group treated with Ca-Mg-gluconolactate [21].

5. *Group intoxicated with ethionine and treated with Mg-glutamogluconate*. From Figs. 11 and 12 it can be seen that the hepatocytes of this group have an ultrastructure closely resembling that of the control group, with slight reminiscences of the ethionine intoxication:

— In the first place, one can appreciate that the blocking effect on lipid transit has disappeared, lipid droplets being very seldom seen in the cells (Figs. 11—12). Hence, the lipogenetic effect most visible in group no. 3 is due to the association of Mg^{2+} with Ca^{2+}. Moreover, in the present case, the lipids are not retained at the level of the fat-storing cells, as in the control group, but sent into circulation (Fig. 11);

— Glycogen synthesis and accumulation has not attained yet the level observed in the control, its quantity being rather small (Fig. 11);

— Mitochondria are numerous and similar to those of the control group (Figs. 11—12);

— RER is present in large quantities, with narrow profiles disposed around the mitochondria and also in parallel profiles (Fig. 12), indicating an activation of the protein synthesis;

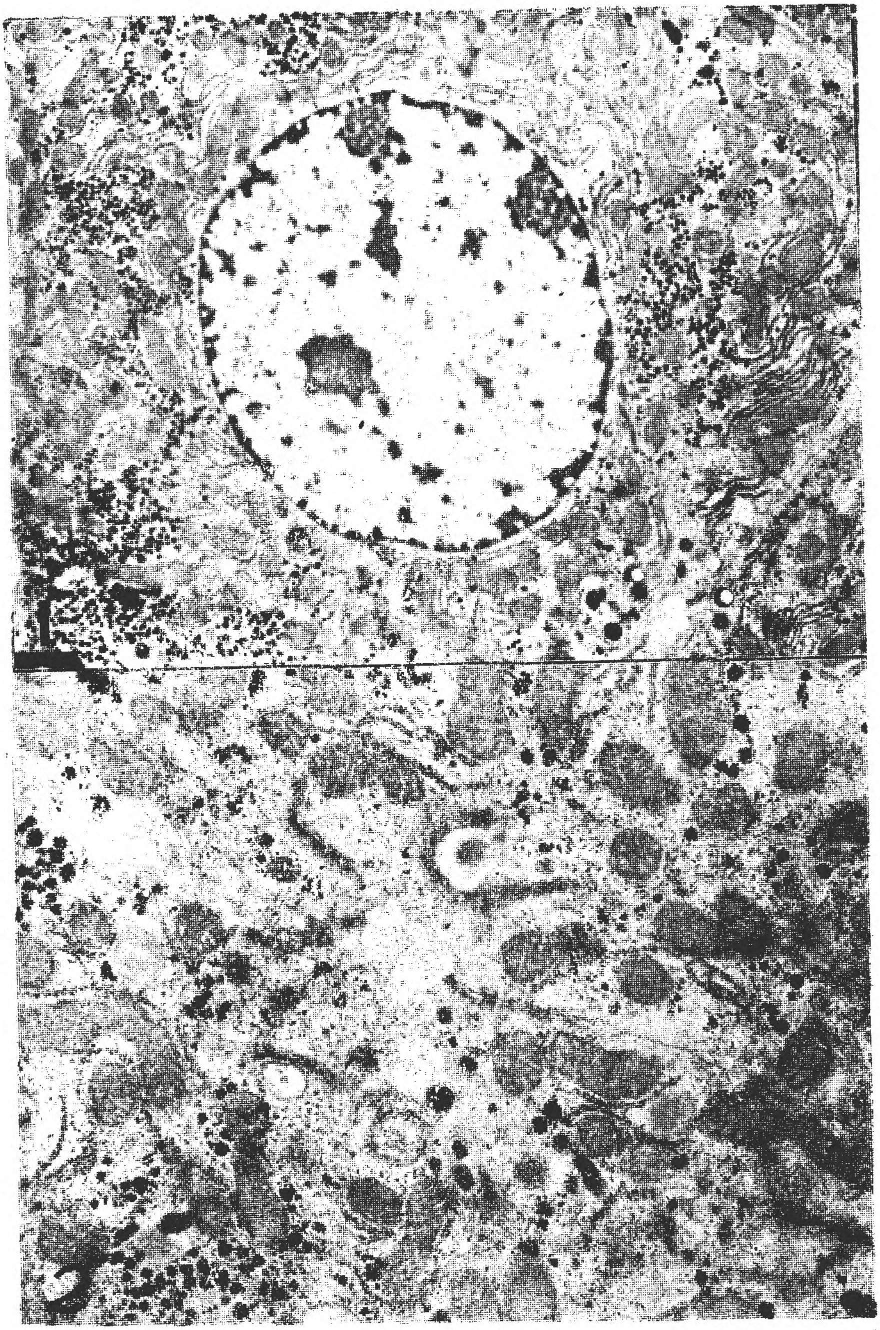
— Nuclei have an outlined contour and 1—3 nucleoli relatively dilated (Fig. 11), as compared to the control;

— There are no lysis foci in the cytoplasmic matrix and no collagen accumulations in the sinusoidal spaces;

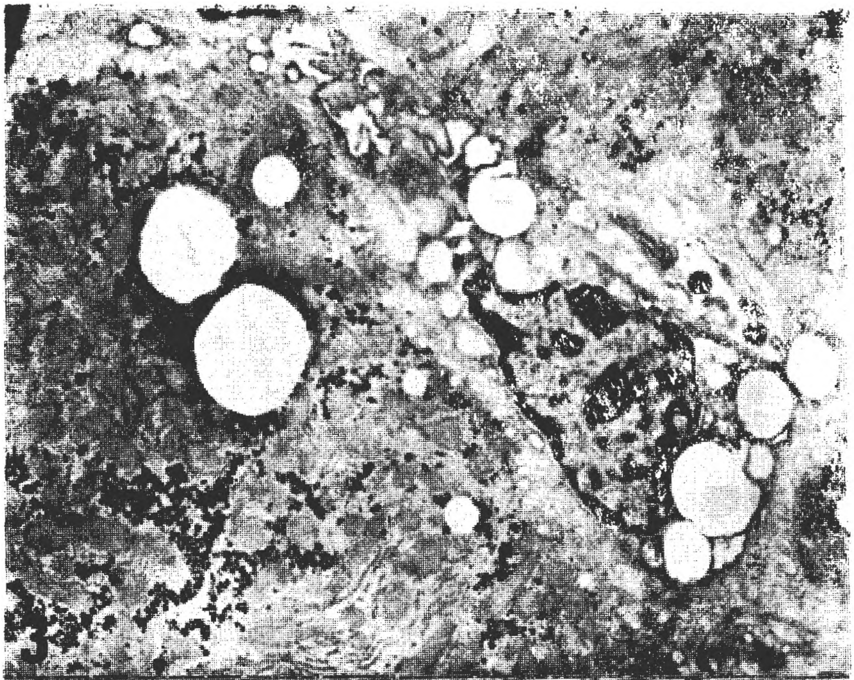
— Biliary canaliculi are usualy in a normal state, with few exceptions, when they look slightly dilated (Fig. 11);

— In general, the hepatocytes of this group have a relatively normal activity. Not only the ultrastructural appearance but the functional tests performed on isolated mitochondria also indicate that this group is closest to the control than any of the others [21].

It is worth mentioning that in the case of allyl alcohol intoxication we have obtained a very good recovery of the hepatocyte ultrastructure [6] and mitochondrial functions [22, 23] following the treatment with Ca-Mg-gluconolactate and/or Trofopar, whereas in the present study Mg-glutamogluconate had better performances. This could mean either that the two types of intoxication are not equivalent, having different requirements for Ca^{2+} and Mg^{2+}, or that the treatment with Mg-glutamogluconate, not tried in the case of allyl alcohol intoxication, might give better results than Ca-Mg-gluconolactate even in that case.



F i g s. 1 – 2. *Hepatocyte ultrastructure in the control group.* × 8,500; × 18,000.



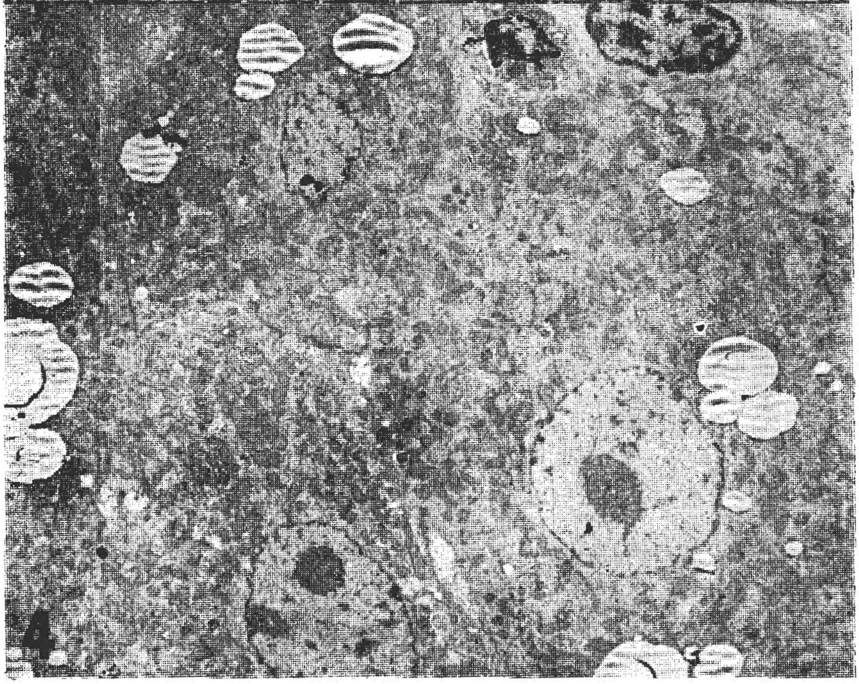
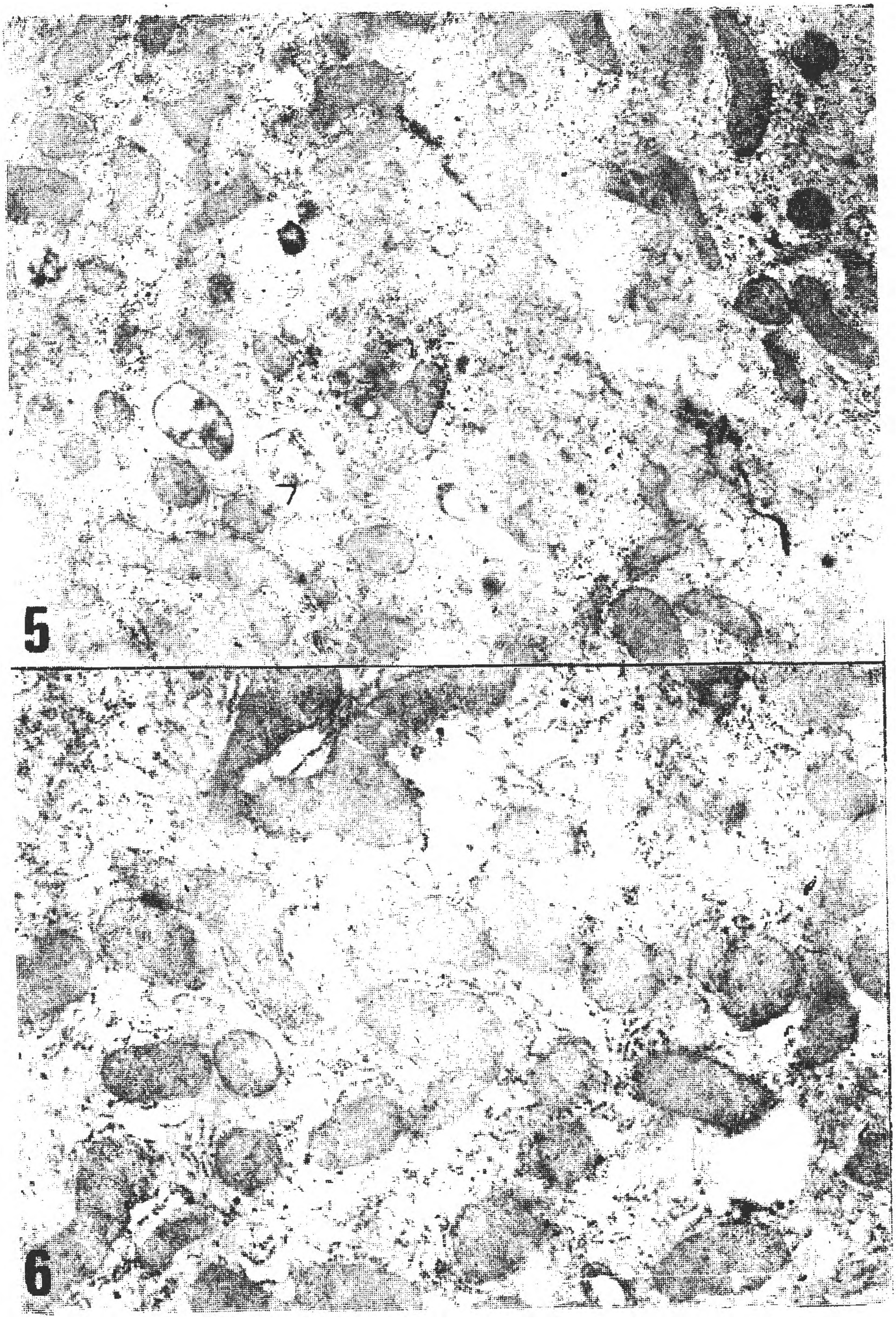
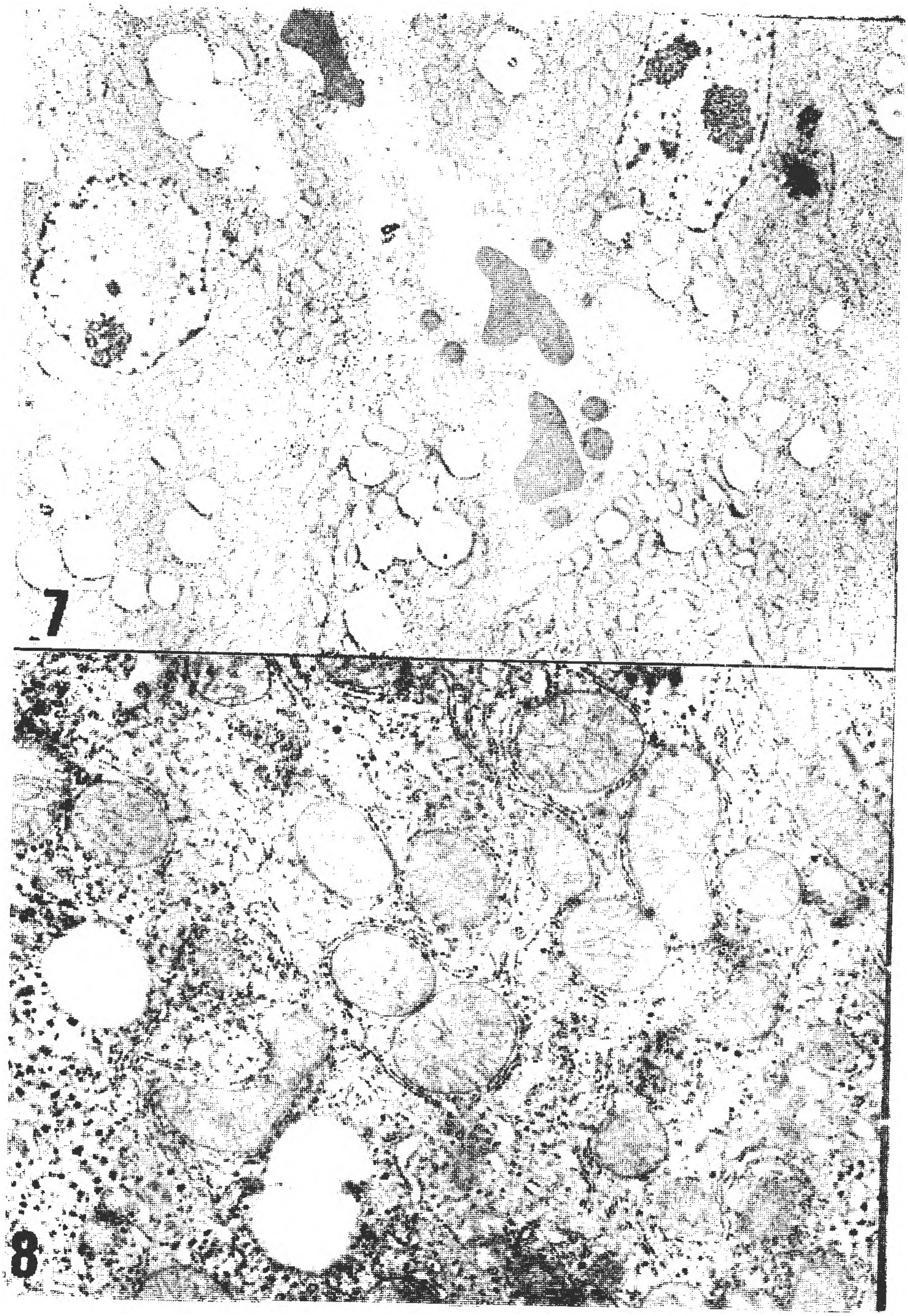


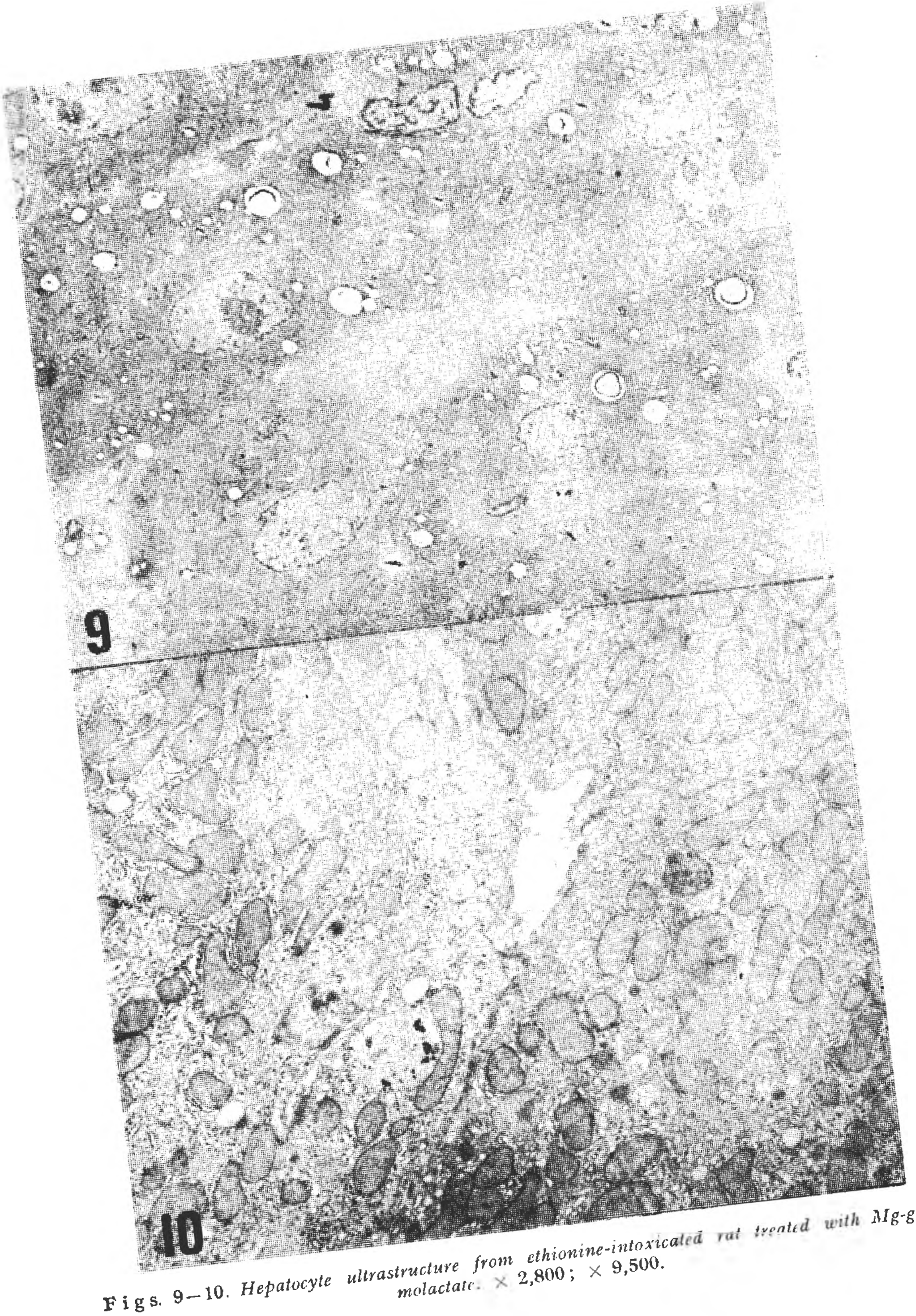
Fig. 3. *Hepatocyte ultrastructure in the control group.* × 8,500.
Fig. 4. *Effect of ethionine intoxication on the hepatic ultrastructure.* × 4,000.



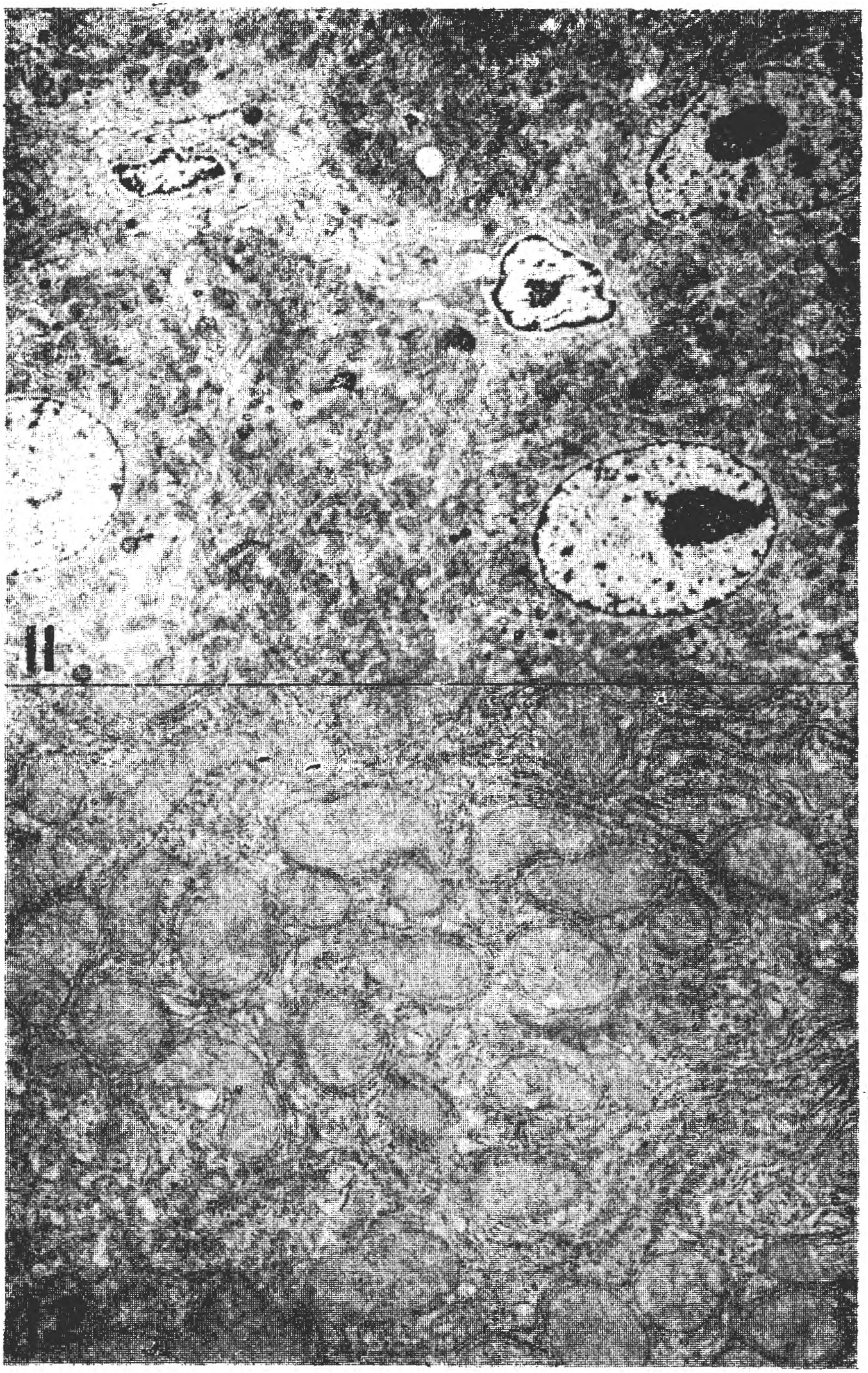
F i g s. 5–6. *Effect of ethionine intoxication on the hepatic ultrastructure.* × 12,500; × 22,000.



F i g s. 7—8. *Hepatocyte ultrastructure from ethionine-intoxicated rat treated with Ca—Mg-gluconolactate.* × 4,400; × 16,000.



Figs. 9–10. *Hepatocyte ultrastructure from ethionine-intoxicated rat treated with Mg-glutamolactate.* × 2,800; × 9,500.



Figs. 11 – 12. *Effect of Mg-glutamogluconate on hepatocyte ultrastructure of ethionine-intoxicated rats.* × 4,000; × 16,000.

Conclusions. From the present study, and also from our previous work [6, 21—23] we can conclude that:

1. The ethionine intoxication has moderate-to-grave effects on the structure and functions of the hepatic tissue and moderate effects on the mitochondria. As compared to allyl alcohol, the toxic effect of ethionine seems milder;
2. In general, the treatment with different Mg organic salts of the ethionine-intoxicated rats has favourable effects on the recovery of the hepatic structures and functions;
3. Among the three Mg containing complexes, Ca-Mg-gluconolactate, Mg-glutamolactate and Mg-glutamogluconate, the most favourable effects were demonstrated by Mg-glutamogluconate;
4. It seems that different types of intoxication have different requirements for Ca^{2+} and Mg^{2+} and possibly for the organic support of these ions. However, given their general importance in metabolism, especially in that of the hepatocyte, and taking into consideration the results of the present and previous studies, Mg^{2+} or a certain ratio of Mg^{2+} to Ca^{2++}, administered in the form of a suitable organic salt may prove very helpful in many types of hepatic intoxications or illnesses.

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EFFECTS OF PROCAINE AND PROCAINE-BASED DRUGS ON THE BIOELECTRIC ACTIVITY OF TWO SUBCORTICAL NERVOUS STRUCTURES AND ON THE CARDIAC RHYTHM IN WHITE RATS

MIRCEA POP* and CORNELIU TARBA*

SUMMARY. — The effects of procaine, Gerovital H_3 or Aslavital on the amplitude and frequency of the bioelectric waves from the lateral hypothalamus and reticular formation as well as on the cardiac rhythm were studied in anaesthetized white rats using two different ways of administration: intravenous and intrahypothalamic. In intravenous injections, procaine (20 mg/kg b.w.) produces a constant depression of the frequency and amplitude of the rhythmic slow waves in both nervous formations, more visible on the lateral hypothalamic tracings. Gerovital H_3 induces a similar depression of the freqency, but, after a transitory decrease, it determines a final increase in the wave amplitude. Although the effects of Aslavital resemble those of Gerovital H_3 with regard to wave amplitude, it produces a very significant increase in the wave freqency at the level of the reticular formation. In the case of intrahypothalamic administration (16 μg procaine equivalents/animal), the pattern of response is generally opposite to that observed with intravenous injections and the changes, at least at the level of the lateral hypothalamus, are more superficial. An opposition between Aslavital and the other two drugs is visible this time for the wave amplitude. This parameter is usually increased by procaine and Gerovital H_3 (more constantly in the reticular formation) and decreased by Aslavital (more constantly in the lateral hypothalamus). In many cases, Aslavital also elicits a burst of positive sharp waves, reminiscent of the epileptiform abnormality. The cardiac rhythm is usually depressed by all drugs, regardless of the way of administration. The differences observed between the two types of experiments and between Aslavital and the other drugs are tentatively explained in terms of dose, chemical composition and selective action of the drugs on different nervous structures.

The nootropic neurodynamic properties of procaine, Gerovital H_3 and Aslavital are well known [3—7, 21]. The pharmacodynamic and neurophysiological characteristics of these substances consist mainly in the improvement of the cognitive processes (memory, attention, elaboration of conditional behaviour, etc.), alleviation or disappearance of physical and psyhic asthenia, anxiety or depression [3—6, 15, 16, 21] as well as the increase of the brain resistance to various stress agressions [7, 18, 20, 21]. The biochemical bases of their action have not been elucidated so far. However, a marked ATP-mediated turnover of the energy-generating processes has been described at the level of the central nervous system [3, 20, 21]. The functioning of other mechanisms of the brain, pointed out by the decrease in the concentration of certain amino acids is probably due to an increased protein synthesis [3]. The anti-

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depressive energogenous effect of procaine and procaine-based drugs (such as Gerovital and Aslavital) may be explained, at least in part, by their inhibitory effect on MAO (monoamine oxidase), given the important role of this enzyme in the nervous system [3, 4, 8, 9, 13, 14, 22]. It seems that the effect of procaine and related drugs consists in the indirect activation of the epinephrine-norepinephrine subsystem, subsequent to MAO inhibition.

However, the action of these drugs is to a great extent dependent of dose, specific components, functional state of the nervous system itself and even of the specific nervous structures or cells [2, 3, 11, 12, 19]. Clinical support of the differences between procaine, Gerovital H_3 and Aslavital has been brought by numerous investigators [4, 10, 18, 20, 23]. Significant differences were observed between procaine and Gerovital H_3 in the reduction of the conditioned and unconditioned vascular reflexes in elderly patients [4]. These results were also confirmed in dogs and rabbits by the use of salivary reflexes [23]. Gerovital H_3 exerts a stronger protective effect than procaine against anoxia induced by curarization or swimming effort as well as against contention-induced gastric ulcers [18]. Aslavital also has nootropic neurodynamic properties superior to procaine [20]. With regard to a direct comparison between the performances of Gerovital H_3 and Aslavital, we have no knowledge of the existence of such data. In the present paper we are reporting the results of a comparative study of the effects of the three drugs on the bioelectric activity of the lateral hypothalamic area and the brain stem reticular formation in white rats.

Materials and methods. The experiments were performed on male Wistar rats of about 250 g, anaesthetized with nembutal (40 mg/kg b.w.). Two types (series) of experiments were conducted on a total number of 49 animals (5—9 animals for each drug, within each series). Ringer's saline solution (without $MgCl_2$ and glucose) was used for the control animals. In one type of experiments, the substances were injected intravenously (in the caudal vein) in doses of 2 mg (0.2 ml)/100 g b.w., calculated in terms of procaine, whereas in the other case, the drugs were injected directly into the lateral hypothalamus with the aid of a Hamilton syringe, each animal receiving 16 μg (0.8 μl) of the substance tested. In both cases, bioelectric recordings were taken from the lateral hypothalamus and the midbrain reticular formation, usually in a bipolar derivation, the distance between the two recording electrodes of a given pair being at most 0.5 mm.

The recording electrodes were prepared from stainless steel wire (0.5 mm in diameter) whose insulation was removed at the tip along a distance of 0.4—0.5 mm, the diameter of the deinsulated recording tip being about 0.12 mm. The integrity of the insulation and the accuracy of the tip deinsulation were tested by immersing the electrodes in a normal saline solution and briefly applying 6-V electric pulses. The electrodes were implanted by means of the stereotaxic technique, according to the co-ordinates of the stereotaxic atlas of Abbe-Fessard *et al.* [1]. The needle of the Hamilton syringe, having a tip diameter of 0.3—0.4 mm and containing the desired substance was also implanted stereotaxically in the lateral hypothalamus, symmetrical to the recording electrodes. After operation, the animals were placed in Faraday chamber and each electrode connected separately to the recording instrument, an 8RG—1 electroencephalograph (G.D.R.), which was usually employed using a time constant of 0.3 s, a 70-Hz filter, a base recorder gain of 100 μV and a speed of 15 mm/s for the recording paper.

Before the injection of the desired substance, the background bioelectric activity was recorded for about 10—15 sec. The substances were injected (either intravenously or intrahypothalamically) 25 min after the installation of the narcotic sleep and 10 min after the stereotaxical implantation of the electrodes. Recordings were then performed at 1, 5, 10 and 20 min after injection. At the end of the experiments, part of the animals were sacrificed and their brains prepared for anatomical control of the correct penetration of the electrodes and the syringe needle.

The variations of the bioelectric rhythm (frequency) and amplitude (voltage) were observed on the EEG tracings. Cardiac frequency was also observed by simultaneous recording of the ECG (DII). The mean percentage variations ($\pm\%$) of the recorded parameters were calculated considering the background activity in each individual case as 100% and the significance of the differences was established by the unilateral "t" test.

The chemicals used were all of analytical grade. Procaine. HCl was from Hoechst (F.R.G.) and Gerovital H_3 and Aslavital were from The Drug Enterprises (Bucharest, Romania).

Results. Since all our experiments were performed on anaesthetized animals, the background bioelectric activity was characterized by tracings of sleep pattern. The mean values of the frequency and amplitude in the lateral hypothalamus were 5.1 ± 0.2 c/s (cycles/sec) and 37.4 ± 1.3 μV, respectively, while in the reticular formation the corresponding values were 6.86 ± 0.42 c/s and 35.3/1.7 μV, thus ranging within the theta and delta rhythms of the classical EEG tracings.

1. Results with intravenous injections. *Control experiments.* A number of 5 rats were injected with Ringer's saline solution. This led to an initial increase in the wave frequency recorded from the reticular formation ($+5.85 \pm 1.65\%$ at 1 min; $p<0.02$), which gradually decreased, becoming significantly lower ($p<0.02$) at 10 min ($-5.0 \pm 1.7\%$), whereas at 20 min the decrease was no longer significant. The amplitude was relatively constant, except for the last period (20 min), when a significant decrease was recorded ($-8.20 \pm 0.65\%$; $p<0.001$). No significant variation was observed in the lateral hypothalamus, neither in frequency nor in amplitude, although toward the end of the recording period the amplitude tended to decrease. In general, for the control experiments, the changes can be regarded as unimportant.

The cardiac rhythm was slightly increased at 1 min after the injection. For the rest of the recording period, the cardiac rhythm was appreciably constant and close to the background values.

Effects of procaine·HCl. The results show that procaine generally induces a marked decrease of the amplitude and frequency of the slow waves from both structures investigated. The amplitude of the waves recorded from the lateral hypothalamus is particularly affected (see Fig. 1). Nevertheless, the changes are mainly reversible. For instance, at 1 and 5 min after injection the mean percentage variations are $-35.45 \pm 8.07\%$ ($p<0.002$) and $-35.53 \pm 7.58\%$ ($p<0.001$), respectively, whereas at 10 min this value is $-9.88 \pm 4.28\%$ ($p<0.05$) and at 20 min the difference becomes totally insignificant. The frequency decrease ($-17.81 \pm 4.43\%$ at 1 min; $p<0.02$) also recovers in time, but to a much smaller degree ($-13.80 \pm 6.67\%$ at 20 min; $p<0.05$). The aspects of the bioelectric changes in the reticular formation are similar to those from the lateral hypothalamus, although the extent of changes is generally smaller.

The cardiac rhythm is also transitorily affected, in the same sense as the bioelectric parameters of the nervous system. Thus, at 1 min the cardiac frequency is strongly depressed ($-18.21\pm4.02\%$; $p<0.005$), whereas at 10 min the decrease is barely significant ($-9.49\pm4.91\%$; $p\cong0.05$) and at 20 min totally insignificant.

Effects of Gerovital H$_3$. Intravenous injection of this drug elicits similar changes to those caused by the procaine, although they are somewhat larger and longer lasting. This is perfectly obvious not only for the lateral hypothalamus but also for the reticular formation (Fig. 2). In fact, the decrease in the frequency of the rhythmic slow waves on the tracings is as large at 20 min as it was initially (*i.e.*, around -25%; $p<0.005$ in the lateral hypothalamus and $p<0.02$ in the reticular formation). In turn, the amplitude seems to recover completely. It starts at $-31.43\pm10.75\%$ (1 min) and ends at $+7.72\pm5{,}52\%$ (20 min) in the lateral hypothalamus, and it begins with $-14.14\pm12.32\%$ (1 min) and ends with $+0.01\pm6.41\%$ (20 min) in the reticular formation.

The cardiac frequency is much less depressed than in the case of the procaine. However, at the end (20 min) the decrease appears statistically significant ($-6.33\pm2.92\%$; $p<0.05$).

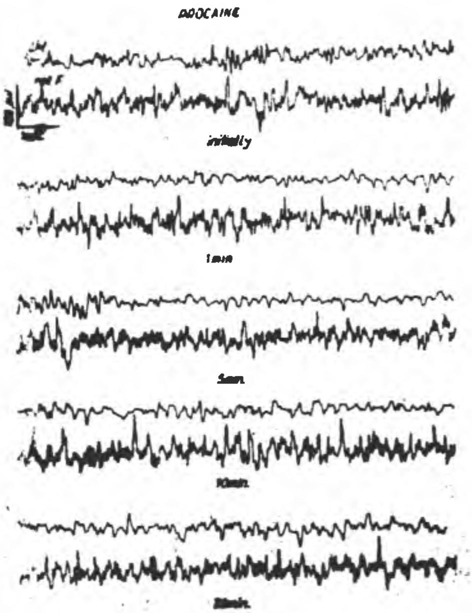

Fig. 1. *Procaine effects on the bioelectric activity recorded from the lateral hypothalamus (LH) and the reticular formation (ret. F).* Different time intervals after intravenous administration.

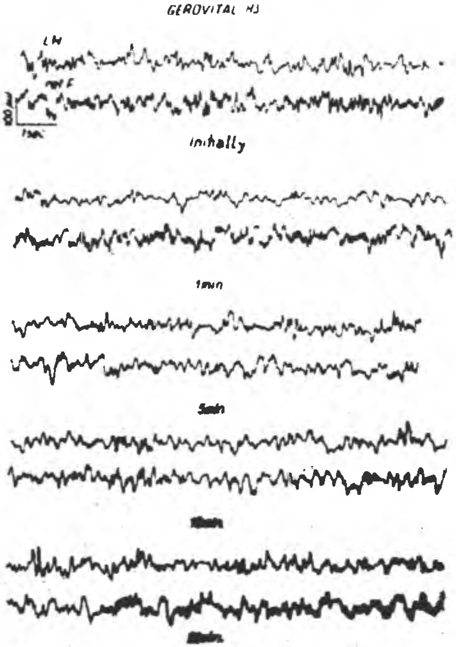

Fig. 2. *Effects of Gerovital H*$_3$ *on the bioelectric activity recorded from the lateral hypothalamus (LH) and the reticular formation (ret. F).*
Different time intervals after intravenous injection.

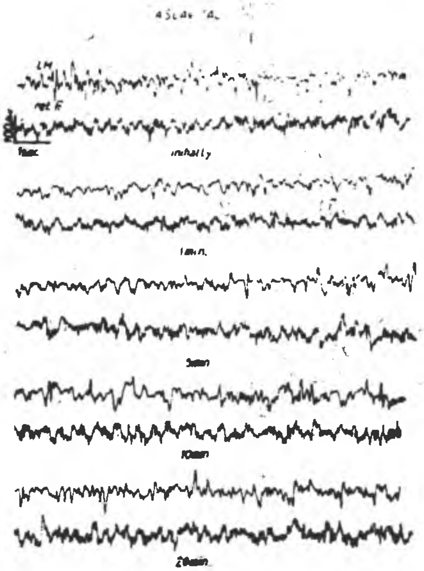

Fig. 3. *Aslavital effects on the bioelectric activity recorded from the lateral hypothalamus (LH) and the reticular formation (ret. F).*

Different time intervals after intravenous injection.

Effects of Aslavital. Intravenous injection of Aslavital has rather different results than the other two drugs. The analysis of the records as well as the tracings presented in Fig. 3 show that the changes produced by Aslavital are more transient. In addition, the frequency patterns of the slow wave tracings vary in opposite directions for the two nervous structures: a moderate decrease in the lateral hypothalamus (—9.19±4.45% at 1 min and —5.73±3.43% at 20 min) and a strong increase in the reticular formation (+19.14±4.37% at 1 min; $p<0.01$), which tends gradually toward the background value, attaining +0.71±4.26% at 20 min. The changes produced in the wave amplitude are similar to those observed in the case of procaine and Gerovital H_3, although their evolution in time is a little different.

There is also an important depression of the cardiac frequency at 1 min (—11.52±4.19%; $p \cong 0.02$), but this difference recovers and becomes insignificant more quickly than in the case of the procaine.

2. Results by intrahypothalamic administration. In order to obtain supplementary comparative data regarding the differential effects of the drugs tested, we have undertaken a series of experiments in which the drugs were administered directly into the lateral hypothalamus, symmetrical to the recording electrodes. Control experiments with Ringer's saline solution were also performed, but none of the changes produced were statistically significant.

Effects of procaine·HCl. Unlike the marked effects of intravenous injection of procaine, the direct administration of this drug into the lateral hypothalamus induces only a slight increase in the rate of the rhythmic slow waves at the level of the lateral hypothalamus (+8.44±3.41% at 1 min, decreasing to +1.58±4.17% at 20 min). The wave amplitude, however, increases constantly, especially in the reticular formation (+ 11.05±9.32% at 1 min, and +46.52±12.42% at 20 min; $p<0.005$). This can be also observed in Fig. 4.

The cardiac frequency is generally much less depressed than in intravenous injections, with the exception of the result obtained at 20 min (—5.51±1.69%; $p<0.02$).

Effects of Gerovital H_3. The effects of this drug are even weaker than those of the procaine. The changes may be described only as slight tendencies toward a frequency decrease and especially toward a voltage decrease of the slow waves recorded from the lateral hypothalamus (see also Fig. 5). This is very much in contrast to its intravenous injection, where the changes produced were very conspicuous.

The cardiac rhythm is slightly depressed, but the decrease becomes significant (about —7.3%) at 10 min ($p<0.05$) and 20 min ($p<0.02$).

Effects of Aslavital. As in the case of the intravenous injection, the effects of Aslavital differ from those of the procaine and Gerovital H_3, especially with regard to wave amplitude. Except for a slight initial increase in the reticular formation, the amplitude decreases significantly in both structures. The frequency of the rhythmic slow waves in the lateral hypothalamus is initially increased ($+18.21 \pm 3.8\%$; $p<0.005$), whereas in the reticular formation it is decreased ($-15.21 \pm 5.47\%$; $p<0.02$). While the increase diminishes with time in the lateral hypo-

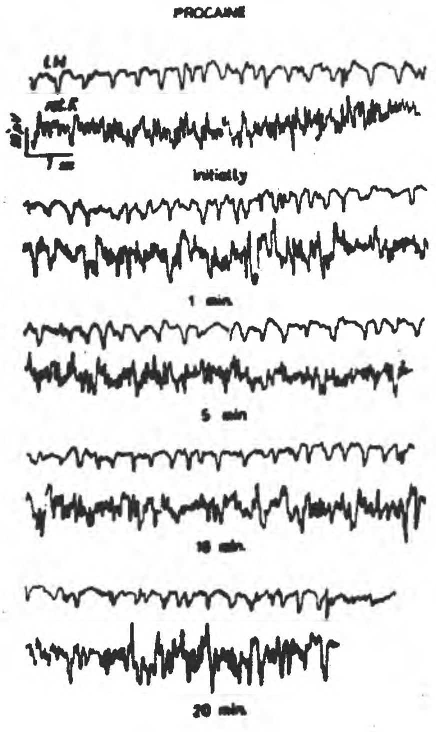

Fig. 4. *Procaine effects on the bioelectric activity recorded from the lateral hypothalamus (LH) and the reticular formation (ret. F).*

Different time intervals after intrahypothalamic administration.

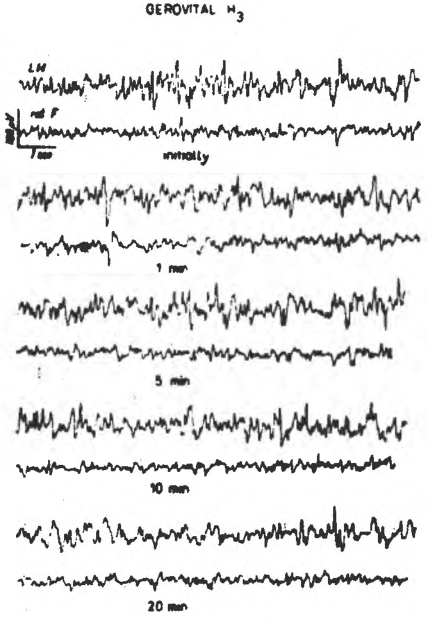

Fig. 5. *Effects of Gerovital H_3 on the bioelectric activity recorded from the lateral hypothalamus (LH) and the reticular formatino (ret. F).*

Different time intervals after intrahypothalamic administration.

thalamus, after a passing change of sign, the negative variation is again present at the end of the recording period ($-18.23 \pm 8.71\%$; $p<0.05$).

It must also be mentioned that in 4 out of 6 cases, rhythmic bursts of high amplitude sharp waves were observed on the tracings derived from the lateral hypothalamus (see Fig. 6). The phenomenon is similar to that observed in the development of the epileptiform abnormality (paroxysmal discharges, composed of spike-wave complexes). At the same time, a reduction or even a loss of the background bioelectric activity can be observed on the tracings recorded from the reticular formation.

The cardiac frequency is generally slightly decreased, except at 5 min, when the decrease appears as highly significant. However, toward the end, this frequency approaches the background values.

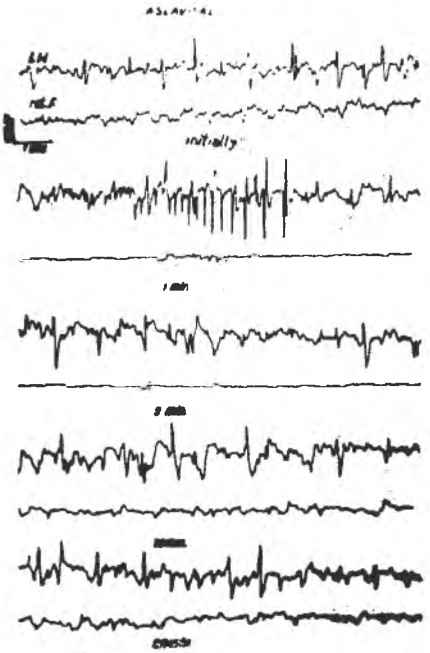

Fig. 6. *Aslavital effects on the bioelectric activity recorded from the lateral hypothalamus (LH) and the reticular formation (ret. F).* Different time intervals after intrahypothalamic administration. (An aspect of the frequent bursts of paroxysmal discharges).

Discussion. Generally, at least on the cortical EEG tracings of awake animals and humans, the reduction of the wave amplitude is normally associated with the increase of the rhythmic discharge and vice versa. In experiments on anaesthetized animals, the changes of the characteristic patterns of the sleep slow waves, following the administration of drugs or other actions on the central nervous system are difficult to interpret when the action does not reverse the sleep EEG pattern to a wakening one. Procaine and Gerovital H_3, for instance, elicit the diminution of the background amplitude and rhythm of the waves, especially at the level of the lateral hypothalamus. According to the literature, the intravenous injection of the same dose of procaine (20 mg/kg b.w.) induces an inhibitory effect on the activity of the higher nervous system in human subjects [23]. Taking this observation into consideration, we incline toward the hypothesis that the changes recorded under our experimental conditions may also express an inhibitory action of the drugs utilized here, more pronounced for Gerovital H_3 than for procaine, and more evident at the level of the lateral hypothalamus. The stronger and more persistent effect of Gerovital H_3 may probably be explained by an increased stability of the procaine molecule conferred by one of the ingredients present in this preparation. As it is known, the procaine molecule is rapidly decomposed in the organism into two metabolic compounds: *p*-aminobenzoic acid and 2-diethylaminoethanol. Experiments have shown that intact procaine molecules could be found in the blood and urine of laboratory animals even hours after the administration of Gerovital H_3 [4].

In general, the changes recorded in the two nervous formations follow a corresponding parallel pattern for each of the two parameters studied, with one notable exception: Aslavital produces a slight-to-moderate decrease of frequency in the lateral hypothalamus and a strong increase in the reticular formation. We do not have a consistent explanation for this difference. However, the differences between the effects of Aslavital and the other two drugs, more visible in the case of the intrahypothalamic administration, especially for the wave amplitude, could be explained or interpreted in terms of dose, composition and selective action of the different drugs upon certain neurons or nervous structures [2, 4, 12, 18—20]. It is worth mentioning that Tsobkallo and Kutcherenko [23] noticed the stimulating effect of 1—2 mg procaine/kg b.w. on the activity of the higher nervous system, as opposed to the inhibitory effect of 20 mg procaine/kg b.w. Stroescu *et al.* [6] showed that even a therapeutic dose of 5 mg procaine/kg b.w. induces EEG changes suggesting a cortical inhibition in rabbit. The problem of selective action is both a function of the nervous structure concerned and of the tested substances. In addition, under our experimental conditions, the problem is complicated by the two different ways of administration (and, presumably, different ways of action) and by the fact that, due to theoretical and technical difficulties, we had to use different types of dose calculation („per body weight", in the case of intravenous injection, and „per individual", in the case of intrahypothalamic administration), each considered to be the most appropriate in the respective case, but none of them completely satisfactory. At any rate, based on the literature data, a selective action can be postulated for procaine. For example, certain authors pointed out that the upper area of the brain is the region mostly influenced by procaine [23]. Adamec *et al.* [2] have found that procaine selectively increases the omega band activity in the amygdala and temporal cortex, in a dose-related fashion. These authors suggest that the increase of the limbic excitation is due in part to interference with local recurrent inhibition. The impact with the opiate receptors, inhibiting inhibition and increasing the hippocampal neural activity is also invoked.

In our opinion, the selective action of procaine, Gerovital H_3 and Aslavital observed in our experiments is in relation to both the neural specificity of the structures investigated and the chemical composition of the drugs concerned. It is known that the pharmacological action of procaine·HCl is modified in Gerovital H_3 which contains benzoic acid and potassium metabisulphate, serving as preservative and antioxidant agents [3]. As compared to Gerovital H_3, Aslavital solution contains glutamic acid and a higher concentration of potassium ions [18]. It is very probable that different specific actions of Aslavital were due to these chemical ingredients. For instance, the paroxysmal high amplitude spike-wave discharges observed after intrahypothalamic administration of Aslavital are probably due to the excess of potassium ions in the solution. Anyway, Sager *et al.* [17] have demonstrated that the excitation of the paraventricular gray substance by injection of 2 drops of a 2% KCl solution (pH 7.3) can elicit at times paroxysmal discharges similar to those observed in the development of the epileptiform abnormality. It should be mentioned, however, that the problem is more complicated because not all types of spikes or spike-wave patterns are indicative of clinical disorders. For example, the positive spikes of 14 and 16 Hz (also present in our results), the so-called small sharp spikes and wave complexes have no definite significance for epilepsy diagnosis [24].

Conclusions. The effects of procaine and Gerovital H_3 in intravenous injections are more visible at the level of the lateral hypothalamus, whereas in the case of the intrahypothalamic administration their effects are stronger at the level of the reticular formation. Also, while for intravenous injections their effects consist mainly in decreasing the amplitude and the frequency of the rhythmic slow waves, a small increase can be observed for the intrahypothalamic administration. The stronger and longer lasting effect of Gerovital is probably due to its higher stability, as a consequence of the ingredients contained by this preparation.

In most cases, the pattern of response to Aslavital is opposite to that observed for procaine and Gerovital H_3. Thus, in intravenous injections, it affects stronger the activity of the reticular formation, where the wave frequency is significantly increased. In intrahypothalamic administration, Aslavital evokes an activation of the sleep slow waves at the level of the hypothalamus, whereas a frequency depression can generally be observed at the level of the reticular formation. The paroxysmal spike-wave discharges are a remarkable feature observed only for intrahypothalamic administration of Aslavital. The differences between the effects of Aslavital and the other two drugs are tentatively explained by us in terms of chemical composition of these preparations and selective action at the level of different nervous structures.

All the investigated substances determine a depression of the background cardiac rhythm, but to a different degree and in a different manner of evolution. However, no statistically significant correlation could be found between the degree of depression of the cardiac rhythm and the changes produced in the bioelectric activity of the two nervous formations studied.

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A VALUABLE COLLECTION OF LEPIDOPTERA IN THE ZOOLOGICAL MUSEUM OF THE UNIVERSITY IN CLUJ-NAPOCA (Part II)

LÁSZLÓ RÁKOSY*

SUMMARY. — The paper represents the second part of the catalogue of Professor Ştefan Péterfi's collection and comprises 2421 specimens. With this contribution the whole material comes up to 4357 specimens belonging to 770 species and subspecies, being a representative collection for the lepidoptera fauna in Transylvania.

In the first part of the Professor Ştefan Péterfi collection [1], we have presented the material up to the *Larentiinae* subfamily, *i.e.* the families *Hepialidae, Sessidae, Zygaenidae, Limacodidae, Heterogynidae, Lymanitriidae, Arctiidae, Ctenuchidae, Nolidae, Noctuidae, Drepanidae* and *Geometridae* (partly).

The present paper deals with the other part of the material, namely *Geometridae* (partly), *Sphingidae, Notodontidae, Dilobidae, Endromidae, Lasiocampidae, Saturniidae, Cossidae, Hesperiidae, Lycaenidae, Papilionidae, Pieridae, Nymphalidae* and *Satyridae.*

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Subfam. *Orthostixinae*

Orthostixis Hübner

O. cribraria Hübner

1 ex.: Balcic (Bulgaria) (D. Culac Mare) 25.VI.1930 (leg. Ostrogovich).

Subfam. *Boarmiinae* (=*Ennominae*)

Abraxas Leach

A. grossulariata Linnaeus

9 ex.: Cluj 9.VII.1927; 15.VII.1927; 7.VII.1927; 27.VII.1929; 18.VII.1928; 12.VII.1927 (2 ex.); Sălicea 30.VIII.1930 (2 ex).

A. sylvata Scopoli

2 ex.: Lăpuşna 13.VII.1930; Rîul Sadu 15.VIII.1920 (leg. Czekelius).

Lomaspilis Hübner

L. marginata marginata Linnaeus

25 ex.: Cluj (Baciu) 15.V.1927 (5 ex.); 1.V.1927; 25.V.1929; 22.V.1927; (V. Popii) 6.V.1928; 13.V.1928 (2 ex.); 20.V.1928 (3 ex.); (V. Pleşca) 17.VI.1928 (2 ex.); 27.VII.1927; 8.VII.1928; 20.V.1928; Bod 10.V.1928; V. Negruţei 5.VII.1928; Sălicea 31.VII.1927.

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Ligdia Guenée

L. adustata Denis et Schiffermüller

7 ex.: Cluj 10.VII.1928; 20.V.1927; 18.VII.1928; 27.VII.1929; 25.V.1929 (3 ex.).

Lomographa Hübner (=*Stegania* Duponchel)

L. dilectaria Hübner

2 ex.: Ineu 21.VI.1928; 20.VI.1928 (leg. Diószeghy).

Semiothisa Hübner (=*Chiasmia* Hübner, =*Macaria* Curtis)

S. notata Linnaeus

5 ex.: Cluj 5.VII.1928; (V. Pleşca) 5.VIII.1928; 27.VII.1927; Sălicea 24.VI.1928; Viţă 10.V.1928.

S. alternaria Hübner

9 ex.: Cluj 3.V.1927 (2 ex.); 30.IV.1928; 18.VII.1928 (3 ex.); 24.IV.1927; 25.V.1929 (ex. p.); 7.VIII.1929.

S. signaria Hübner

11 ex.: V. Negruţei 5.VII.1928 (8 ex.); Mt. Vlădeasa 17.VII.1929 (2 ex.); Retezat (1200 m) 14.VII.1928 (leg. Diószeghy).

S. liturata Clerck

2 ex.: Fînaţele Clujului 15.VII.1928; Mt. Vlădeasa 17.VII.1929.

S. clathrata clathrata Linnaeus

11 ex.: Cluj 7.IX.1926; 10.VII.1952; 4.VII.1953; (V. Popii) 10.IV.1927; 1.V.1928 (2 ex.); 1.VII.1927; 10.VII.1927; 27.V.1928; Fînaţele Clujului 20.V.1940; Viţă 10.V.1928.

S. glarearia Brahm

11 ex.: Cluj 20.IV.1927; 12.VII.1932 (2 ex.); (V. Popii) 19.V.1928; 31.V.1929; Fînaţele Clujului 29.V.1929; Cheile Turzii 23.VII.1933 (2 ex.); Viţă 10.V.1928; Deva 7.VI.1928 (2 ex.).

S. artesiaria Denis et Schiffermüller

1 ex.: Ineu 30.VI.1921 (leg. Diószeghy).

Tephrina Guenée (=*Eubolia* Duponchel)

T. murinaria Denis et Schiffermüller

17 ex.: Fînaţele Clujului 30.VI.1929; 27.V.1928 (3 ex.); 25.IV.1930; 28.VII.1929; 21.VII.1928 (5 ex.); 19.IV.1930; 3.VI.1928; 10.VIII.1928; 5.VI.1929; Cluj (V. Popii) 20.V.1928; (V. Pleşca) 7.VII.1929.

T. arenacearia Denis et Schiffermüller

7 ex.: Cluj (Mănăştur) 14.VII.1928; (Becaş) 9.VI.1928; Peştişul Mic 9.VII.1931; Nighighiş 14.VII.1931 (3 ex.); Sălicea 26.V.1933.

Isturgia Hübner (=*Fidonia* Treitschke)

I. roraria rablensis Zeller

6 ex.: Mt. Cibinului (Fedelesch) 16.VI.1929 (2 ex.) (leg. Czekelius); Cluj (V. Pleşca) 20.V.1928; 31.VII.1932; Sălicea 7.VI.1933 (2 ex.).

I. roraria limbaria Fabricius

3 ex.: Cluj (V. Pleşca) 8.V.1927; Cluj (Făget) 26.IV.1927; Sălicea 31.VI.1928,

Itame Hübner (=*Thamnanoma* Lederer)

I. wauaria Linnaeus

5 ex.: Cluj 29.VI.1927; 17.VI.1927; 24.VI.1927; (V. Popii) 7.V.1931; Retezat (1000 m) 20.VII.1926 (leg. Diószeghy).

Cepphis Hübner

C. advenaria Hübner

6 ex.: Cluj 13.VI.1928 (ex. p.); 22.V.1927 (2 ex.); (V. Pleşca) 26.V.1929; Sălicea 24.VI.1928; Stana 1.VII.1928.

Petrophora Hübner (=*Lithina* Hübner)

P. chlorosata Scopoli (=*petraria* Hübner)

22 ex.: Sălicea 26.V.1929 (15 ex.); 2.VI.1929 (2 ex.); 24.VI.1928; Cluj (V. Pleşca) 24.VI.1928; V. Mişidului (Crişul Repede) 24.V.1928 (3 ex.).

Plagodis Hübner (=*Anagoga* Hübner, =*Numeria* Duponchel)

P. pulveraria pulveraria Linnaeus
7 ex.: Cluj (V. Popii) 20.V.1928; 24.V.1930 (2 ex.); (V. Pleşca) 17.VI.1928; 24.V.1930; Ineu 1.V.1927 (leg. Diószeghy); V. Ierii 6.VII.1928.

P. dolobraria Linnaeus
2 ex.: V. Ierii 6.VII.1928; Ineu 18.IV.1920 (leg. Diószeghy).

Opisthograptis Hübner

O. luteolata Linnaeus
6 ex.: Cluj 9.VI.1927; 16.V.1927; (V. Popii) 8.VI.1929; (V. Pleşca) 30.V.1934; Mada 9.VI.1928 (2 ex.).

Epione Duponchel

E. vepandaria Hufnagel (=*apiciaria* Denis et Schiffermüller)
2 ex.: Cluj (V. Pleşca) 29.VII.1928; Sălicea 3.VIII.1930.

E. paralellaria Denis et Schiffermüller (=*vespertaria* auct.)
2 ex.: Cluj (V. Pleşca) 22.VII.1928; Sălicea 29.VII.1928.

Pseudopanthera Hübner (=*Venilia* Duponchel)

P. macularia Linnaeus
28 ex.: Fînaţele Clujului 29.V.1929 (3 ex.); 27.V.1928; 3.VI.1928 (2 ex.); 25.IV.1930; Cluj (V. Pleşca) 26.V.1929 (2 ex.); 20.V.1928; (V. Popii) 20.V.1928; 3.V.1928; 25.V.1927; (Făget) 1.V.1927 (2 ex.); Fînaţele Clujului 5.VI.1933; V. Gîrbăului 6.V.1928 (2 ex.); Sălicea 24.VI.1928; Mada 10.VI.1928; Cluj (Baciu) 15.V.1927; V. Mişidului 24.V.1928 (2 ex.); Săcărîmb 8.VI.1928; 9.VI.1928; Cheile Turzii 10.V.1929; Mt. Măgura 4.VII.1928; Cheile Turenilor 12.V.1929.

Therapis Hübner (=*Caustoloma* Lederer)

T. flavicaria Denis et Schiffermüller
2 ex.: Cluj 29.V.1927; 25.V.1929.

Hypoxystis Prout

H. pulviaria Fabricius (=*adspersaria* Hübner)
7 ex.: Cluj (V. Pleşca) 1.V.1928; 29.IV.1928 (2 ex.); 12.VII.1928 (2ex.); Cluj (Făget) 26.IV.1927; Sălicea 2.VII.1929.

Ennomos Treitschke

E. autumnaria autumnaria Werneburg
6 ex.: Cluj 17.IX.1928; 18.IX.1930; 19.IX.1930 (2 ex.); 13.IX.1922; 7.IX.1925.

E. quercinaria Hufnagel
9 ex.: Cluj 5.VIII.1928; 31.VII.1928; 19.VIII.1928; 25.VII.1928; Cluj (V. Pleşca) 10.VII.1927; 2.IX.1928; 5.VIII.1928; Cluj (Făget) 4.VIII.1927; Sălicea 19.VII. 1928.

E. fuscantaria Haworth
4 ex.: Cluj 12.VIII.1927 (2 ex.); Ineu 23.VIII.1927; 17.VIII.1927 (leg. Diószeghy).

E. erosaria Denis et Schiffermüller
2 ex.: Cluj 22.VII.1928; 18.VII.1928.

Selenia Hübner

S. dentaria Fabricius (=*bilunaria* Esper, =*illunaria* Hübner)
5 ex.: Cluj 10.IV.1927; 22.V.1932; 31.III.1916; Cluj (V. Popii) 16.VI.1929; Rîul Sadu 15.VI.1926 (leg. Czekelius).

S. lunularia Hübner (=*lunaria* Denis et Schiffermüller)
3 ex.: Cluj 25.IV.1927; 22.V.1927; 9.V.1927.

S. tetralunaria Hufnagel
1 ex.: Cluj 18.VII.1928.

Artiora Meyrick

A. evonymaria Denis et Schiffermüller
4 ex.: Cluj 6.IX.1918; Ineu 2.IX.1929; 10.IX.1928; 11.VIII.1928 (leg. Diószeghy).

Apeira Gistl

A. syringaria Linnaeus

2 ex.: Ineu 9.VIII.1925; 21.VIII.1920 (leg. Diószeghy).

Odontopera Stephens (=*Gonodontis* auct.)

O. bidentata Clerck

2 ex.: V. Negruței 5.VII.1928; Rîul Sadu 20.VI.1926 (leg. Czekelius).

Ourapteryx Leach

O. sambucaria Linnaeus

2 ex.: Cluj 3.VI.1924; 16.VI.1924.

Colotois Hübner (=*Himera* Duponchel)

C. pennaria Linnaeus

6 ex.: Cluj 3.X.1927; 23.X.1927 (2 ex.); 21.X.1927; 25.X.1929; Ineu 16.X.1929 (leg. Diószeghy).

Angerona Duponchel

A. prunaria prunaria Linnaeus

12 ex.: Cluj 25.VI.1928; (V. Calului) 5.VII.1928; (V. Popii) 15.VI.1930; (V. Pleșca) 21.VI.1927 (2 ex.); Sălicea 24.VI.1927; 19.VII.1933; Someșul Rece 3.VII.1927; Răcătău 3.VII.1928 (4 ex.).

Apocheima Hübner (=*Phigalia* Duponchel)

A. hispidaria Denis et Schiffermüller

2 ex.: Ineu 18.III.1933; 27.II.1933 (leg. Diószeghy).

A. pilosaria Denis et Schiffermüller (=*pedaria* Fabricius)

3 ex.: Cluj 26.III.1924; 11.IV.1929; Ineu 20.II.1931 (leg. Diószeghy).

Lycia Hübner

L. hirtaria Clerck

6 ex.: Cluj 21.III.1930; 10.IV.1921; 12.IV.1929; 12.IV.1935; 30.IV.1929; 12.IV.1931.

Nyssia Duponchel

N. zonaria zonaria Denis et Schiffermüller

4 ex.: Fînațele Clujului 19.IV.1931; 20.IV.1929; 25.IV.1930 (♀); Ineu 27.II.1925 (leg. Diószeghy).

Biston Leach (=*Amphidasis* Treitschke)

B. strataria strataria Hufnagel

1 ex.: Cluj 12.V.1921.

B. betularia betularia Linnaeus

4 ex.: Cluj 18.VII.1928 (4 ex.).

Agriopis Hübner

A. leucophaearia Denis et Schiffermüller

2 ex.: Ineu 5.III.1921; 7.XI.1930 (leg. Diószeghy).

A. bajaria Denis et Schiffermüller

2 ex.: Ineu 30.X.1921; 2.XI.1922 (leg. Diószeghy).

A. aurantiaria Hübner

4 ex.: Cluj 16.X.1931; Rîul Sadu 25.X.1925 (leg. Czekelius); Ineu 31.X.1921; 27.X.1930 (leg. Diószeghy).

A. marginaria Fabricius

5 ex.: Cluj 30.III.1930; 21.IV.1929; 16.X.1931; 25.III.1930 (♀); Ineu 1.III.1930 (leg. Diószeghy).

Erannis Hübner (=*Hybernia* Berthold)

E. defoliaria defoliaria Clerck

4 ex.: Cluj 12.XI.1928; Ineu 16.XI.1930 (leg. Diószeghy); Rîul Sadu 12.XI.1925 (2 ex.) (leg. Czekelius).

Synopsia Hübner

S. sociaria Hübner

3 ex.: Ineu 9.VIII.1929; 29.VIII.1928; 5.VIII.1929 (leg. Diószeghy).

Peribatodes Wehrli (=*Boarmia* s.l.)

P. rhomboidaria Denis et Schiffermüller (=*gemmaria* Brahm)
10 ex.: Cluj 2.VI.1927; 30.VIII.1927; 16.VII.1929; 7.V.1931; 4.VI.1927; 29.V.1927 (2 ex.); 28.VIII.1926; V. Drăganului 18.VII.1929 (2 ex.).

P. secundaria Esper
3 ex.: Mt. Retezat (950 m) 22.VII.1927 (2 ex.); (1000 m) 24.VII.1927 (leg. Diószeghy).

Selidosema Hübner

S. plumaria plumaria Denis et Schiffermüller (=*brunnearia* Villers)
2 ex.: Cheile Remetea (Bihor) 4.IX.1931; 5.IX.1931.

Cleora Curtis

C. cinctaria Denis et Schiffermüller
2 ex.: Cluj 20.IV.1927; 3.V.1929.

Alcis Curtis

A. repandata repandata Linnaeus
4 ex.: Cluj (Vf. Peana) 7.VII.1929 (3 ex.); V. Ierii 13.VII.1932.

A. maculata bastelbergeri Hirschke
1 ex.: Mt. Retezat (1400 m) 29.VII.1926 (leg. Diószeghy).

A. jubata jubata Thunberg
2 ex.: V. Negruţei 5.VII.1928; Mt. Retezat (1100 m) 15.VII.1928 (leg. Diószeghy).

Boarmia Treitschke

B. roboraria roboraria Denis et Schiffermüller
4 ex.: Cluj 25.VI.1928; 10.VIII.1928; 25.VIII.1927; Ineu 12.VI.1926 (leg. Diószeghy).

B. viertlii Bohatsch
1 ex.: Ineu 12.VI.1922 (leg. Diószeghy).

Serraca Moore

S. punctinalis Scopoli (=*consortaria* Fabricius)
4 ex.: Cluj 22.V.1929; 7.VIII.1929; Peştişul Mic 8.V.1921; Ineu 9.V.1920 (leg. Diószeghy).

Cleorodes Warren

C. lichenaria Hufnagel
1 ex.: Ineu 21.VII.1927 (leg. Diószeghy).

Fagivorina Wehrli

F. arenaria Hufnagel (=*angularia* Thunberg)
2 ex.: Ineu 1.V.1927 (2 ex.) (leg. Diószeghy).

Ascotis Hübner

A. selenaria selenaria Denis et Schiffermüller
6 ex.: Cluj 19.VII.1927; 18.VI.1928; 27.VII.1929 (2 ex.); 22.VII. 1928; Bucureşti 27.IV 1928 (ex. p.).

Ectropis Hübner

E. bistortata Goeze
16 ex.: Cluj 4.VII.1929 (2 ex.); 22.VII.1929 (2 ex.); 30.III.1927; (V. Pleşca) 17.VI. 1928 (2 ex.); 25.III.1930; 3.V.1928; 23.IV.1935; 30.V.1934; Sălicea 22.VI.1927; 24.VI.1928; Vf. Peana 30.IV.1927; Ineu 1.V.1926, 28.III.1927 (leg. Diószeghy).

f. *defessaria* Freyer
4 ex.: Cluj 23.III.1927; 23.IV.1935; 30.III.1927; Ineu 24.III.1927 (leg. Diószeghy).

E. consonaria Hübner
1 ex.: Peştişul Mic 8.V.1921 (e).

E. extersaria extersaria Hübner (=*luridata* Borkhausen)
3 ex.: Cluj 17.VI.1928; (V. Pleşca) 30.V.1934; Sălicea 24.VI.1928.

Aethalura McDunnough

A. punctulata Denis et Schiffermüller
3 ex.: Cluj 22.VI.1928; 21.V.1931; Sălicea 9.V.1929.

Ematurga Lederer

E. atomaria Linnaeus

51 ex.: Cluj 22.V.1927; 18.IV.1927 (4 ex.); 25.IV.1927; (Făget) 1.V.1927 (2 ex.); 26.IV.1927; 10.V.1928; 25.IV.1927; (V. Pleşca) 29.IV.1928 (11 ex.); 6.V.1928 (6 ex.); 10.VII.1927; 20.V.1928; 9.V.1930; 28.VII.1933; 21.VIII.1929; (V. Popii) 1.V.1928 (5 ex.); 13.VII.1928; 13.V.1928; Fînaţele Clujului 24.IV.1927 (3 ex.); 27.V.1928; Sălicea 9.V.1929 (2 ex.); 31.VII.1927 (2 ex.); 26.V.1929; 19.VII.1928; Boholt 30.VII.1931.

Tephronia Hübner

T. sepiaria Hufnagel

3 ex.: Ineu 10.VII.1928; 6.VII.1928; 20.VII.1932 (leg. Diószeghy).

Cabera Treitschke

C. pusaria Linnaeus*

9 ex.: Cluj 9.VII.1928; 1.V.1927; 25.V.1929; 22.V.1927; (V. Pleşca) 17.V.1928; 21.VII.1930; 7.VII.1929; V. Ierii 6.VII.1928; Săcărîmb 9.VI.1928.

C. exanthemata exanthemata Scopoli*

10 ex.: Cluj 25.VII.1928 (2 ex.); 2.V.1927; 29.V.1927; (V. Pleşca) 15.VI.1929; V. Negruţei 5.VII.1928 (3 ex.); Săcărîmb 8.VI.1928; Mada 15.VI.1928.

Bapta Stephens

B. bimaculata bimaculata Fabricius

3 ex.: Cluj 8.V.1927; Fînaţele Clujului 20.V.1930; Ineu 6.VI. 1929 (leg. Diószeghy).

B. temarata Denis et Schiffermüller

3 ex.: Cluj (Făget) 22.IV.1928; (V. Pleşca) 24.V.1928; Ineu 12.IV.1927 (leg. Diószeghy).

Theria Hübner

T. rupicapraria Denis et Schiffermüller

3 ex.: Ineu 8.II.1931; 1.III.1930; 19.II.1931 (♀) (leg. Diószeghy).

Campaea Lamarck

C. margaritata Linnaeus

3 ex.: Sălicea 29.VI.1927; Padiş (Glăvoiu) 22.VII.1934; (V. Ponor) 29.VII.1934.

Hylaea Hübner (=*Elliopia* Treitschke)

H. fasciaria Linnaeus (=*prosapiaria* Linnaeus, =*prasinaria* Denis et Schiffermüller)

1 ex.: Retezat (1500 m) 26.VII.1926 (leg. Diószeghy).

Puengeleria Rougemont

P. capreolaria Denis et Schiffermüller

2 ex.: Retezat (1400 m) 17.VII.1926 (leg. Diószeghy); Scăriţa-Belioara 17.VII.1933.

Odontognophos Wehrli

O. dumetata Treitschke

1 ex.: Peştişul Mic 26.VIII.1927.

Gnophos Treitschke

G. furvata Denis et Schiffermüller

1 ex.: Retezat (700—1100 m) 16.VII.1927 (leg. Diószeghy).

G. obscuratus Denis et Schiffermüller (=*myrtillata* Thunberg)

1 ex.: Ineu 29.VII.1924 (leg. Diószeghy).

G. pullata Denis et Schiffermüller

3 ex.: Retezat 17.VII.1926; (800—1400 m) 20.VII.1926 (leg. Diószeghy); V. Ierii 13.VII.1932.

G. glaucinaria Hübner

2 ex.: Retezat (1100 m) 26.V.1922; (1100 m) 5.VI.1923 (leg. Diószeghy).

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* identifications on the basis of ♂ and ♀ genitalia.

Psodos Treitschke (=*Psolos* Berthet)
P. coracina dioszeghyi Schmidt
3 ex.: Retezat (2250 m) 7.VII.1928; (2150 m) 16.VII.1928 (leg. Diószeghy); Bucegi (Babele) 1.VII.1928 (leg. Ostrogovich).

Siona Duponchel (=*Scoria* Stephens)
S. lineata Scopoli
11 ex.: Cluj 29.V.1927; Fînaţele Clujului 27.V.1928; 10.VI.1929; Sălicea 2.VI.1929; Săcărîmb 8.VI.1928; Deva 7.VI.1928; Cheile Turzii 8.VI.1932 (2 ex.); Tg. Mureş 4.VI.1928 (2 ex.); Mt. Vlădeasa 21.VII.1934.

Aspitates Treitschke
A. gilvaria gilvaria Denis et Schiffermüller
11 ex.: Fînaţele Clujului 10.VIII.1928 (8 ex.); 21.VIII.1928 (2 ex.); 27.VII.1929.
A. ochrearia Rossi
1 ex.: Techirghiol 26.VIII.1924 (leg. Ostrogovich).

Dyscia Hübner (=*Scodiona* Boisduval)
D. conspersaria Denis et Schffermüller
5 ex.: Fînaţele Clujului 30.VI.1929 (2 ex.); 13.V.1934 (3 ex.).

Superfam. SPHINGOIDEA

Fam. SPHINGIDAE

Agrius Hübner (=*Herse* Oken; =*Herse* Agassiz)
A. convolvuli Linnaeus
2 ex.: Cluj 13.VI.1927; Cluj 27.IX.1930.

Acherontia Laspeyres
A. atropos Linnaeus
1 ex.: Cluj 14.IX.1928.

Sphinx Linnaeus
S. ligustri ligustri Linnaeus
5 ex.: Cluj 17.VI.1927 (2 ex.); 27.VI.1927; 18.VI.1927; 9.VI.1921.

Hyloicus Hübner
H. pinastri pinastri Linnaeus
2 ex.: Cluj 1.VII.1945; Rîul Sadu VII.1929 (leg. Czekelius).

Smerinthus Latreille
S. ocellatus ocellatus Linnaeus
1 ex.: Cluj 13.VI.1927.

Mimas Hübner
M. tiliae tiliae Linnaeus
5 ex.: Ineu 4.V.1925 (leg. Diószeghy); Cluj 2.VI.1934; 18.VI.1932; 6.VII.1930; Rîul Sadu VI.1929 (leg. Czekelius)

Laothoe Fabricius (=*Amorpha* Kirby)
L. populi populi Linnaeus
2 ex.: Cluj 21.V.1927; Retezat (1000 m) 2.IX.1929 (leg. Diószeghy).

Hemaris Dalman
H. tityus tityus Linnaeus (=*scabiosae* Zeller)
6 ex.: Cluj (D. Hoia) 15.V.1927; Fînaţele Clujului 24.IV.1930; 26.IV.1930; Cluj (V. Popii) 16.VI.1929; Detunata 27.V.1929; Scăriţa Belioara 17.VII.1933.
H. fuciformis fuciformis Linnaeus
1 ex.: Cluj (Vf. Peana) 3.VI.1936.

Macroglossum Scopoli

M. stellatarum Linnaeus
5 ex.: Cluj 12.VI.1927; Cluj (V. Pleşca) 8.VII.1928; 27.VII.1927; Sălicea 31.VII.1927; Cluj 21.X.1930.

Hyles Hübner (=*Celerio* Oken, *Deilephila* auct.)

H. euphorbiae euphorbiae Linnaeus
4 ex.: Cluj 13.VI.1927; 17.VII.1927 (ex. larva) (nr. 741); 23.VII.1927 (ex. l.); Cluj (V. Popii) 10.VIII.1928.
H. gallii Rottenburg (nec *galii*)
1 ex.: Fînaţele Clujului 31.VII.1927 (ex. l.).

Deilephila Laspeyres (=*Pergesa* Walker)

D. elpenor elpenor Linnaeus
1 ex.: Cluj 17.VI.1927.
D. porcellus porcellus Linnaeus
5 ex.: Cluj (D. Hoia) 8.VI.1933; Cluj 19.V.1931; Cluj (Mănăştur) 22.V.1927; Cluj (V. Popii) 22.V.1932; Cluj (V. Pleşca) 8.VIII.1926.

Superfam. NOTODONTOIDEA
Fam. NOTODONTIDAE

Phalera Hübner

P. bucephala Linnaeus
1 ex.: Cluj (D. Hoia) 8.VI.1933.
P. bucephaloides Ochsenheimer
1 ♀: Ineu 18.VII.1933 (leg. Diószeghy) (e).

Cerura Schrank (=*Dicranura* auct.)

C. vinula vinula Linnaeus
2 ex.: Rîul Sadu 10.V.1926 (leg. Czekelius); Măgura Călăţelei 2.VII.1935.
C. erminea erminea Esper
1 ex.: Rîul Sadu VIII.1921 (leg. D. Czekelius)

Harpyia Ochsenheimer (=*Cerura* auct)

H. bifida bifida Brahm (=*hermelina* Goeze)
1 ex.: Eger (Hungary) (leg. Gaál), (e).

Stauropus Germar

S. fagi fagi Linnaeus
1 ex.: Rîul Sadu 25.V.1927 (leg. Czekelius).

Notodonta Ochsenheimer

N. dromedarius Linnaeus
1 ex.: Cluj 23.VIII.1926.

Ochrostigma Hübner

O. melagona Borkhausen
2 ex.: Rîul Sadu VII.1929 (leg. Czekelius); Rîul Sadu 1927 (e).

Drymonia Hübner

D. dodonea Denis et Schiffermüller (=*trimacula* Esper)
1 ex.: Rîul Sadu 3.V.1911 (leg. Czekelius), (nr. 806).

Pheosia Hübner

P. tremula Clerck
1 ex.: Rîul Sadu 5.V.1927 (leg. Czekelius), (nr. 808).
P. gnoma Fabricius (=*dictaeoides* Esper)
1 ex.: Rîul Sadu 20.VII.1926 (leg. Czekelius).

Ptilophora Stephens

P. plumigera Denis et Schiffermüller
10 ♂♂: Cluj 5.X.1923; 8.X.1923; 30.X.1923; Ineu 23.XI.1930 (2 ex.) (leg. Diószeghy); 27.XI.1930 (leg. Diószeghy); 22.XI.1930; 24.XI.1924; 7.XII.1930 (2 ex.) (leg. Diószeghy).

Pterostoma Germar

P. palpina Clerck
3 ex.: Cluj 25.VI.1929; 31.VII.1927 (e); Sălicea 3.VIII.1930.

Ptilodon Hübner (=*Lophopteryx* Stephens)

P. capucina Linnaeus (=*camelina* Linnaeus)
1 ex.: Rîul Sadu 20.VII.1925 (leg. Czekelius), (nr. 841).

Eligmodonta Kiriakoff

E. ziczac ziczac Linnaeus
2 ex.: Cluj 30.IV.1930; 13.X.1928 (ex. ovo).

Spatalia Hübner

S. argentina Denis et Schiffermüller
2 ex.: Cluj 28.V.1929; 7.VIII.1929.

Clostera Samouelle (=*Pygaera* auct.)

C. curtula Linnaeus
1 ex.: Rîul Sadu 26.VI.1926 (leg. Czekelius), (nr. 855).

C. anachoreta Denis et Schiffermüller
1 ex.: Cluj 30.VII.1936.

C. anastomosis anastomosis Linnaeus
3 ex.: Cluj (V. Pleşca) 15.VI.1929; Rîul Sadu 13.VIII.1913 (leg. Czekelius); Eger (Hungary) (leg. Gaál).

C. pigra Hufnagel
1 ex.: Rîul Sadu 25.V.1925 (leg. Czekelius), (nr. 870).

Fam. DILOBIDAE*

Diloba Boisduval

D. caeruleocephala Linnaeus
1 ex.: Cluj 13.XI.1929.

Superfam. BOMBYCOIDEA

Fam. ENDROMIDAE

Endromis Ochsenheimer

E. versicolora Linnaeus
1 ex.: Rîul Sadu VI.1929 (leg. Czekelius).

Fam. LASIOCAMPIDAE

Poecilocampa Stephens

P. populi Linnaeus
1 ♂: Rîul Sadu 1925 (leg. Czekelius).
2 ♀♀: Fînaţele Clujului 12.XI.1933; Rîul Sadu 1926 (leg. Czekelius).

Trichiura Stephens

T. crataegi Linnaeus
1 ♂: Rîul Sadu IX.1927 (leg. Czekelius).

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* A genus considered family by Kiriakoff (1970) on the basis of tympanal organs, but rejected by several lepidopterists.

Eriogaster Germar
E. lanestris Linnaeus
2 ♂♂: Fînaţele Clujului 26.II.1929; 6.I.1928 (ex. l.).
1 ♀ Fînaţele Clujului 2.XII.1933.
E. catax Linnaeus
4 ♂♂: Cluj 21.X.1927; 15.X.1927 (3 ex.) (ex. l.).
6 ♀♀: Cluj 12.X.1927 (3 ex.); 4.X.1927 (2 ex.); 16.X.1927 (ex. l.).

Lasiocampa Schrank
L. trifolii Denis et Schiffermüller
3 ♂♂: Fînaţele Clujului 4.VIII.1928 (3 ex.) (ex. l.).
2 ♀♀: Fînaţele Clujului 3.VIII.1928; 31.VIII.1928 (2 ex.) (ex. l.).
L. quercus quercus Linnaeus
1 ♂: Cheile Turzii 24.VII.1933.
3 ♀♀: Cluj (V. Pleşca) 10.VII.1928 (ex. l.); Fînaţele Clujului 13.VII.1928 (2 ex.) (ex. l.).

Macrothylacia Rambur
M. rubi Linnaeus
4 ♂♂: Ardeu 10.VI.1928 (2 ex.); Răcătău 3.VII.1928 (2 ex.).
3 ♀♀: Cluj 4.VI.1927 (ex. l.); 10.VI.1927 (ex. l.); Răcătău 3.VII.1928.

Phyllodesma Hübner (=*Epicnaptera* Rambur)
P. tremulifolia Hübner
1 ♀: Cluj 3.V.1928 (ex. l.).

Gastropacha Ochsenheimer
G. quercifolia Linnaeus
4 ♂♂: Cluj 15.VII.1928; 23.VII.1929; 30.VIII.1933; Sălicea 2.VII.1930.
1 ♀: Cluj 22.VI.1921.

Odonestis Germar
O. pruni Linnaeus
2 ♂♂: Ineu 4.IX.1922; 10.VII.1928 (leg. Diószeghy).

Fam. SATURNIIDAE

Saturnia Schrank (=*Eudia* Jordan)
S. pyri Denis et Schiffermüller
1 ♂: Cluj 10.V.1931.
2 ♀♀: Cluj 22.V.1931; 24.VI.1933.
S. pavonia pavonia Linnaeus
2 ♀♀: Făget (Cluj) (undated) (leg. Maticka); Cheile Baciului 16.VI.1931.
S. spini Denis et Schiffermüller
1 ♀: Fînaţele Clujului 21.III.1934.

Aglia Ochsenheimer
A. tau Linnaeus
2 ♂♂: Cluj (Făget) 26.IV.1927; (V. Pleşca) 29.IV.1928.
2 ♀♀: Cluj 16.V.1926; (Vf. Peana) 8.V.1932.

Superfam. COSSOIDEA

Fam. COSSIDAE

Subfam. *Zeuzerinae*

Phragmataecia Newman
P. castanea Hübner
2 ex.: Cluj (V. Pleşca) 15.VI.1929; Eger (Hungary) (undated) (leg. Gaál).

Zeuzera Latreille
Z. pyrina Linnaeus
3 ex.: Cluj 18.VII.1928 (2 ex.); Peştişul Mic 12.VII.1931.

Subfam. *Cossinae*

Cossus Fabricius

C. cossus cossus Linnaeus
2 ex.: Cluj 22.VI.1927; 4.VII.1922.

Parahypopta Daniel (=*Hypopta* Kirby)

P. caestrum caestrum Hübner
3 ex.: Sibiu (Viile Sibiului) 22.VI.1927 (2 ex.); 11.VII.1928 (all ex. leg. Czekelius).

Dyspessa Hübner

D. ulula Borkhausen
1 ex.: Ineu 31.V.1921 (leg. Diószeghy).

Subord. APARASTERNIA Niculescu

Superfam. HESPERIOIDEA

Fam. HESPERIIDAE

Subfam. *Pyrginae*

Erynnis Schrank (=*Nisoniades* Hübner) = (*Thanaos* Boisduval)

E. tages tages Linnaeus
12 ex.: Cluj (V. Popii) 6.V.1928 (4 ex.;) 1.V.1928 (4 ex.); (Făget) 18.IV.1927; Sălicea 29.VIII.1926; Viţa 10.V.1928 (2 ex.).

Carcharodus Hübner

C. alceae alceae Esper
5 ex.: Cluj (V. Popii) 24.V.1928; 14.VIII.1927; 22.VI.1928; 18.VIII.1927; 11.VII.1926.

C. lavatherae Esper
4 ex.: Cluj (D. Sf. Paul) 16.VI.1929; Cheile Turzii 6.VII.1929; V. Drăganului 25.VII.1934; 8.VII.1933 (Hungary) (P. Peször) (leg. Uhrik).

C. flocciferus flocciferus Zeller (=*altheae* Hübner)
4 ex.: Cluj 27.VIII.1926; 17.VII.1929; (V. Popii) 13.VI.1928; 2.VI.1927.

Pyrgus Hübner (=*Hesperia* Fabricius)

P. malvae malvae Linnaeus
19 ex.: Cluj (V. Pleşca) 6.V.1928 (2 ex.); 9.V.1920 (2 ex.); 2.IX.1928; (V. Popii) 13.V.1928; 20.V.1928; 22.VIII.1929 (2 ex.); 12.V.1927; 1.V.1928; 29.IX.1928; Fînaţele Clujului 5.VI.1933; 9.IX.1929; 27.V.1928; 20.V.1929; Ineu 28.IV.1921 (leg. Diószeghy); Retezat (1000 m) 21.VI.1922 (leg. Diószeghy); Neteda 8.VII 1933.

P. alveus alveus Hübner
18 ex.: Cluj (V. Popii) 20.VII.1930; 4.VI.1928; 8.VI.1929 (2 ex.); (V. Pleşca) 8.VII.1928; Fînaţele Clujului 27.V.1928 (2 ex.); 3.VI.1928 (4 ex.); Sălicea 19.VIII.1928; 21.VIII.1928; 2.IX.1928 (2 ex.); Făget-Cluj 8.VIII.1926; Ineu 16.V.1925; Retezat (1350 m) 10.VII.1928 (leg. Diószeghy).

P. serratulae serratulae Rambur
11 ex.: Cluj (V. Pleşca) 10.VII.1927; 21.VII.1929; (V. Popii) 4.VI.1928 (4 ex.); Fînaţele Clujului 30.VI.1929; Cheile Turzii 6.VII.1929; Drăgoiasa 25.VII.1934; Vlădeasa 21.VII.1934; Retezat (900 m) 28.VII.1926 (leg. Diószeghy).

P. sidae sidae Esper
1 ex.: Balcic (Bulgaria) (D. Culae Mare) 16.VII.1928 (leg. Ostrogovich).

P. fritillarius Poda (=*carthami* Hübner)
25 ex.: Cluj 16.VI.1929; 12.VIII.1922; (V. Popii) 4.VI.1928 (3 ex.); 31.V.1929; 22.V.1927 (2 ex.); 8.VI.1933 (2 ex.); (D. Hoia) 8.VI.?; Fînaţele Clujului 10.VI.1928; 26.VI.1928; 20.V.1940; Cheile Baciului 15.V.1927; Cheile Turzii 6.VI.1929;

25.VI.1933; Răcătău 3.VII.1928; V. Drăganului 25.VII.1934; Drăgoiasa 25VII. 1934; Mada 10.VI.1928; Sălicea 7.VI.1933; Ardeu 20.VI.1928; 10.VI.1929; 10.VII.1931.

P. cacaliae Rambur
3 ex.: M-ţii Bucegi (Piatra Arsă) 27.VII.1929 (2 ex.); 27.VII.? (unlocated) (ex. p.).

Spialia Swinhoe

S. sertorius orbifer Hübner (=*sao* Hübner)
1 ex.: 21. VIII. 1926 (leg. Kolar).

Syrichtus Boisduval

S. cribrellum Eversmann
3 ex.: Cluj (V. Popii) 8. VI. 1929; Fînaţele Clujului 8. VI. 1930; 20. V. 1929 (leg. Müller).

Subfam. *Hesperiinae*

Heteropterus Duméril

H. morpheus morpheus Pallas (=*steropes* Denis et Schiffermüller)
3 ex.: Cluj (V. Pleşca) 12. VII. 1928; 13. VII. 1928; Căpuşul Mic 29. VI. ?.

Carterocephalus Lederer (=*Pamphila* Fabricius)

C. palaemon palaemon Pallas
8 ex.: Cluj (Făget) 8. V. 1927; (V. Plesca) 24. V. 1928; 20. V. 1928; (V. Popii) 8. VI. 1933; Cheile Baciului 15. V. 1927 (3 ex.); Sălicea 20. V. 1929.

Thymelicus Hübner (=*Adopaea* Billberg)

T. lineola lineola Ochsenheimer
17 ex.: Cluj 24. VI. 1928 (3 ex.); 24. VI. 1927 (2 ex.); 18. VI. 1927 (2 ex.); (V. Popii) 13. VII. 1928 (3 ex.); (V. Pleşca) 29. VI. 1927; Fînaţele Clujului 30. VI. 1929 (5 ex.); Balcic (Bulgaria) (D. Culac Mare) 20. VII. 1928 (leg. Ostrogovich).

T. sylvestris Poda (=*thaumas* Hufnagel)
7 ex.: Cluj (V. Pleşca) 12. VII. 1928; 29. VI. 1926 (2 ex.); (V. Popii) 13. VII. 1928 (3 ex.); 10. VII. 1927.

T. acteon acteon Rottenburg
2 ex.: Balcic (Bulgaria) (D. Culac Mare) 21. VII. 1928; 18. VII. 1928 (leg. Ostrogovich)

Hesperia Fabricius (= *Augiades* Hübner)

H. comma comma Linnaeus
7 ex.: Cluj 26. VIII. 1928; (V. Pleşca) 2. IX. 1928 (2 ex.); 10. VII. 1927; (Făget) 8. VIII. 1926; 19. VII. 1928; Sălicea 26. VIII. 1928.

Ochlodes Scudder

O. venatus faunus Turati (= *sylvanus* Esper)
17 ex.: Cluj (V. Pleşca) 10. VII. 1927; 12. VII. 1928; 26. VII. 1927 (2 ex.); 1. VII. 1928 (2 ex.); 29. VI. 1927; (V. Popii) 11. VIII. 1926; 12. VI. 1927; (Făget) 1. VII. 1928; Fînaţele Clujului 15. VII. 1928 (2 ex.); Sălicea 24. VI. 1928 (2 ex.); 21. VII. 1929; Mţii Apuseni (V. Ponor) 29. VII. 1934; 1 ex. unlabelled.

Superfam. PAPILIONOIDEA

Fam. LYCAENIDAE

Subfam. *Riodininae*

Hamearis Hübner

H. lucina lucina Linnaeus
8 ex.: Cluj (V. Popii) 13. V. 1928 (2 ex.); 29. IV. 1928; 13. V. 1928 (e); 6. V. 1928 (3 ex.); Drăgoiasa (Mţii Apuseni) 25. VII. 1934.

Subfam. *Lycaeninae*

Lycaena Fabricius (= *Heodes* Dalman), (= *Chrysophanus* Hübner), (= *Palaeochrysophanus* Verity)

L. phlaeas phlaeas Linnaeus
18 ex.: Cluj (V. Popii) 13. V. 1928; 20. V. 1928 (3 ex.); 9. IX. 1926; 25. IX. 1927; 22. V. 1927; 14. VII. 1927; 25. VII. 1928; Fînaţele Clujului 9. IX. 1928; Sălicea 2. IX. 1928; 29. VIII. 1928 (3 ex.); Techirghiol 26. VI. 1927; 23. VI. 1927; 9. VII. 1927 (2 ex.).

L. dispar rutilus Werneburg
8 ex.: Cluj 30. VI. 1928; 9. IX. 1926; (Mănăştur) 29. V. 1927 (2 ex.); 22. V. 1927; 14. VIII. 1927; 25. VII. 1927; Sălicea 16. VII. 1930.

L. virgaureae virgaureae Linnaeus
5 ex.: Sălicea 21. VII. 1929; 29. VII. 1928; Cluj (V. Pleşca) 1. VII. 1928; V. Ierii 13. VII. 1932; 8. VI. 1921 (unlocated) (leg. Czekelius).

L. alciphron alciphron Rottenburg
5 ex.: Cluj 22. VII. 1932; (V. Pleşca) 5. VI. 1927; 8. VII. 1928; 5. VII. 1930; Sălicea 24. VI. 1928.

L. tityrus Poda
12 ex.: Cluj (V. Pleşca) 24. V. 1930; 20. V. 1928 (2 ex.); 5. VIII. 1928; 24. V. 1928; 4. VI. 1933; (V. Popii) 28. VII. 1928; 24. V. 1927; Sălicea 29. VII. 1928 (2 ex.); 26. V. 1929; Săcărîmb 8. VI. 1928.

Thersamonia Verity

T. thersamon thersamon Esper
7 ex.: Cluj (Mănăştur) 2. VI. 1927; 25. VII. 1927; 7. VIII. 1927; 14. VIII. 1927; 11. IX. 1927; 14. VIII. 1928; (V. Popii) 24. VIII. 1298.

Subfam. *Plebejinae*

Cupido Schrank (= *Zizera* Moore)

C. minimus minimus Fuessly
14 ex.: Cluj (V. Popii) 12. V. 1927; 20. V. 1928; 13. VII. 1928; (V. Pleşca) 26. V. 1929; 24. V. 1930; 4. VI. 1933; (Făget) 1. V. 1927; Fînaţele Clujului 30. VI. 1929; 5. VI. 1929; 20. V. 1940; Săcărîmb 8. VI. 1928; Deva 7. VI. 1928; Cheile Turzii 25. VI. 1933; Poeni 19. VII. 1929.

C. osiris Meigen (= *sebrus* auct.)
7 ex.: Cluj (Mănăştur) 12. VI. 1927; 14. VII. 1927 (2 ex.); (V. Pleşca) 17. VII. 1928; Fînaţele Clujului 26. VI. 1928 (3 ex.).

Everes Hübner

E. argiades argiades Pallas
4 ex.: Cluj (Vf. Peana) 31. VII. 1932 (3 ex.); Fînaţele Clujului 5. VI. 1933.

Celastrina Tutt

C. argiolus Linnaeus
11 ex.: Cluj (Făget) 18. IV. 1927 (2 ex.); 10. IV. 1927; 23. VII. 1926; 10. IV. 1927 (e); (V. Pleşca) 10. V. 1928; 24. V. 1930; (V. Popii) 1. V. 1928; Fînaţele Clujului 29. VII. 1927; Cheile Turzii 10. V. 1929; Poeni 19. VII. 1929.

Glaucopsyche Scudder

G. alexis alexis Poda (= *cyllarus* Rottenburg)
17 ♂♂: Cluj (Mănăştur) 22. V. 1927 (3 ex.); (Făget) 24. V. 1926; Fînaţele Clujului 10. VI. 1928; 27. V. 1928; 3. VI. 1928; 4. IV. 1930; 20. V. 1940; Cluj (V. Popii) 20. V. 1928 (3 ex.); (V. Pleşca) 8. V. 1927; 8. VI. 1927; Sălicea 2. VI. 1929; Mada 3. VI. 1928; Săcărîmb 8. VI. 1928.
11 ♀♀: Cluj (Mănăştur) 22. V. 1927; (V. Popii) 9. V. 1929; 19. V. 1928; 24. VI. 1928; 20. VI. 1928; (V. Pleşca) 10. VI. 1921; 10. VI. 1930; (D. Hoia) 15. V. 1927; Sălicea 24. VI. 1928 (2 ex.); Stana 1. VII. 1928.

Maculinea van Ecke

M. arion arion Linnaeus
13 ex.: Cluj 10. VII. 1927; 22. VII. 1928; 20. VII. 1931; 10. VII. 1927; 22. VI. 1932; (V. Popii) 22. VII. 1928; (V. Pleşca) 17. VII. 1927; (Făget) 7. VII. 1926; Mt. Măgura 4. VII. 1928 (2 ex.); Balcic (Bulgaria) (D. Culac Mare) 16. VII. 1928 (leg. Ostrogovich); Sălicea 29. VII. 1928; 6. VII. 1930.

M. alcon alcon Denis et Schiffermüller
8 ex.: Cluj (V. Pleşca) 12. VII. 1928; Sălicea 26. VI. 1927 (2 ex.); 21. VI. 1927; V. Iarii 13. VII. 1932; Sibiu 8. VII. 1917 (leg. Czekelius); 1 ex. (leg. Reskovits) ?

M. nausithous Bergsträsser (= *arcas* Rottenburg h.i.)
1 ex.: Sibiu (D. Guşteriţei) 24. VIII. 1914 (leg. Czekelius).

Iolana Bethune Baker

I. iolas iolas Ochsenheimer
2 ex.: Balcic (D. Culac Mare) 16. VII. 1928 (leg. Ostrogovich); Budapesta (Farkasvölgy) 16. VII. 1934.

Philotes Scudder

P. bavius hungaricus Diószeghy
6 ex.: Fînaţele Clujului 2. V. 1953 (5 ex.); Viţa IV. 1918 (leg. B. Varga).

P. baton Bergsträsser
1 ex.: Mţii Apuseni (Vîrtop) 23. VII. 1934.

Scolitantides Hübner

S. orion orion Pallas
4 ex.: Cheile Turzii 25. VI. 1933 (3 ex.); Fînaţele Clujului 5. VI. 1929.

Plebejus Kluk

Subgenus **Plebejus** Kluk

P. (P.) argus argus Linnaeus (= *aegon* Denis et Schiffermüller)
2 ex.: Cluj 11. IX. 1927 (e); Fînaţele Clujului 30. VI. 1929.

P. pylaon sephirus Frivaldsky
9 ex.: Cluj (D. Hoia) 5. VI. 1932 (2 ex.); Fînaţele Clujului 8. VI. 1930 (3 ex.); 8. VI. 1921 (leg. Müller); Sălicea 3. VIII. 1930; 2. IX. 1928; Suatu 7. VI. 1931.

Subgenus **Lycaeides** Hübner

P. (L.) idas idas Linnaeus
8 ex.: Cluj (V. Popii) 8.VI.1929; 22.V.1927; 3.IX.1930; 21.VI.1932; Sălicea 26.VI.1933; Boholt 20.VII.1931; Vlădeasa 21.VII.1934 (2 ex.).

P. (L.) argyrognomon Bergsträsser (=*ismenias* Meigen h.i.)
2 ex.: Fînaţele Clujului 3.VI.1928; Băbeşti 14.VII.1931.

Aricia Reichenbach Leipzig

Subgenus **Aricia** Reichenbach Leipzig (s.str.)

A.(A.) agestis agestis Denis et Schiffermüller (=*astrarche* Bergsträsser)
5 ex.: Cluj (V. Popii) 8.VI.1929 (2 ex.); 22.VII.1928; Fînaţele Clujului 9.IX.1928; Drăgoiasa 25.VII.1934.

A.(A.) artaxerxes montensis Verity
1 ex.: Cluj (V. Popii) 15.VI.1930.

Cyaniris Dalman

C. semiargus semiargus Rottenburg
23 ex.: Cluj (V. Pleşca) 26.VI.1927; 26.V.1929; (V. Popii) 24.V.1931 (3 ex.); 22.VI. 1927; 4.VI.1928; Fînaţele Clujului 3.VI.1928 (8 ex.); 10.VI.1928; 27.V.1928 (3 ex.); Cheile Baciului 15.V.1927; Stana 8.VI.1928 (2 ex.); Răcătău 3.VI.1928.

Polyommatus Kluk

Subgenus **Polyommatus** s.str.

P.(P.) icarus icarus Rottenburg
44 ex.: Cluj (V. Popii) 8.VI.1929 (5 ex.); 7.V.1931; 13.VI.1930 (4 ex.); 19.VIII.1928;

24.V.1931; 22.VII.1928; (V. Pleşca) 2.VI.1929; Fînaţele Clujului 20.V.1930; 9.VI.1929 (2 ex.); 29.VI,1929. (2 ex.) 10.VI.1928; 20.V.1940; 30.V.1929; 5.VI 1929; Cluj 5.VIII.1928; 10.VII.1953; 20.VIII.1933; Sălicea 3.VIII.1930 (2 ex.); 24.VI.1927; 24.VI.1927; 19.VIII.1928 (2 ex.); 31.VII.1927; 20.VII.1933; 26.VI. 1933; Cheile Baciului 15.V.1927; Cheile Turzii 13.VIII.1930; 25.VI.1933 (2 ex.); Suatu 7.VI.1931; Drăgoiasa 25.VII.1934; Vîrtop 23.VII.1934; Vlădeasa 21.VII. 1934; 1 ex. leg. Gaál (Hungary).

P. dorylas Denis et Schiffermüller (=*argester* Bergsträsser) = (*hylas* Esper h.i.)

8 ex.: Cluj (V. Pleşca) 26.VI.1930; 24.VI.1928 (2 ex.); 5.VIII.1928; 29.V.1926; (Făget 2.VI.1927; Fînaţele Clujului 29.VI.1928; Sibiu (D. Guşteriţa) 15.VII.1919 (leg. Czekelius).

P. amanda amanda Schneider

6 ex.: Fînaţele Clujului 9.VI.1929 (3 ex.); 26.VI.1928; 8.VI.1930; 29.VI.1928.

P. thersites Cantener

10 ex.: Cluj (Mănăştur) 12.VI.1927; 24.VI.1931; (V. Popii) 29.V.1929; 24.V.1931; Fînaţele Clujului 27.VII.1929 (3 ex.); 9.VI.1929; 8.VI.1930; Boholţ 20.VII.1931.

Subgenus **Meleageria** Sagarra

P.(M.) daphnis daphnis Denis et Schiffermüller (=*meleager* Esper)

19 ex.: Cluj (V. Pleşca) 17.VII.1927; 9.VII.1928; 12.VIII.1928; 25.VII.1926; 5.VIII. 1928; Sălicea 12.VIII.1928 (4 ex.); 26.VIII.1928 (2 ex.); 31.VII.1927; 29.VIII. 1928. (3 ex.); Fînaţele Clujului 11.VII.1926(3 ex.); Balcic (Bulgaria) (D. Culac Mare) 24.VII.1928 (leg. Ostrogovich).

Subgenus **Lysandra** Hemming

P.(L.) coridon coridon Poda

17 ex.: Cluj (V. Popii) 14.VIII.1927; 22.VIII.1928; 25.VII.1927 (2 ex.); 27.VIII.1930; (V. Pleşca) 5.VIII.1928; 12.VIII.1928; 5.VIII.1928; Cluj 25.VIII.1928; Sălicea 2.IX.1928; 3.VIII.1930; 19.VIII.1928; Fînaţele Clujului 5.VIII.1928; 27.VII. 1929; Cheile Turzii 13.VIII.1930; Hunedoara 24.VII.1932; ?, 27.VIII.1930.

P.(L.) bellargus bellargus Rottenburg

25 ♂♂: Cluj (V. Pleşca) 1.VII.1928; 14.VIII.1927; 7.VIII.1928; (V. Popii) 22.VI.1928; Sălicea 26.VIII.1928 (2 ex.); 24.VI.1928 (3 ex.); 2.IX.1928 (4 ex.); 29.VIII. 1926; 19.VIII.1928; Cluj (Mănăştur) 14.VIII.1927 (2 ex.); Fînaţele Clujului 29.V.1928; 26.VI.1928; 21.VIII.1928 (3 ex.); 9.IX.1928; Madă 10.VI.1928; Mt. Măgura 4.VII.1928.

12 ♀♀: Cluj 12.IX.1927; 4.VIII.1927; (V. Popii) 22.VI.1928; (V. Pleşca) 2.IX.1928; Sălicea 2.IX.1928 (3 ex.); Fînaţele Clujului 9.IX.1928 (2 ex.); 9.IX.1929; Cheile Turzii 25.VI.1933; Mt. Măgura 4.VII.1928.

f. *ceronus* Esper

1 ♀: Cluj (Mănăştur) 12.VI.1927.

Subfam. *Theclinae*

Thecla Fabricius (=*Zephyrus* Dalman) = (*Quercusia* Verity)

T. betulae betulae Linnaeus

2 ♂♂: Cluj (V. Popii) 15.VIII.1926; 11.VIII.1926 (e).

6 ♀♀: Cluj (V. Popii) 11.VIII.1926 (2 ex.); 11.IX.1927; 15.VIII.1927; Fînaţele Clujului 10.VIII.1928; 21.VIII. 1928.

T. quercus quercus Linnaeus

3 ♂♂: Cluj (V. Pleşca) 10.VII.1927 (2 ex.); (D. Galcer) 28.VII.1933 (e).

2 ♀♀: Cluj (V. Pleşca) 10.VII.1927; Boholt 20.VII.1931.

Nordmannia Tutt (=*Strymon* Hübner) = (*Thecla* Fabricius)

N. ilicis ilicis Esper

6 ex.: Cluj (V. Pleşca) 1.VII.1928; Fînaţele Clujului 28.V.1930; 30.VI.1929 (2 ex.); 5.VI.1929 (2 ex.).

N. acaciae nostras Courvoisier

5 ex.: Cluj (V. Popii) 28.VI.1932; 12.VI.1927; Stana 1.VII.1928 (2 ex.); Fînaţele Clujului 29.VI.1929.

Strymonidia Tutt

P. pruni Linnaeus
3 ex.: Cluj 8.VI.1927; Stana 1.VII.1928; Deva 7.VI.1928.

S. spini spini Denis et Schiffermüller
12 ex.: Cluj 18.VIII.1922; (Făget) 4.VII.1926; Fînaţele Clujului 26.VII.1928; 30.VI.1929; 15.VII.1928; 12.VIII.1922 (2 ex.); Cluj (V. Pleşca) 8.VII.1928; 12.VII.1928; Stana 1.VII.1928; Cheile Turzii 6.VI.1929; Balcic (Bulgaria) (D. Culac Mare) 19.VII. 1928 (leg. Ostrogovich).

S. w-album w-album Knoch
1 ex.: Ineu 13.VI.1927 (leg. Diószeghy).

Callophrys Billberg

C. rubi virgatus Verity
9 ex.: Cluj (V. Popii) 29.IV.1928 (2 ex.); (Făget) 1.V.1927 (e); Sălicea 26.V.1929 (2 ex.); 25.VI.1933; Cheile Turzii 10.V.1929; Fînaţele Clujului 3.V.1928; Mada 9.VI.1928.

Fam. PAPILIONIDAE

Subfam. *Papilioninae*

Papilio Linnaeus

P. machaon machaon Linnaeus
2 ♂♂: Cluj (Vf. Peana) 8.V.1932; Cluj 24.VII.1934.
3 ♀♀: Cluj (V. Popii) 24.VII.1928; Cluj 15.VII.1927; Sălicea 18.VII.1926.

Iphiclides Hübner

. *podalirius podalirius* Linnaeus
4 ♂♂: Cluj (V. Popii) 10.V.1929; (V. Pleşca) 10.VII.1927; Cheile Turzii 12.V.1929; Viţa 15.IV.1928.
7 ♀♀: Cluj (V. Pleşca) 12.VIII.1928; 6.V.1928; 29.IV.1928; 10.VII.1927; (V. Popii) 10.V.1929; 20.IV.1927; 18.VI.1927 (e).

Subfam. *Parnassiinae*

Parnassius Latreille (=*Doritis* Fabricius)

P. apollo jaraensis Kertész
43 ♂♂: Răcătău 14.VII.1929 (2 ex.); 5.VII.1928 (5 ex.); 3.VII.1928 (28 ex.); 5.VII.1928; 3.VII.1927 (4 ex.); V. Ierii 13.VII.1923 (3 ex.).
9 ♀♀: Răcătău 3.VII.1928 (5 ex.); 3.VII.1927; VII.1928; 14.VII.1929; 5.VII.1928.

P. mnemosyne Linnaeus
8 ♂♂: Tg. Mureş 4.VI.1928; Cheile Turzii 17.V.1931; Săcărîmb 9.VI.1928; Tg. Mureş 4.V.1928 (2 ex.); Răcătău 3.VII.1928; Cheile Turzii 25.VI.1933; V. Ponor (M-ţii Apuseni) 29.VII.1934.
5 ♀♀: Răcătău 3.VII.1928; Tg. Mureş 4.VI.1928; Săcărîmb 9.VII.1938; Cheile Turzii 17.V.1931; Ardeu 10.VI.1928.

P. mnemosyne transsylvanica Schmidt
1♀: Retezat (900 m) 1.VI.1922 (leg. et det. Diószeghy). (Topotype).

Subfam. *Zerynthiinae*

Zerynthia (Ochsenheimer (=*Thais* Fabricius h.i.) = (*Parnalius* Rafinesque) = (*Allancastria* Bryk)

Z. polyxena polyxena Denis et Schiffermüller (=*hypsipyle* Schulze)
3 ♂♂: Ineu 20.V.1928 (ex. l.); 26.IV.1928 (ex. l.); 24.IV.1928 (ex. l.) (leg. Diószeghy).
1 ♀: Ineu 24.IV.1928 (ex. l.) (leg. Diószeghy).

Fam. PIERIDAE

Subfam. *Dismorphiinae*

Leptidea Hübner (=*Leucophasia* Stephens)

L. *sinapis sinapis* Linnaeus

83 ex.: Cluj (V. Popii) 13.VII.1928 (5 ex.); 6.V.1928 (5 ex.); 20.V.1928; 22.VI.1931 (2 ex.); 23.VI.1929; 22.VII.1928 (2 ex.); 22.VIII.1929; 25.VII.1928; 29.IV.1928; 20.VIII.1930; 24.V.1930 (2 ex.); 22.VIII.1929; (V. Pleşca) 12.VII.1928 (9 ex.); 1.V.1928 (3 ex.); 25.VII.1929 (2 ex.); 21.VII.1929 (5 ex.); 8. VII.1928; 8.VII.1928; 25.VII.1928; 5.VIII.1928; 17.VII.1927; Cluj 22.VII.1928 (5 ex.); 25.VII.1928 (2 ex.); 5.VIII.1928 (3 ex.); (Făget) 10.IV.1927 (2 ex.); 22.IV.1928 (2 ex.); Sălicea 1.VII.1928; 3.VIII.1930; 26.VI.1928; 9.V.1929; 21.VI.1927; 21.VII.1929; 26.VI.1927; 21.VII.1929; Fînaţele Clujului 15.VII.1928; 4.VI.1933 (2 ex.); 30.VI.1928; Cheile Baciului 15.V.1927; Bucegi 10.VII.1927 (2 ex.); Viţa 10.V.1928; Cheile Turzii 10.V.1929 (2 ex.); 6.VI.1929; Poeni 19.VII.1929 (3 ex.).

L. *morsei major* Grund

18 ex.: Cluj (V. Pleşca) 29.IV.1928; 21.VII.1929 (2 ex.); 1.V.1928 (2 ex.); (V. Popii) 6.V.1928; 13.V.1928 (2 ex.); 13.VII.1928; Cluj 22.VII.1928; (Făget) 22.IV.1928; 10.IV.1927 (4 ex.); Sălicea 25.VII.1928.

Subfam. *Pierinae*

Aporia Hübner

A. *crataegi crataegi* Linnaeus

7 ex.: Cluj 3. VII.1933; (V. Popii) 20.V.1934 (2 ex.); (Făget) 2.VI.1927 (2 ex.); Fînaţele Clujului 5.VI.1929; Lita Română 19.VII.1933.

Pieris Schrank

P. *rapae rapae* Linnaeus

21 ex.: Cluj 26.VII.1928; 19.VIII.1928; 3.IV.1927; (V. Popii) 18.VI.1927; 12.VI.1927 (3 ex.); 10.V.1929 (2 ex.); (V. Pleşca) 22.IV.1928; 10.VII.1927; (Becaş) 2.IX.1928; Stana 1.VII.1928; Făget 1.V.1927 (2 ex.); Cheile Turenilor 24.VII.1933; Fînaţele Clujului 19.IV.1930 (2 ex.); 30.VII.1930; Mada 9.VI.1928; Bucegi 18.VII.1927.

P. *napi meridionalis* Heyne

26 ex.: Cluj (V. Popii) 10.V.1929; (V. Pleşca) 22.IV.1928; (Făget) 12.IV.1927; 10.IV.1927 (4 ex.); 22.IV.1928 (3 ex.); Sălicea 13.VII.1928; 19.VII.1928; 29.VII.1928 (4 ex.); 21.VII.1929; Fînaţele Clujului 10.VI.1928; 15.VII.1928; M-ţii Bucegi 10.VII.1927; V. Drăganului 12.VII.1929; 18.VII.1928; 19.VII.1929; Cheile Turzii 10.V.1929 (2 ex.); Poeni 19.VII.1929.

P. *bryoniae carpathensis* Moucha

1 ex.: Rîşnov 10.VII.1927.

P. *bryoniae* ssp ? 2 ex.: Stana 1.VII.1928; Bolboci 24.VII.1929.

P. *manni rossi* Stefanelli

2 ex.: Retezat (1100 m) 23.VII.1928; 26.VII.1928 (leg. Diószeghy).

P. *brassicae brassicae* Linnaeus

3 ex.: Cluj (Făget) 2.VI.1927; (V. Popii) 22.VII.1928; Sălicea 31.VII.1932.

Pontia Fabricius (=*Leucochloe* Röber)

P. *daplidice daplidice* Linnaeus

25 ex.: Cluj 28.IV.1926; 23.IX.1930; (V. Popii) 11.IV.1928 (12 ex.); 11.IX.1923; 13.VII.1928; 24.VIII.1928; 25.IX.1927; 27.VIII.1930; Sălicea 12. VI.1928(2 ex.); 19.VI.1929; Făget 5.VI.1937; Fînaţele Clujului 15.VI.1928; Hunedoara 25.VIII. 1927.

Anthocharis Boisduval

A. *cardamines meridionalis* Verity

18 ex.: Cluj 8.V.1927; (V. Pleşca) 1.V.1928; 26.V.1929 (2 ex.); 6.V.1928 (5 ex.); 2.V.1926 (2 ex.); (V. Popii) 20.V.1928; 12.V.1927; Sălicea 26.IV.1927; Tg. Mureş 11.VI.1928; Cluj (Făget) 1.V.1927 (2 ex.); M-ţii Bucegi 10.VII.1927.

Subfam. *Coliadinae*

Colias Fabricius

C. hyale Linnaeus

15 ♂♂: Cluj (V. Popii) 31.V.1929; 22.VII.1928 (2 ex.); 8.IX.1928; 11.IX.1927; 9.IX.1926; 13.VII.1928; 22.VII.1928 (2 ex.); 24.VIII.1928; (V. Pleşca) 10.VII.1927 (det. Czekelius ab. *emarginata* Röb., nr. 19.); Fînaţele Clujului 15.VII.1928; 4.VI.1933; Cheile Baciului 15.VI.1927 (det. Czekelius ab. *intermedia* Tutt, nr. 21); M-ţii Bucegi 14.VII.1927 (leg. Nágler).

11 ♀♀: Cluj (V. Popii) 22.VII.1928; 21.IX.1930; 24.VII.1928 (2 ex.); 7.X.1928; 8.X.1928; 12.IX.1928; Fînaţele Clujului 9.IX.1928 (2 ex.); (V. Pleşca) 5.VI.1927; Deva—Cetate 7.VI.1928.

C. alfacariensis Ribbe (=*australis* Verity)

5 ♂♂: Cluj (V. Popii) 4.VI.1928; 8.X.1927; (Făget) 16.V.1926 (det. Czekelius *C. hyale* ab. *unimaculata* Tutt, nr. 20); Fînaţele Clujului 9.IX.1928; Sălicea 29.VII.1928.

4 ♀♀: Cluj (V. Pleşca) 8.IX.1928; Cheile Baciului 15.V.1927; Fînaţele Clujului 9.IX.1928 (2 ex.).

C. crocea crocea Geoffroy in Fourcroy (=*edusa* Fabricius)

17 ♂♂: Cluj (V. Popii) 24.VII.1928 (2 ex.); 25.IX.1927; (V. Pleşca) 2.IX.1928; 8.IX.1928; Sălicea 26.VIII.1928 (4 ex.); 12.VIII.1928 ;Fînaţele Clujului 9.IX.1928 (4 ex.); Mărişel 3.VII.1927; V. Ierii 6.VII.1928; Rîşnov 14.VII.1927.

25 ♀♀: Cluj (V. Popii) 22.VII.1928 (3 ex.); 24.VII.1928; 12.IX.1926; 22.VII.1928; (V. Pleşca) 8.IX.1928; Sălicea 26.VIII.1928 (3 ex.); 19.VIII.1928; 22.VIII.1926; Fînaţele Clujului 9.IX.1928 (11 ex.); Rîşnov 8.VIII.1927; M-ţii Retezat (Gura Apei) 17.VII.1928 (leg. Diószeghy).

C. chrysotheme Esper

2 ♂♂: Budaörs (Hungary) 18.IX.1938; 30.VII.1936.

3 ♀♀: Sălicea 19.VIII.1928; Budapest (Csiki hegyek) 20.VIII.1937; 25.IX.1938 (leg. Surmin).

C. myrmidone myrmidone Esper

8 ♂♂: Cluj (V. Pleşca) 4.VIII.1927 (2 ex.); Sălicea 29.VIII.1928; 26.VIII.1928 (3 ex.); 19.VIII.1928; 9.IX.1928.

1 ♀: Sălicea 22.VIII.1926.

Gonepteryx Leach

G. rhamni transiens Verity

13 ex.: Cluj (V. Pleşca) 25. .1928; 12.V .1928; Sălicea 21.V I.1929; 26.VIII.1928; Făget 10.IV.1929; Fînaţele Clujului 30.VI.1929 (2 ex.); 15.VII. 1928; Poeni 19.VII.1929; Valea Drăganului 18.VII.1928; Răcătău 14.VII.1929; M-ţii Bucegi 27.VII.1927 (2 ex.).

Fam. NYMPHALIDAE

Subfam. *Nymphalinae*

Apatura Fabricius

A. iris iris Linnaeus

14 ex.: Cluj (V. Pleşca) 10.VII.1927; Sălicea 7.VII.1929 (3 ex.); 1.VII.1928; 12.VII.1928 (2 ex.); 29.VI.1927; 22.VI.1927; 25.VII.1928 (2 ex.); 29.VII.1928; Retezat (1200 m) 18.VII.1928 (leg. Diószeghy); Rîşnov 8.VII.1928.

A. ilia ilia Denis et Schiffermüller

25 ex.: Cluj 26.VI.1927; (Vf. Peana) 22.VII.1928 (2 ex.); Sălicea 7.VII.1929 (2 ex.); 29.VI.1927 (8 ex.); 22.VII.1928 (2 ex.); 12.VII.1928 (3 ex.); 25.VI.1928; 21.VII.1929 (2 ex.); 22.VII.1928 (2 ex. ♀♀); 29.VII.1928 (2 ex. ♀♀).

Neptis Fabricius

N. rivularis rivularis Scopoli (=*lucilla* Fabricius)

17 ex.: Cluj 12.VI.1924; Retezat 1.VII.1928 (leg. Diószeghy); Mt. Măgura 4.VII.1928 (3 ex.); Vlădeasa 18.VII.1928 (2 ex.); V. Abruzelului 27.VI.1927; Someşul

Rece 3.VII.1927; Răcătău 3.VII.1928; V. Negruței 5.VII.1928; V. Drăganului 19.VII.1928; V. Ierii 13.VII.1932; 6.VII.1928 (2 ex.); V. Ponor (M-ții Apuseni); M-ții Bucegi 14.VII.1927.

N. sappho sappho Pallas (=*hylas* auct.)

10 ex.: Cluj (V. Popii) 20.V.1928 (2 ex.); 13.V.1928 (3 ex.); (V. Pleșca) 27.VII.1927; 8.V.1927; 26.V.1929; 5.VIII.1928; (Făget) 1.V.1927.

Ladoga Moore (=*Limenitis* auct.)

L. populi Linnaeus

9 ♂♂: Sălicea 5.VII.1927 (3 ex.); 1.VII.1928; 16.V.1929; 19.VI.1932; Cluj 21.V.1927 (e); 1 ex. unlabelled; Retezat 15.VII.1928 (leg. Diószeghy).

1 ♀: Sălicea 1.VII.1928.

L. camilla camilla Linnaeus (=*sibilla* Linnaeus)

9 ex.: Cluj 5. VIII. 1928 (2 ex.); Sălicea 22.VII.1928 (2 ex.); 26.VI.1927 (2 ex.); Rișnov 8.VII.1928; 1 ex. unlabelled.

Nymphalis Kluk

N. polychloros polychloros Linnaeus

14 ex.: Cluj 25.VI.1929 (2 ex.); 21.VI.1926; 19.VII.1933; (V. Pleșca) 25.III.1928; (V. Popii) 21.VI.1929; (Feleac) 1.IV.1928; V. Drăganului 18.VII.1929; Roșia Montană 28.VI.1927; Retezat (1000 m) 29.VI.1929; (1000 m) 24.VI.1929; (1000 m) 10.VII.1929 (leg. Diószeghy); Cluj (Făget) 20.III.1927; 1 ex. unlabelled.

N. xanthomelas xanthomelas Denis et Schiffermüller

4 ex.: Sălicea 22.VII.1928 (2 ex.); Retezat (1100 m) 19.VII.1929; (1100 m) 30.VI.1929 (leg. Diószeghy).

N. antiopa antiopa Linnaeus

4 ex.: Cluj 12.VII.1929; 17.VII.1923 (ex. l.); Vf. Peana 22.VII.1928; Sălicea 18.VII. 1926; 29.VII.1928.

Inachis Hübner

I. io io Linnaeus

8 ex.: Cluj 24.VI.1927; 26.VI.1927 (2 ex.), (ex. p.); 5.VIII.1928; Sălicea 29.VII.1928 (2 ex.); V. Drăganului 18.VII.1929 (2 ex.).

Vanessa Fabricius (=*Pyrameis* Hübner)

V. atalanta atalanta Linnaeus

4 ex.: Cluj 21.VII.1927 (ex. p.); V. Pleșca 5.VIII.1928; Sălicea 22.VII.1928; 29.VII. 1928.

Cynthia Fabricius

C. cardui cardui Linnaeus

14 ex.: Cluj (V. Popii) 22.VII.1928 (7 ex.); Sălicea 29.VII.1928 (7 ex.).

Aglais Dalman

A. urticae urticae Linnaeus

7 ex.: Cluj 14.VI.1927 (ex. p.); 18. VI.1927; Sălicea 29.VII.1928 (3 ex.); Tg. Mureș 4.VI.1928; M-ții Bucegi 10.VII.1927.

Polygonia Hübner

P. c-album c-album Linnaeus

10 ex.: Cluj 22.VII.1928; (Făget) 10.IV.1927; (V. Pleșca) 10.VII.1927; Sălicea 22.VII. 1928 (2 ex.); Stana 1.VII.1927; Răcătău 3.VII.1928; Mt. Măgura 4.VII.1928; M-ții Bucegi 14.VII.1927 (2 ex.).

P. egea Cramer

1 ex.: Albania (Scutari) 7.VII.1917 (leg. Bartha).

Araschnia Hübner

A. levana levana Linnaeus

2 ex.: V. Mișidului (M-ții Apuseni) 21.V.1928; Ineu 4.IV.1927 (leg. Diószeghy).

f. *prorsa* L.

3 ex.: Cluj (Vf. Peana) 31.VII.1932 (2 ex.); Ineu 19.VIII.1926 (leg. Diószeghy).

Subfam. *Argynninae*

Clossiana Reuss

C. selene selene Denis et Schiffermüller
12 ex.: Cluj 26.VIII.1928 (2 ex.); (V. Pleşca) 26.V.1929 (3 ex.); 2.VI.1927 (2 ex.); 24.V.1928; 17.VII.1927; 17.VII.1928; (V. Popii) 24.V.1930; V. Ierii 6.VII.1928.

C. euphrosyne euphrosyne Linnaeus
10 ex.: Cluj (V. Pleşca) 8. V. 1927 (3 ex.); 6. V. 1928 (4 ex.); 24. V. 1928; Fînaţele Clujului 10. V. 1929; Vîrtop 23. VII. 1934.

C. dia dia Linnaeus
22 ex.: Cluj 27. VIII. 1930; (V. Popii) 14. VIII. 1927; 10. IV. 1927; 29. IV. 1928; 24. VI. 1927; 21. VI. 1927; (V. Pleşca) 1. V. 1928 (6 ex.); 2. X. 1928 (2 ex.); 29. IV. 1928; V. Gîrbăului 6. V. 1928; Fînaţele Clujului 21. VIII. 1928; Cheile Turzii 10. V. 1929; Răcătău 3. VII. 1928; Poeni 19. VII. 1929; Braşov 13. VII. 1927; Sălicea 7. VI. 1933.

Argynnis Fabricius

Subgenus **Brenthis** Hübner

A. (B.) hecate hecate Denis et Schiffermüller
19 ex.: Cluj (V. Popii) 7. V. 1931; 15. VI. 1930 (2 ex.); (V. Pleşca) 1. VIII. 1928; 22. VI. 1927; 16. V. 1930; 21. VI. 1927 (2 ex.); 12. VII. 1928; 10. V. 1930; (Făget) 5. VI. 1927 (2 ex.); 4. VII. 1926; Fînaţele Clujului 29. VI. 1928 (2 ex.); 30. IV. 1929 (4 ex.).

A. (B.) daphne daphne Denis et Schiffermüller
1 ex.: Retezat (1100 m) 23. VII. 1928 (leg. Diószeghy).

A. (B.) ino ino Rottenburg
7 ex.: Cluj 21. VII. 1927 (2 ex.); (V. Pleşca) 1. VII. 1922; (Făget) 11. VI. 1926; Lăpuşna 12. VII. 1930 (2 ex.); Răcătău 14. VII. 1929.

Subgenus **Issoria** Hübner

A. (I.) lathonia lathonia Linnaeus (= *charlotta* Haworth)
8 ex.: Cluj 25. III. 1920; 5. VI. 1933; (V. Popii) 18. IV. 1927; (V. Pleşca) 20. VII. 1927; Sălicea 26. VIII. 1928; 3. VII. 1928; Braşov 8. VII. 1927; Deva 7. VI. 1928.

Subgenus **Mesoacidalia** Reuss

A. (M.) aglaja aglaja Linnaeus (= *charlotta* Haworth)
14 ex.: Cluj (V. Popii) 22. VII. 1928; (Făget) 21. VI. 1927; Fînaţele Clujului 7. VII. 1930; V. Ierii 6. VII. 1928 (3 ex.); Răcătău 14. VII. 1929; Mt. Dobrin (1500 m) 5. VII. 1928; Mt. Măgura 4. VII. 1928 (4 ex.); V. Abruzelului 27. VI. 1927; Mt. Bucegi 10. VII. 1927.

Subgenus **Fabriciana** Reuss

A. (F.) adippe adippe Denis et Schiffermüller
8 ex.: Cluj 12. VIII. 1922; (V. Pleşca) 7. VII. 1930; (Făget) 13. VII. 1926; Sălicea 18. VII. 1926; 2. VII. 1926; 4. VII. 1926; 6. VII. 1930; 21. VII. 1929; Retezat (1100 m) 25. VII. 1928 (leg. Diószeghy).

A. (F.) niobe niobe Linnaeus
8 ex.: Cluj (V. Pleşca) 12. VII. 1928; 21. VII. 1927, 10. VII. 1927; 7. VI. 1930; (V. Popii) 22. VII. 1928; (Făget) 21. VII. 1927; Sălicea 31. VII. 1927, Poeni 19. VII. 1928

Subgenus **Arginnis** Fabricius

A. (A.) paphia paphia Linnaeus
6 ex.: Cluj (V. Pleşca) 17. VII. 1927 (2 ex.); 12. VIII. 1928; Sălicea 7. VII. 1929; V. Drăganului 18. VII. 1929; Braşov 8. VII. 1927.

Subgenus **Pandoriana** Warren

A. (P.) pandora pandora Denis et Schiffermüller

2 ex.: Sibiu (D. ?) 24. VIII. 1919 (leg. Czekelius); Apahida (D. Mineşului) 27. VIII. 1930.

Euphydryas Scudder

E. maturna partiensis Varga

2 ex.: Cluj (V. Popii) 15. VI. 1930; Retezat (800 m) 18. VI. 1923 (leg. Diószeghy).

E. aurinia aurinia Rottenburg

1 ex.: Sălicea 5. VI. 1927.

Melitaea Fabricius (= *Mellicta* Billberg)

M. didyma didyma Esper

21 ex.: Cluj (V. Pleşca) 13. VII. 1926; 10. VII. 1927; (V. Popii) 20. VIII. 1930; Sălicea 29. VII. 1928; 26. VIII. 1928; Fînaţele Clujului 15. VII. 1928 (6 ex); 9. VI. 1927; Cheile Turzii 13. VIII. 1930; 6. VI. 1929; Săcărîmb 8. VI. 1928 (4 ex.); Ardeu 10. VI. 1928; Mada 10. VII. 1928 (2 ex.).

M. cinxia cinxia Linnaeus

10 ex.: Cluj 22. V. 1927; (V. Popii) 8. VI. 1929; Fînaţele Clujului 10. VI. 1928 (3 ex.); 27. V. 1928; 3. VI. 1928; Mada 10. VI. 1928; Deva 7. VI. 1928; Tg. Mureş 4. VI. 1928.

M. phoebe phoebe Denis et Schiffermüller

8 ex.: Cluj 14. VIII. 1927 (2 ex.); 22. V. 1927; 7. VIII. 1927; (V. Pleşca) 2. VI. 1927; (Făget) 24. V. 1926; Tg. Mureş 4. VI. 1928; Mada 10. VI. 1928.

M. trivia trivia Denis et Schiffermüller

8 ex.: Cluj (V. Pleşca) 2. VI. 1927; V. Drăganului 25. VII. 1934; Mada 10. VI. 1928 (5 ex.); Cluj (Făgădău) 26. VIII. 1928.

M. diamina diamina Lang (= *dictynna* auct.)

3 ex.: Cluj (V. Pleşca) 1. VII. 1928; 21. VIII. 1929; Retezat (1200 m) 7. VII. 1929 (leg. Diószeghy).

M. athalia athalia Rottenburg

39 ex.: Cluj 25. VII. 1928; (V. Pleşca) 29. VI. 1927; 1. VII. 1928 (3 ex.); 12. VII. 1928 (6 ex.); 2. VI. 1927; 21. VII. 1929 (2 ex.); 26. V. 1929; 5. VI. 1927; (Făget) 2. VI. 1927; (V. Popii) 22. VI. 1931; 3. V. 1929; 15. VI. 1930; Fînaţele Clujului 10. VII. 1928; (Mănăştur) 14. VIII. 1927; Cheile Turzii 8. VI. 1932; 25. VI. 1933 (2 ex.); Retezat (900 m) 28. VI. 1929; (1100 m) 5 VI. 1929; (1400 m) 10. VII. 1929; (1100 m) 18. VII. 1929; (700 m) 28. VI. 1929 (leg. Diószeghy); Mada 10. VI. 1928; Săcărîmb 8. VI. 1928; Mt. Măgura 4. VII. 1928 (2 ex.); Crişul Repede 24. V. 1928; Zau de Cîmpie 27. VIII. 1930; Ardeu 10. VI. 1928; (P. Ţigăneşti) (undated).

M. aurelia aurelia Nickerl

13 ex.: Cluj (V. Popii) 16. VII. 1929; 22. V. 1927; (V. Pleşca) 29. VI. 1927; (Făget) 2. VI. 1927; (Vf. Peana) 3. VI. 1936; Fînaţele Clujului 26. VII. 1928; 10. VI. 1928 (2 ex.); 15. VII. 1928 (2 ex.); Deva 2. IX. 1928; Cheile Ţurzii 6. VII. 1933; Ineu 4. VI. 1926 (leg. Diószeghy).

Fam. SATYRIDAE

Melanargia Meigen (= *Agapetes* Billberg)

M. galathea Linnaeus

55 ex.: Cluj (V. Pleşca) 26. VI. 1927 (2 ex.); 1. VII. 1928; (V. Popii) 24. VI. 1927 (2 ex.); 13. VII. 1928 (4 ex.); (Mănăştur) 1. VII. 1927 (3 ex.); 10. VII. 1927; Stana 1. VII. 1928 (2 ex.); Fînaţele Clujului 29. VI. 1928 (3 ex.); 30. VI. 1929 (16 ex.); 15. VII 1928 (8 ex.); Sălicea 21. VII. 1929 (3 ex.); Răcătău 3. VII. 1928 (2 ex.); Poeni 19. VII. 1929 (2 ex.); V. Abruzelului 27. VI. 1927 (2 ex.); Braşov 9. VII. 1927; 13. VII. 1927, Mt. Măgura 4. VII. 1928 (2 ex.).

Pararge Hübner

Subgenus **Pararge** Hübner

P. aegeria tircis Butler
15 ex.: Cluj 7. VII. 1927; 5. V. 1933; (V. Popii) 6. V. 1928; 13. V. 1928 (5 ex.); 26. IV. 1927; 19. IV. 1926; 5. VIII. 1928 (2 ex.); Făget 18. IV. 1927 (2 ex.); Cheile Turzii 21. IV. 1930.

Subgenus **Lasiommata** Humphreys et Westwood

P. (L.) megera megera Linnaeus
7 ex.: Cluj 8. V. 1927 (e); (Mănăştur) 25. IX. 1927; Cheile Baciului 15. V. 1927; Sălicea 24. VI. 1928; Deva 31. VIII. 1927 (3 ex.).

P. (L.) maera maera Linnaeus
17 ex.: Cluj 27. V. 1927; (V. Popii) 15. VI. 1930; (Făget) 2. VI. 1927 (2 ex.); Sălicea 24. VI. 1928; 12. VIII. 1928; Mt. Măgura 4. VII. 1928 (3 ex.); Vlădeasa 17. VII. 1929 (2 ex.); Răcătău 3. VII. 1928; Tg. Mureş 4. VI. 1928 (2 ex.); V. Drăganului 18. VII. 1928; Hunedoara 31. VII. 1927; Cheile Baciului 15. V. 1927.

Subgenus **Lopinga** Moore

P. (L.) achine achine Scopoli
2 ex.: Cluj (V. Popii) 3. VI. 1934; P. Ţigăneşti (undated).

Satyrus Latreille

Subgenus **Hipparchia** Fabricius

S. (H.) fagi fagi Scopoli
7 ex.: Boholt 21. VII. 1931 (2 ex.); 2. IX. 1927 (2 ex.); 20. VII. 1931; Ineu 5. VII. 1926; 25. VI. 1925 (leg. Diószeghy).

Subgenus **Parahipparchia** Kudrna

S. (P.) semele semele Linnaeus
15 ex.: Cluj 31. VII. 1928 (2 ex.); (V. Pleşca) 5. VIII. 1928; Sălicea 21. VII. 1929 (2 ex.); 29. VI. 1927 (2 ex.); 29. VII. 1928; 22. VII. 1928; Fînaţele Clujului 24. VI. 1928; 30. VI. 1929; V. Drăganului 18. VII. 1928 (2 ex.); 25. VII. 1934; V. Ierii 6. VII. 1928.

Subgenus **Neohipparchia** de Lesse

S. (N.) statillinus Hufnagel
1 ex.: Csepel (Hungary) 18. VII. 1934 (leg. Surmin).

Subgenus **Chazara** Moore

S. (C.) briseis saga Fruhstorfer
7 ex.: Cluj (V. Pleşca) 4. VIII. 1927 (2 ex.); 5. VIII. 1928; Fînaţele Clujului 28. VII. 1929; 9. IX. 1928; Suatu 27. VIII. 1930 (2 ex.).

Subgenus **Brinthesia** Fruhstorfer (= *Kanetisa* Moore)

S. (B.) circe circe Fabricius
1 ex.: Ineu 5. VII. 1926 (leg. Diószeghy).

Subgenus **Arethusana** de Lesse

S. (A.) arethusa arethusa Denis et Schiffermüller
4 ex.: Ineu 3. VIII. 1925; 9. VIII. 1929 (2 ex.); 29. VIII. 1926 (leg. Diószeghy).

Subgenus **Minois** Hübner

S. (M.) dryas Scopoli
8 ex.: Cluj (V. Pleşca) 10. VII. 1928; 5. VIII. 1928; 17. VII. 1927; 27. VII. 1927; 4. VIII. 1927; Sălicea 19. VIII. 1928 (2 ex.); 29. VIII. 1928.

Erebia Dalman

E. ligea carthusianorum Fruhstorfer
20 ex.: V. Drăganului 18. VII. 1927 (3 ex.); 25. VII. 1934; V. Negruţei 5. VII. 1928; Detunata (1200 m) 27. VI. 1927 (2 ex.); V. Ierii 6. VII. 1928 (2 ex.); Retezat

(950 m) 14. VII. 1928; (700 m) 7. VIII. 1927; (1200 m) 23. VII. 1928; Bucegi 14. VII. 1927 (3 ex.); 10. VII. 1927; Braşov 23. VII. 1927; Someşul Rece 3. VII. 1927; 20. VI. 1926 (no place) (leg. Czekelius); 2 unlabelled specimens.

E. euryale syrmia Fruhstorfer

35 ex.: V. Ierii 6. VII. 1928 (6 ex.); Vlădeasa 18. VII. 1929 (5 ex.); V. Negruţei 5. VII. 1928; V. Drăganului 18. VII. 1929 (12 ex.); V. Calului 6. VII. 1928 (2 ex.); Lăpuşna 1. VIII. 1924; 12. VII. 1928; Bucegi 10. VII. 1927; 14. VII. 1927; Piatra Arsă 5. VIII. 1929; Retezat (1400 m) 7. VII. 1927; (1200 m) 12. V. 1928; (1400 m) 15. VII. 1926; (2000 m) 3. VIII. 1927 (leg. Diószeghy).

E. manto trajanus Hormuzachi

1 ex.: Retezat (1400 m) 4. VIII. 1927 (leg. Diószeghy).

E. epiphron transsylvanica Rebel

7 ex.: Retezat 3. VIII. 1927; (800—1300 m) 29. VII. 1926; (1700 m) 2. VIII. 1927 (leg. Diószeghy); Bucegi 31. VII. 1929 (2 ex.); 7. VIII. 1929; 19. VI. 1927 (no place) (leg. Czekelius).

E. sudetica Staudinger

5 ex.: Retezat (1400—1800 m) 12. VII. 1929; (900) and (1400 m) 14. VII. 1928; (1400 m) 18. VII. 1928; 15. VII. 1928 (leg. Diószeghy).

E. aethiops Esper

21 ex.: Cluj 22. VII. 1928 (2 ex.); 25. VII. 1928; 5. VIII. 1928; (V. Popii) 18. VI. 1926; 22. VII. 1926; (V. Pleşca) 5. VIII. 1928; 17. VII. 1927 (2 ex.); 22. VII. 1928; 27. VII. 1927; Sălicea 12. VIII. 1928 (2 ex.); Someşul Rece 3. VII. 1927; Răcătău 5. VII. 1928; Cheile Turzii 13. VIII. 1930; Retezat (400 m) 25. VII. 1928; 23. VII. 1928 (2 ex.); 20. VII. 1928; (1000 m) 4. VIII. 1927 (leg. Diószeghy).

E. medusa Denis et Schiffermüller

16 ex.: Cluj 26. V. 1935; 21. V. 1935; (Vf. Peana) 3. VI. 1936 (9 ex.); Tg. Mureş 4. VI. 1928 (2 ex.); Bucegi (Babele) 35. VII. 1934 (3 ex.).

E. gorge pirinica Buresch (= *fredericikoenigi* Varga)

1 ex.: Bucegi 3. VIII. 1929.

E. cassioides neleus Freyer

5 ex.: Retezat (2500 m) 3. VIII. 1927; (1500 m) and (1700 m) 2. VIII. 1927; (2100 m) and (1800 m) 3. VIII. 1927 (leg. Diószeghy).

E. melas melas Herbst

1 ex.: Mt. Domogled 25. VII. 1922.

E. pandrose roberti Peschke (= *lappona* Esper)

3 ex.: Retezat (1500 m) 15. VII. 1928 (leg. Diószeghy); M-ţii Bucegi (Babele) 23. VII 1929 (leg. Ostrogovich); M-ţii Cibinului (Fedelesch) 17. VI. 1928 (leg. Czekelius).

Maniola Schrank (= *Epinephele* Hübner)

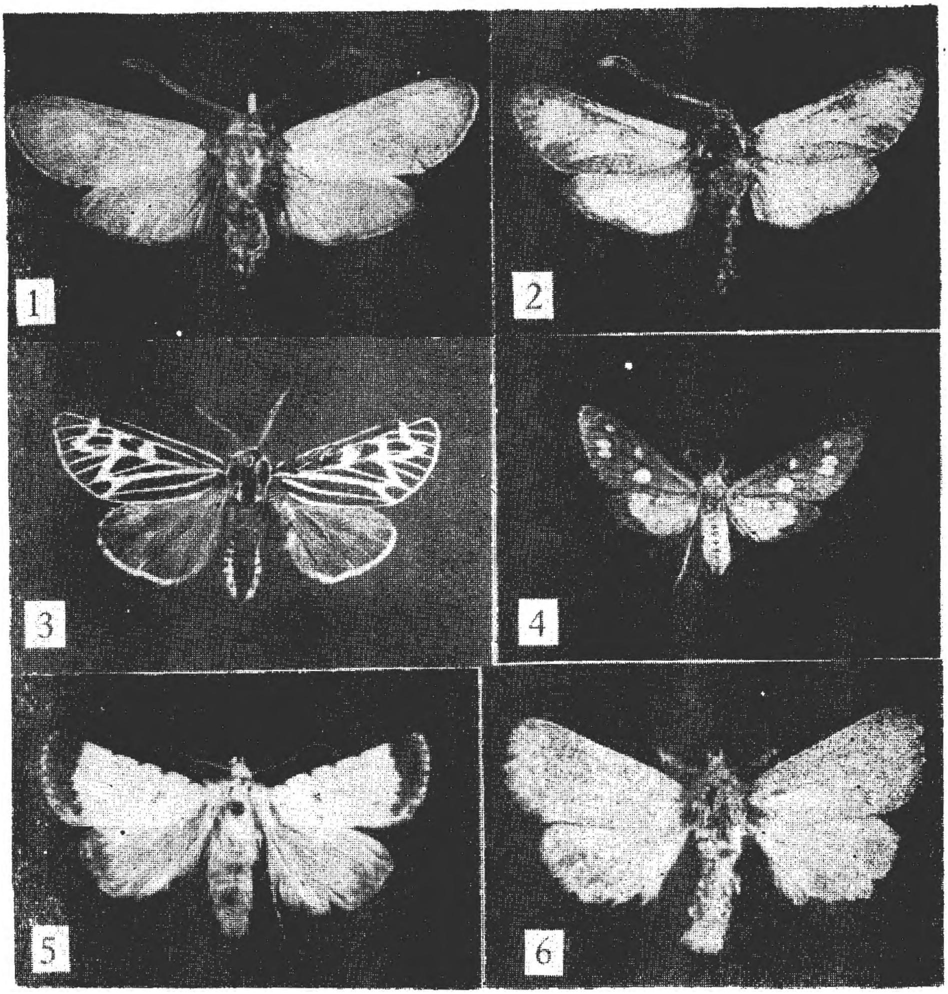
M. jurtina jurtina Linnaeus

44 ex.: Cluj 19. VIII. 1928; 25. VII. 1928; 22. VIII. 1928; 20. VII. 1933; (V. Popii) 14. VIII. 1927; 12. VI. 1927; 22. VII. 1928 (3 ex.); 16. VII. 1929; (V. Pleşca) 13. VII. 1928; 4. VIII. 1927; 17. VII. 1927; 12. V. 1928; 12. VII. 1928 (3 ex.); 26. VII. 1927; 10. VII. 1927; 1. VII. 1928 (3 ex.); 4. VIII.1927 (2 ex.); 10. VIII. 1927; (Făget) 2. VII. 1926 (2 ex.); 8. VIII. 1926; Sălicea 21. VII. 1928; 26. VII. 1927; 24. VI. 1928; 21. VII. 1929; 12. VII. 1928; Stana 1. VII. 1928; Fînaţele Clujului 11. VII. 1926; 10. VII. 1926; 30 VI. 1929 (2 ex.); 15. VII. 1928; Deva 31. VII. 1927; Boholţ 2. IX. 1927 (4 ex.); V. Ierii 6. VII. 1928; Poeni 19. VII. 1928 (3 ex.).

Aphantopus Wallengren

A. hyperantus hyperantus Linnaeus

11 ex.: Cluj 22. VII. 1928; Sălicea 26. VI. 1927; Cluj (V. Pleşca) 26. VI. 1927; Someşul Rece 3. VII. 1927; Răcătău 3. VII. 1928; Mt. Măgura 4. VII. 1928; V. Ierii 6. VII. 1928; Fînaţele Clujului 3. VI. 1928; Abrud 21. VI. 1927; 27. VI. 1927; Braşov 8. VII. 1928.



Pl. 1. Fig. 1. Agrumenia loti caliacrensis *Reiss*, ♀ *Balcic, 16.VII. 1928, Paralectotype (leg. Ostrogovich).*

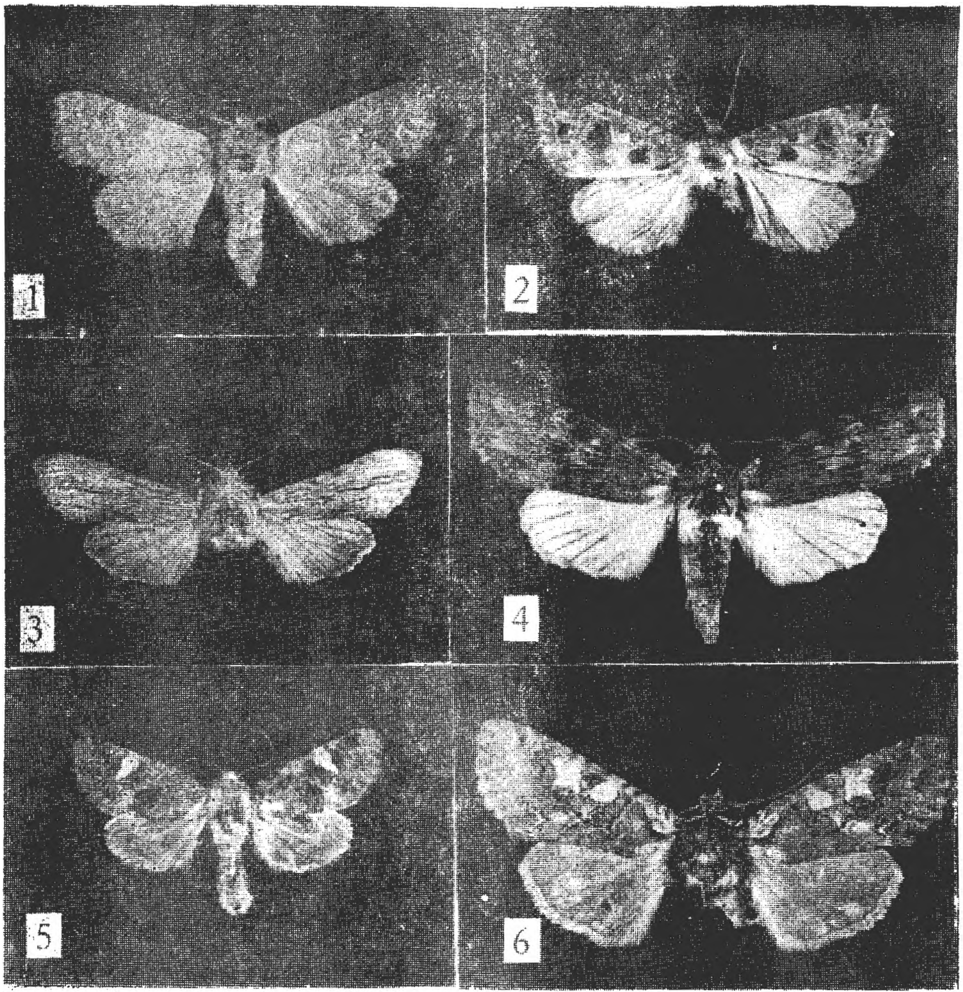
Fig. 2. Mesembrynus contaminei *Bsd.*, ♂ *Balcic, 19.VII.1928 (leg. Ostrogovich).*

Fig. 3. Orodemnias quenselii *Payk*, ♂ *Babele (Bucegi Mountains), 1.VII.1921 (leg. Ostrogovich).*

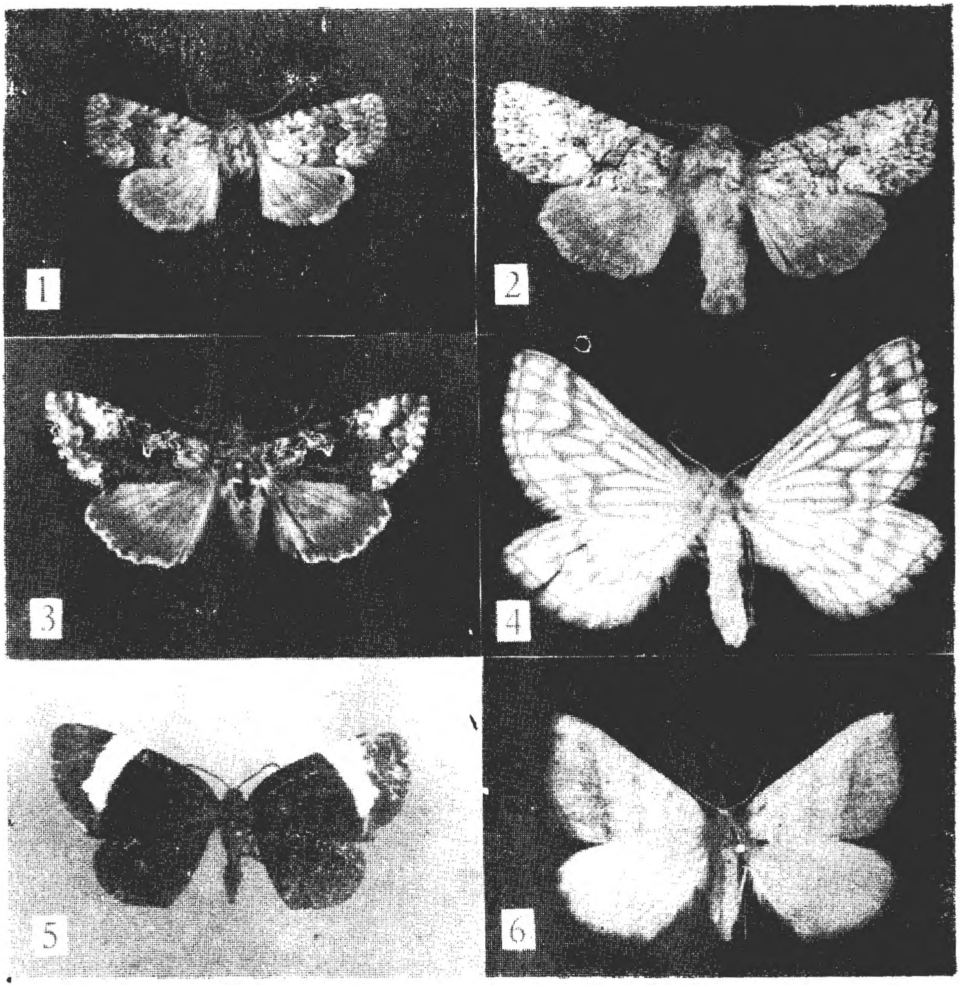
Fig. 4. Dysauxes punctata *Fab.*, ♀ *Cheile Turzii, 13.VIII.1930.*

Fig. 5. Ochropleura melanura albida *Car.*, ♂ *Balcic, 6.VII.1929 (leg. Ostrogovich).*

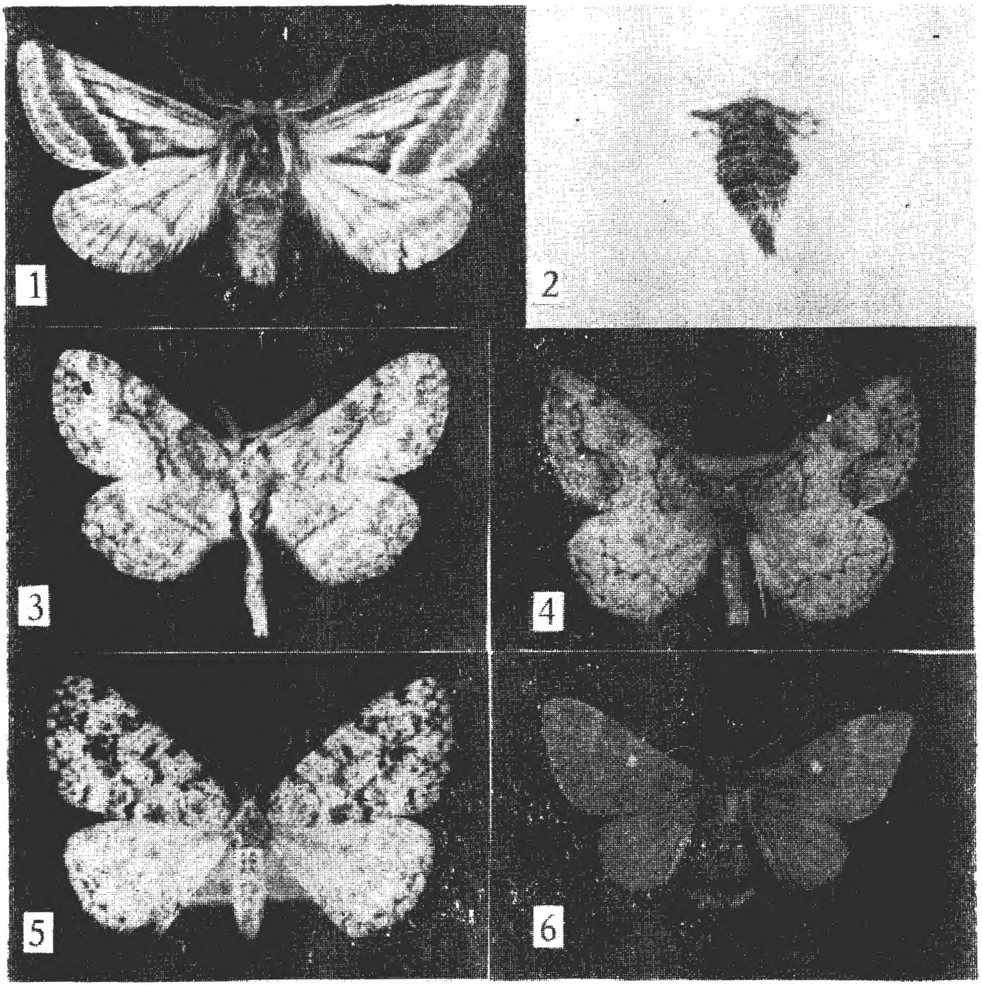
Fig. 6. Orthosia schmidtii *Diósz.*, ♂ *Ineu, 11.IV.1938 (leg. Diószeghy).*



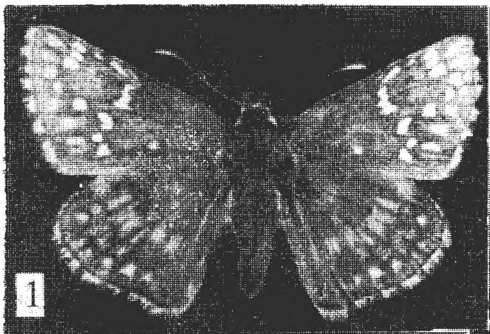
Pl. 2. Fig. 1. Orthosia schmidtii *Diósz.*, *Ineu, 11.IV.1938 (leg. Diószeghy).*
Fig. 2. Hysia cavernosa *Ev.*, ♂ *Banhida (leg. Gaál).*
Fig. 3. Cucullia tanaceti *Den. et Schiff.*, ♂ *Techirghiol, 6.IX.1927.*
Fig. 4. Scotochrosta pulla *Den. et Schiff.*, ♀ *Ineu, 11.IX.1928 (leg. Diószeghy).*
Fig. 5. Rileyana fovea *Tr.*, ♂ *Ineu, 19.X.1929 (leg. Diószeghy).*
Fig. 6. Dichonia aeruginea *Hb.*, ♂ *Ineu, 6.X.1924 (leg. Diószeghy).*

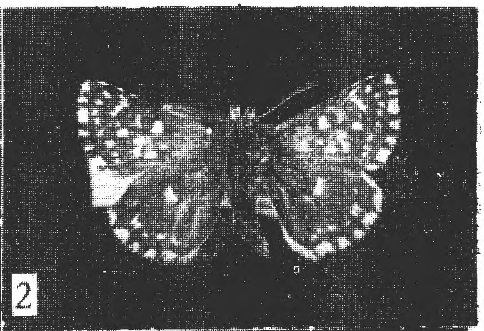


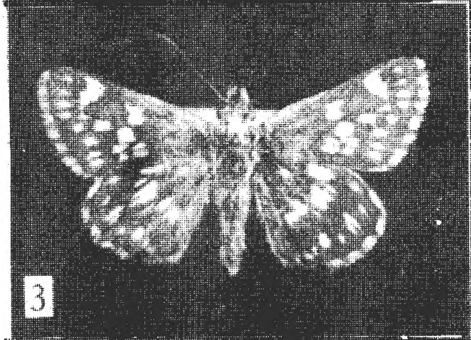
Pl. 3. Fig. 1. Amphipyra micans *Led.*, ♂ *Ineu, 14.VII.1920 (leg. Diószeghy).*
Fig. 2. Dryobotodes monochroma *Esp.*, ♂ *Ineu, 17.IX.1928 (leg. Diószeghy).*
Fig. 3. Syngrapha interrogationis *L.*, ♂ *Rîul Sadu, VII.1928 (leg. Czekelius).*
Fig. 4. Schistostege decussata *Den. et Schiff.*, *Ineu, 21.V.1926 (leg. Diószeghy).*
Fig. 5. Baptria tibiale *Esp.*, ♂ *Retezat (900 m), 20.VII.1928 (leg. Diószeghy).*
Fig. 6. Semiothisa artesiaria *Den. et Schiff.*, ♀ *Ineu, 32.VI.1921 (leg. Diószeghy).*

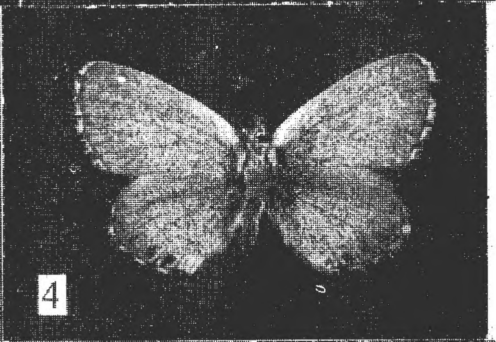


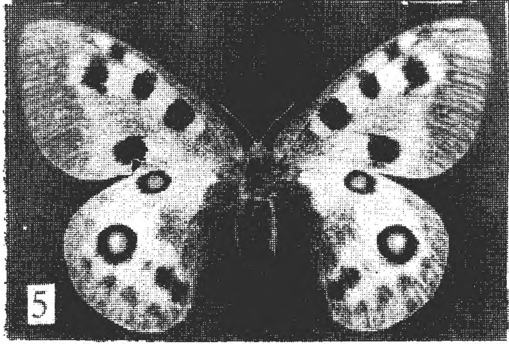
Pl. 4. Fig. 1. Nyssia zonaria *Den. et Schiff.*, ♂ *Fînațele Clujului, 20.IV.1930.*
Fig. 2. Nyssia zonaria *Den. et Schiff.*, ♀ *Fînațele Clujului, 25.IV.1930.*
Fig. 3. Boarmia viertlii *Bohatsch*, ♂ *Ineu, 16.VI.1922 (leg. Diószeghy).*
Fig. 4. Cleorodes lichenaria *Hfn.*, ♂ *Ineu, 27.VII.1922 (leg. Diószeghy).*
Fig. 5. Fagivornia arenaria *Hfn.*, ♀ *Ineu, 1.V,1927 (leg. Diószeghy).*
Fig. 6. Eriogaster catax *L.*, ♀ *Cluj, 4.X.1927 (ex. larva).*

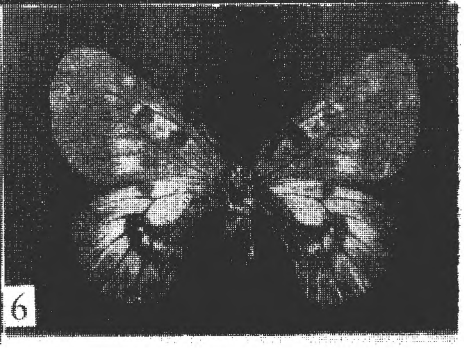




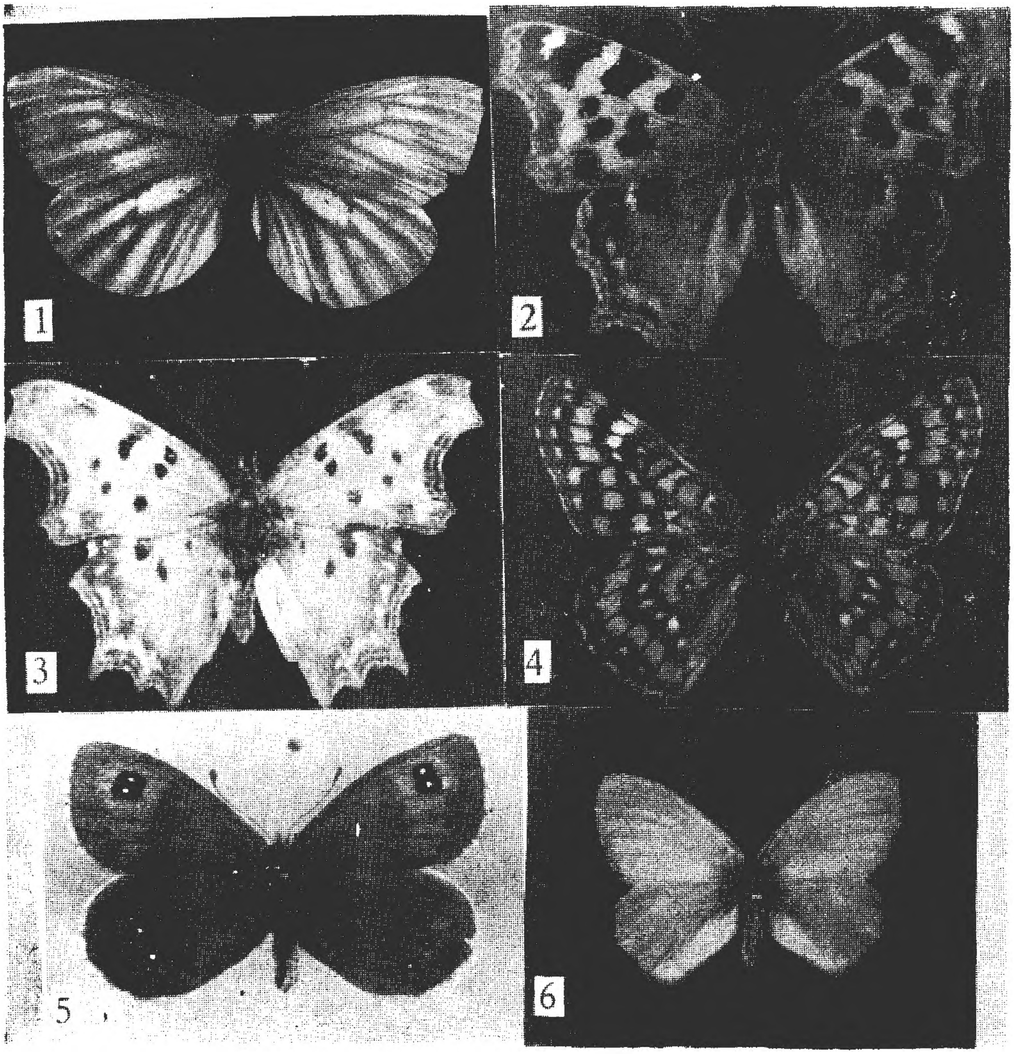








Pl. 5. Fig. 1. Pyrgus sidae *Esp.*, ♀ *Balcic, 16.VII.1928 (leg. Ostrogovich).*
Fig. 2. Spialia sertorius orbifer *Hbn.*, ♂ *?, 21.VIII.1926 (leg. Kolar).*
Fig. 3. Syrichtus cribrellum *Ev.*, ♂ *Fînațele Clujului, 8.VI.1929.*
Fig. 4. Philotes bavius hungaricus *Diósz.*, ♂ *Fînațele Clujului, 2.V.1953.*
Fig. 5. Parnassius apollo jaraensis *Kertész*, ♀ *Răcătău, 3.VII.1928.*
Fig. 6. Parnassius mnemosyne transsylvanica *Schmidt*, ♀ *Retezat (900 m), 1.VI 1928 (leg. Diószeghy).*



Pl. 6. Fig. 1. Pieris bryoniae carpathiensis *Moucha*, ♂ *Rîşnov, 10.VII.1928.*
Fig. 2. Nymphalis xanthomelas *Den. et Schiff.*, ♂ *Sălicea, 22.VII.1928.*
Fig. 3. Polygonia egea *Cramer*, ♂ *Scutari (Albania), 7.VII.1917 (leg. Bartha).*
Fig. 4. Euphydryas maturna partiensis *Varga*, ♂ *Retezat (800 m), 17.VI.1923 (leg. Diószeghy).*
Fig. 5. Erebia cassioides neleus *Freyer*, ♀ *Retezat (1800 m), 3.VIII.1927 (leg. Diószeghy).*
Fig. 6. Coenonympha tullia schmidtii *Diósz.*, ♂ *Retezat (1900 m), 17.VII.1926 (leg. Diószeghy).*

Pyronia Hübner

P. tithonus tithonus Linnaeus

16 ex.: Ineu 3. VIII. 1925; 9. VIII. 1929 (3 ex.), (leg. Diószeghy); Bolboci 20. VII. 1931 (6 ex.); Boholţ (Deva) 21. VII. 1931 (6 ex.).

Coenonympha Hübner (= *Chortobius* Dunning et Pickard)

C. tullia schmidtii Diószeghy

1 ex.: Retezat (1900 m) 27. VII. 1926 (leg. Diószeghy).

C. pamphilus pamphilus Linnaeus

48 ex.: Cluj (V. Popii) 19. VIII. 1928 (8 ex.); 24. VIII. 1928; 8. IX. 1928 (2 ex.); 14. VIII. 1927 (4 ex.); 20. V. 1928 (4 ex.); 12. IX. 1926; 12. V. 1928; 25. IX. 1927 (2 ex.); 19. V. 1928; 8. VI. 1929; 20. VIII. 1934; 27. VIII. 1926; 12. VI. 1927; 10. V. 1929; (V. Pleşca) 8. IX. 1928 (2 ex.); 6. V. 1928; 5. VIII. 1928; (Făget) 8. V. 1925; 2. IX. 1928 (2 ex.); Fînaţele Clujului 15. VI. 1927; 26. V. 1928; 27. V. 1928; 10. VI. 1928 (3 ex.); V. Drăganului 18. VII. 1929 (2 ex.); Hunedoara 25. VIII. 1927; Viţa 10. V. 1928; Sălicea 2. IX. 1928 (3 ex.).

C. arcania arcania Linnaeus (= *amyntas* Poda)

11 ex.: Cluj (V. Pleşca) 1. VII. 1928 (4 ex.); 2. VI. 1927; 12. VI. 1928; (V. Popii) 11. VI. 1926; 15. VI. 1930; Fînaţele Clujului 29. VI. 1928; Sălicea 24. VI. 1928; Bucegi 10. VII. 1927.

C. glycerion glycerion Borkhausen (= *iphis* Denis et Schiffermüller)

50 ex.: Fînaţele Clujului 9. IX. 1928 (8 ex.); 26. VI. 1928 (7 ex.); 10. VI. 1928 (2 ex.); 20. V. 1940; Cluj 10. VI. 1953; (V. Popii) 8. VI. 1929; Sălicea 24. V. 1928; Răcătău 3. VII. 1928 (4 ex.); Mt. Măgura 4. VII. 1928; Săcărîmb 8. VI. 1928 (3 ex.); Deva 7. VI. 1928 (4 ex.); 11. VI. 1928 (2 ex.); Tg. Mureş 4. VI. 1928 (5 ex.); V. Ierii 6. VII. 1928; Hunedoara 25. VIII. 1927 (2 ex.); Stana 1. VII. 1928; Boholt 2. IX. 1927; Mada 10. VI. 1928; Poeni 19. VII. 1929; Drăgoiasa (Mţii Apuseni) 24. VII. 1934; Cheile Turzii 25. VI. 1933; Ardeu 10. VI. 1928.

STUDIA UNIV. BABEŞ—BOLYAI, BIOLOGIA, XXXIII, 1, 1988

RECENZII

Martin Luckner, **Secondary Metabolism in Microorganisms, Plants and Animals.** Second revised and enlarged edition, VEB Gustav Fischer Verlag, Jena, 1984, 576 pages with 338 figures and 80 tables.

The book, consisting of 6 sections, deals with the organization and significance of the biosynthesis, storage, conversion and degradation of the most important groups of secondary products in the living organisms. As shown by the author himself in „Preface“ and Section A of the book, secondary metabolism refers to a variety of chemical pathways, which are characteristic of only a few species, races or even of a certain stage of differentiation of specialized cells, the chemical compounds resulting from this metabolism being called secondary products. Such products are frequently revealed by their colour, smell or taste and are responsible for the flavour of most foodstuffs and beverages and for the colour and fragrance of the flowers and fruits. Many of them are part of the natural pharmacopoeia (alkaloids, cardiac glycosides, antibiotics, etc.) or are used by industry (tannins, rubber, etc.).

After discussing the methods used in the investigation of the secondary metabolism (Section B), the author treats the important groups of secondary metabolic enzymes (Section C), the structure, biosynthesis and metabolism of secondary products in microorganisms, plants and animals (Section D — the most extensive one) and the significance of the secondary metabolism and secondary products for the producer organisms (Section E). It is shown that the formation of secondary products is a common characteristic of specialized cells, brought about by the action of special enzymes, encoded by specific genetic material, and it is demonstrated that the biosynthesis of secondary products is typically without significance for the individual producer cell, but may play a decisive role in the development and function of the producer organism, or in the relationships between different types of organisms (as is the case with attractants, repellents, pheromones, etc.). The last part of the book (Section F) gives an idea about the different uses of the secondary products in the human life and society.

The book may serve as a valuable source of information for advanced students and scientists working in organic chemistry, pharmacology, biochemistry, microbiology, physiology, agriculture and other related fields. Although, due to space limitations, the author does not usually discuss the means by which the given facts were proven or the reliability of different results, references for further reading are cited at the end of each individual subsection. The information is very much extended by the presence of a great number of figures and tables and it is made more understandable and useful by specific examples on almost every occasion. The book also ends with a very helpful „Index“ of over 30 pages.

CORNELIU TARBA

T. P Slavnina, L. I. Inisheva, **Biologicheskaya aktivnost' pochv Tomskoi oblasti** ***(Biological Activity in Soils of the Tomsk Region),*** Izdatel'stvo Tomskogo Universiteta, Tomsk, 1987, 216 pages including 75 tables and 29 figures.

The work is a monograph describing the soil-enzymological and microbiological investigations carried out by Professor T. P. Slavnina and her collaborators at the Tomsk University. It consists of 4 chapters.

Chapter 1 reviews the history of investigations on the microflora living in soils of the Tomsk region, the first microbiological study of these soils being published in 1938.

The other chapters are devoted to the description of soil-enzymological investigations in the Tomsk region which were initiated by the senior author in 1959. A lot of hydrolase (invertase, amylase, urease, proteinase) and oxidoreductase (catalase, peroxidase, polyphenol oxidase, nitrate, nitrite, sulphate and ferri-reductase) activities were determined in many automorphic and flood plain soils. Besides the enzyme activity measurements, the number of soil microorganisms belonging to different physiological groups (ammonification, nitrification, aerobic and anaerobic N_2-fixation, denitrification, etc.) and the intensity of soil respiration (CO_2 evolution) were also determined and correlated with physical and chemical data (temperature, humidity, redox potential, NH_4^+, Fe^{2+} and Fe^{3+} contents, etc.). The main topics studied comprise the depth-dependent variation and seasonal dynamics of soil biological activity, the influence of organic and mineral fertilization and that of drainage on this activity. The final conclusion drawn from these investigations is that the enzyme content and the state of microbial coenoses can be used as controlling parameters of the transformations occurring in soil at every moment.

The investigations described may serve as a model for complex regional pedoenzymological and pedomicrobiological researches. Therefore, the book is a valuable source of information for those interested in the complex study of soils. The two bibliographical lists enclosed (one, of general soil-biological literature with 228 titles and the other, listing 133 papers dealing with enzyme activity and microorganisms in soils of the Tomsk region) are also valuable.

ŞTEFAN KISS

Proceedings of the 9th International Symposium on Soil Biology and Conservation of the Biosphere. *Volumes 1 and 2*, Edited by J. Szegi, Akadémiai Kiadó, Budapest, 1987, XXII+XIII+945 pages including 162 figures and 251 tables.

This symposium was organized by the Biological Section of the Hungarian Society of Soil Science and held at the Sopron University of Forestry and Timber Industry (26—28 August, 1985). The Proceedings comprise the Opening address, Preface, 104 papers grouped into 8 chapters, Closing remarks, Subject index and List of contributors (300 researchers and experts).

In the first chapter, „The effect of fertilization on soil biological processes", 14 papers deal with the effect of different mineral and organic fertilizers on the counts of bacteria, actinomycetes, microscopic fungi, fauna, N_2-fixing, ammonifying, nitrifying and denitrifying microorganisms, on the amylolytic microbial community, cellulolytic activity, respiration (CO_2 evolution) and enzymatic activities in arable, grassland and forest soils. Two papers are devoted to laboratory testing of the efficiency of N-Serve and to psychrophilic and mesophilic $Ca_3(PO_4)_2$-dissolving bacteria, respectively.

Chapter 2, „Interaction between pesticides and soil organisms", consists of 9 papers. Most of them describe studies on the effect of different herbicides, herbicide mixtures or herbicides + fertilizers, fungicides, insecticides and nematicides on soil microbial and faunal counts, microbial biomass, cellulolysis, N-cycling, respiration and dehydrogenase activity. In another study, the combined effect of herbicides and humic acid was tested on *Chlorella* cells. The topic of another paper is the inoculation of the soil with microbial decomposers, as an approach to the control of herbicide persistence.

The authors of 23 papers in chapter 3, „Importance of biological nitrogen fixation in soil fertility", cover a wide range of topics: effectiveness of the inoculation of legumes with *Rhizobium* preparations; effect of N, P or NPK fertilizers, pesticides, extenders, polymeric aluminium and pollutants (Cd, H_2S, SO_2) on the growth of rhizobia, nodulation and growth of legumes, nitrogenase activity, seasonal variation in N_2 fixation; competition among rhizobia; improvement of fungicide tolerance in rhizobia; physiological and biochemical indications of the effectiveness of legume-*Rhizobium* symbiosis; associative N_2 fixation.

Chapter 4 „The role of soil organisms in the decomposition and synthesis of organic matter", is formed of 18 papers. A part of the studies deal with the microbial decomposition of extracellular bacterial polysaccharides, cellulose, lignin, rye straw, maize stalk, rice crop residues, pine litter, and humic and fulvic acids. The effect of mineral and organic fertilization on the humification of organic matter has also been studied. Three papers have topics from the field of compost microbiology and enzymology, and one paper is devoted to sewage sludge microbiology.

Chapter 5, consisting of 12 papers, deals with „The role of soil organisms in the soil-forming processes". The main topics in this chapter are related to the biological recultivation of lignite and coal mine wastes, to the microbiological recultivation of oil-polluted agricultural areas and to the biotransformation of pollutants by soil microorganisms. The biodegradation of aluminosilicates in soil has also been dealt with.

Eight papers are grouped into chapter 6, „Soil organisms and their role in the soil ecosystem". Their main topics are: the role of microorganisms in soil aggregate formation in forest ecosystems; biomass of soil fungi in a flood plain forest ecosystem; microorganisms as a component of submontane grassland ecosystems; soil enzyme activities in forest ecosystems.

Chapter 7, „Interrelations between soil properties and biological activity", comprises 10 papers. Most of them deal with the effect of mineral and organic fertilizers, lime, conditioners, sewage sludge, heavy metals and acidification on the microbial counts, respiration and enzyme activities in different soils. The influence of soil loosening and compacting on respiration, the role of microorganisms in the retention of radioiodine by calcareous soils, and the role of phototrophic bacteria in submerged soils are also dealt with.

The topics of the 8 papers grouped into chapter 8, „Relationships between higher plants and soil organisms", are the following: soil respiration during wheat growth and subsequent residue decay; mycorrhizal fungi; phyllosphere zymoflora; serology of *Erwinia carotovora;* physiological variability of *Helminthosporium gramineum;* soil fungi parasitic on cyst-forming nematodes; biological control of soil-borne pathogens in black locust seedlings.

Each paper constitutes a valuable contribution to a better understanding of the biological processes taking place in soil and playing a key role in the environment-protecting and energy-economic agricultural production.

The *Proceedings* represent a very useful source of information not only for soil biologists and biochemists and agronomists, but for environmentalists, ecologists, botanists and zoologists as well.

ŞTEFAN KISS

Current Topics in Environmental and Toxicological Chemistry, *Volume 3, Mutagenicity Testing and Related Analytical* V. A. T-h. Brinkman, Gordon and *Techniques,* Edited by R. W. Frei and Breach Science Publishers, London, New York, Paris. 1981, IX + 320 pages with 85 figures and 56 tables.

Today, when many countries are actively legislating to control mutagenic compounds, this timely study of pollutants will be of keen interest to biologists and analytical chemists. This book contains selected papers which have been presented at the 10th Annual Symposium on the Analytical Chemistry of Pollutants, held in Dortmund (FRG), in May, 1980.

The papers of this book have been divided into two sections.

The first section deals with mutagenicity testing and other aspects of mutagenicity including management and legislation.

The second section deals with analytical chemistry of known or suspected mutagens and other compounds of interest to toxicologists or other scientists. The discussion in this section deals only with organic compounds; these, however, comprise the major groups of mutagens.

Its up-to-date information given by well-known scientists (particularly on testing procedures and related aspects and on the newest analytical methodology and data) makes it valuable to a wide segment of scientists concerned with research, control, management and legislation in connection with solving of environmental problems.

This volume is a valuable source of bibliographical information for chemistry and biology lecturers, researchers and students.

NICOLAE COMAN

Chemical and Enzymatic Synthesis of Gene Fragments — A Laboratory Manual, Edited by H. G. Gassen and Ann Lang, Verlag Chemie, Weinheim, Deerfield Beach, Florida, Basel, 1982, X + 250 pages with 64 figures, 5 schemes and 8 tables.

This book is an account of the state-of-the-art. It is based on the lectures and demonstrations presented at a laboratory course on „Automated Chemical and Enzymic Gene Synthesis", held in Darmstadt (FRG), in 1982, which has been sponsored by the European Molecular Biology Organization (EMBO).

The volume consists of 4 parts. Part I comprises 8 protocols about the chemical synthesis of polydeoxyribonucleotides of defined sequence. Part II groups 4 protocols on the topic „Biochemical modification of gene fragments". Part III consists of three protocols dealing with „Enzymatic syntheses of RNA fragments of defined sequence". Three protocols are grouped in the last part. There are described methods of purification and analysis of DNA and RNA fragments.

This book aims at providing those interested in DNA/RNA research with state-of-the-art methods used in the synthesis, purification, and analysis of DNA and RNA fragments. At the same time, the volume is a valuable source of information for various categories of readers, including geneticists, microbiologists, biotechnologists and other specialists interested in genetical engineering.

NICOLAE COMAN

Chromosome and Cell Genetics, Edited by A. K. Sharma and Archana Sharma, Gordon and Breach Science Publishers, New York, London, Paris, Montreux, Tokyo, 1985, VIII + 311 pages with 85 figures and 29 tables.

This volume, comprising 11 papers, presents a comprehensive, highly readable review of the latest advances in the fast-expanding field of genetics, with particular focus on chromosomal material. The authors, eminent experts in the field, take an in-depth look at the structure of chromosomes, with studies ranging from *in situ* hybridization at the electron microscope level to the split gene concept and chromosome axis. They also uncover and integrate theories and experimental results relating to the DNA molecule and chromosomal alterations that occur during differentiation and the evolutionary process of higher groups, and present a vital up-to-date synthesis on chromosomal banding and chemical mutagenesis.

The studies of heredity with modern techniques like cell fusion, cell and molecular hybridization, coupled with mutagenesis, have emerged as powerful tools in the understanding of the events at subcellular and molecular levels.

Separation techniques, involving both column and density gradient separation, as well as the use of restriction enzymes, have led to the identification of individual segments and sequence complexity in the chromosome architecture. The remarkable findings based on the new methodologies call for their dissemination amongst all interested in gene and genetics in general, and research workers in particular.

The volume is an important source of bibliographical information for research workers, teachers and students in this field of genetics.

NICOLAE COMAN

Exkursionsflora für die Gebiete der DDR und der BRD, *Band 1, Niedere Pflanzen,* 2. Auflage *(Flora Field Guide for the Regions of the GDR and the FRG,* Volume 1, Lower Plants, 2nd Edition), Herausgegeben von (Edited by) H. Schubert, H. H. Handke und (and) H. Pankow, Volk und Wissen Volkeigenes Verlag, Berlin, 1984, 811 pages with 790 plates.

Although published in 1984, the book remains up-to-date and extremely useful both for amateurs and specialists in lower plants. The fame of the well-known specialists collaborating to this book is in itself a guarantee of its high quality.

Conceived as a handbook for species identification, this volume comprises a large amount of information, due to its excellent graphic presentation.

The book is structured on the following groups of lower plants: algae *(Cyanophyta* and *Phycophyta,* 187 pages), fungi and mushrooms *(Mycophyta: Myxomycetes, Oomycetes, Endomycetes, Zygomycetes, Ascomycetes, Fungi imperfecti* and *Basidiomycetes,* 327 pages), lichens *(Lichenophyta,* 103 pages), and liverworts and mosses *(Bryophyta: Hepaticae* and *Musci,* 164 pages).

For each large group, useful information is given on its structure and biology, reproduction and distribution, collection, preparation, microscopic analysis, cultivation (algae, fungi), reagent receipts, supplementary bibliography that is sometimes completed with recent papers (algae, fungi), and a glossary of technical terms.

The keys for identification are given for all plant groups: classes, orders, families, genera and species, usually without subunits, except for the algae and fungi where the subclasses are also given. Besides the diagnoses in the keys, short descriptions for higher taxa (classes, orders, seldom for families) are also presented where necessary.

The book is richly illustrated, 1—5 figures faultlessly drawn being given for each species. The figures on plates are not explained due to shortage in space.

The nomenclature of taxa (genera, species) is not always brought up-to-date, but this does not diminish the scientific value of this excellent book.

EMANOIL PLĂMADĂ

Exkursionsfauna für die Gebiete der DDR und der BRD, *Band 3, Wirbeltiere,* 10. Auflage *(Fauna Field Guide for the Regions of the GDR and the FRG,* Volume 3, Vertebrates, 10th Edition). Herausgegeben von (Edited by) Konrad Senglaub und (and) Hans-Joachim Hannemann, Volk und Wissen Volkseigener Verlag, Berlin, 1987, 370 pages with 445 figures in the text and 4 plates.

The last edition of the world-wide known „Exkursionsfauna (Vertebrata)", founded in 1955 by the great ornithologist E. Stresemann, is an unchanged new impression of the 9th edition (1984), which, in its turn, was a revised and improved version of the 6th edition. The editio princeps was structured like a small booklet (pocket book) for field work, especially with identification keys of species for the whole territory of both German states. This model was conserved throughout all next editions. Since the 6th edition, after the death of the founder editor, the text was revised and brought up-to-date by a team of 6 authors, all from the GDR: R. Angermann (mammals, excepting the bats), K. Deckert (fishes), G. Freytag (amphibians), H. Hackethal (bats), W. Makatsch (birds), and G. Peters (reptiles).

Like all previous editions, the 10th edition is a valuable field guide for both the professional zoologist and the amateur, working on vertebrates in various habitats, from the Rhine to the Oder-Neisse, from the North Sea to the Constance Lake. Descriptions of species, differential definitions are brief and clear. Their precision is beyond any doubt. The fine drawings are helpful for identification of species, too.

A curious feature of the text is the preference for the use of trivial (popular) names, instead of artificial names for animals. German zoological nomenclature is well known for its richness in German names, made by zoologists who translated Latin names for species and genera, even for those which do not belong to the Central European fauna and are, therefore, unknown to the non-professional German people in zoology. So, there was built a certain nomenclatural load in German-language zoological literature, which makes it difficult to be understood by non-German zoologists. The edition reviewed here breaks with this tradition. Where there were no trivial names, no artificial ones were invented. In this way, the „Exkursionsfauna" became more open for zoologists and amateurs from non-German-speaking European countries.

Finally we mention that the volume contains separate literature lists for each class of vertebrates and registers of German trivial names and Latin names for animal species.

BOGDAN STUGREN

Quantitative Aspects of the Ecology of Biological Invasions, Edited by Hans Kornberg and M. H. Williamson, in „Philosophical Transactions of the Royal Society of London, B. Biological Sciences", 1986, Vol. 314, No. 1167, pages 501—746 with 55 figures and 39 tables in the text.

In 1958, Charles Elton, one of the founders of modern ecology, published a book on *The Ecology of Invasions by Animals and Plants,* which became a classical work with new ideas and new ways of thinking about population explosions and dispersion over continents and seas. Elton's work was a qualitative natural history of fascinating phenomena in the living world: the spread of Colorado beetle from North America to Europe, the invasion of a crustacean from China, *Eriocheir sinensis,* in European inland waters, and other similar wonders of natural history. In the last 30 years, biological invasions were studied both by generalizations of observed facts, and by mathematical modelling. The volume discussed here represents a synthesis of results acquired by both methods. The volume comprises 15 articles, signed by scientists, from the UK only, covering various aspects of invasions, being the British contribution to the SCOPE-Programme (the Scientific Committee on Problems of the Environment). Despite the fact that most of the discussed materials are based on events from the British Isles, general problems, interesting also for other countries, are always emphasized.

. As in other fields of ecology, mathematical models can not solve research problems alone, or may not discover essential mechanisms in ecosystems, and biological invasions. But they can bring us nearer to the essential mechanisms of the population dynamics of invading species. This is emphasized in the article of M. H. Williamson and K. C. Brown (The analysis and modelling of British invasions). Based on the knowledge of actual seed production and dispersion rates of forest trees, K. D. Bennett tells about the history of the expansion of forest trees in Postglacial Europe (The rate of spread and population increase of forest trees during the postglacial), from the perspective of population biology of plants. A new subject, which was not described by Elton, is the natural history of epidemiological waves as population dynamics phenomena. So, R. M. Anderson and R. M. May describe disturbances caused by viruses in normal ecological systems, like prey-predator interactions (The invasion, persistence and spread of infectious diseases within animal and plant communities). This is an unexplored subject from the standpoint of ecology. The authors analysed a basic model of AIDS spread throughout the world, too. J. Ross and A. M. Tittensor discuss the myxomatosis as an invasion process in England and Australia (The establishment and spread of myxomatosis and its effect on rabbit populations), with new data about the interactions between the virus and its mammalian hosts. The volume being elaborated only by British authors, there is no surprise that such old problems of British fauna as the invasion of birds from the European continent in Britain (R. J. O'Connor: Biological characteristics of invaders among bird species in Britain), and introduction of fish species in lakes (P. Hickley: Invasion by zander and the management of fish stocks) are largely discussed. A special article is dedicated by J. H. Lawton and K. C. Brown to „The population and community ecology of invading insects“. Ecological successions of vegetation are treated as biological invasions, too (J. P. Grime: The circumstances and characteristics of spoil colonization within a local flora). Palaeoecology is linked to population ecology by the article of G. R. Coope dealing with „The invasion and colonization of the North Atlantic islands: a palaeoecological solution to a biogeographic problem“. Other articles deal with population genetics of invading species (A. J. Gray: Do invading species have definable genetic characteristics?), and with "The population biology of invaders“ (M. J. Grawley). Finally, the applied aspects of the theory of biological invasions are not neglected. M. B. Usher discusses "Invasibility and wildlife conservation: invasive species on nature reserves“, while D. Mollison deals with "Modelling biological invasions: chance, explanation, prediction“.

As a concluding remark, one can say that the volume is an image of the progress of invasion ecology in the last 30 years in Britain. And yet, there remain some unsolved problems such as the prediction of the evolution of an invasion and its damages for agricultural crops and forest economy.

BOGDAN STUGREN

Lehrbuch der Ökologie. 2. Auflage (*Textbook of Ecology*, 2nd Edition), Herausgegeben von (Edited by) Rudolf Schubert, VEB Gustav Fischer Verlag, Jena, 1985, 596 pages with 331 figures and 56 tables in the text.

Ecology is nowadays no more a science with restricted topics. It is rather a complex of sciences, *i. e.* a polydisciplinary field of knowledge. Therefore, an individual author is unable to synthesize the enormous information on ecological processes in various life zones, in the plant and animal kingdom, and in the microbial realm, too. To be up-to-date and fundamental, a comprehensive textbook or better a handbook of ecology should be the work of a team of scientists, whose different research subjects would be united by the principles of general ecology. Exactly such a textbook was until now never written in German. The textbook reviewed here is the first one in German-speaking countries, and the fourth one in the world literature (the first comprehensive textbook of ecology was edited in the USA (1949) by W. C. Allee and others, the second was the work of a single author, G. Marcuzzi in Italy (1968), and the third was also the work of a single author, R. Margalef in Spain (1977)). The editor, Professor Schubert, is a plant biologist, a well-known specialist in phytosociology, head of the Department of Plant Biology at the University of Halle, GDR. The collective work was done by a team of 29 scientists, all from the GDR. It is not only a general ecology, not only a system of principles and basic concepts, but also a real handbook in the best German tradition, which comprises all field of knowledge included in or related to ecology, without degenerating into an encyclopaedia of general biology. In every section of the book the anthropogenic impact on ecological processes is emphasized. The textbook is based on an original logical pattern, being also a model of unity between theory and practice, of theoretical ecology and its applied branches. It has a stylistic unity, using a modern „hochdeutsch" not loaded with too many technical terms. Therefore, it is really a work which could be read with pleasure, and not only consulted for information extraction. This is, first off, the merit of the editor.

After the Introduction (Chapter 1), Chapter 2 comprises fundamentals of ecology (Schubert), from the viewpont of the ecosystems and biogeochemical cycles, concluded by problems of ecosystem modelling. Chapter 3 (D. Schlee) is dedicated to biochemical interactions between living beings and their environment. A multiauthor chapter (4) comprises autecology, divided into separate sections for microorganisms, plants, and animals. The multiauthor Chapter 5 deals with general concepts of population ecology. Ecosystems are discussed again in Chapters 6 and 7 (multiauthor also), but no more from structural standpoints as before, but from the perspective of major habitats of the Earth, both in present and in geological times, too. Schubert's textbook comprises chapters which one cannot find in any other textbook of ecology: the ecology of Man and Biosphere-system (Chapter 8 by H. A. Freye), and a section on applied ecology (Chapter 9 written by more authors). The textbook is provided by 21 pages of literature and a subject index.

Let me conclude this book review by a personal, sentimental statement. In 1978, when visiting professor Schubert at the University of Halle, I had the opportunity to examine the project of this textbook. It impressed me by its encyclopaedical horizon, but, to tell the truth, I remained skeptical about its future. Today, reading the Schubert textbook, in its second edition already (editio princeps 1984), I am glad that my skepticism was contradicted by the work of the Editor and his team.

BOGDAN STUGREN

Lothar Kämpfe, Rolf Kittel, Johannes Klapperstück, **Leitfaden der Anatomie der Wirbeltiere**, 5. Auflage (*Guidelines of Vertebrate Anatomy*, 5th Edition), VEB Gustav Fischer Verlag, Jena, 1987, 309 pages with 205 figures and 4 tables in the text.

In the last decades of the 19th century, the university town of Jena (Germany, today GDR) became the capital of vertebrate anatomy in Europe. This tradition was founded by brilliant professors of anatomy as Carl Gegenbaur, and by the Gustav Fischer publishing house, where textbooks of comparative anatomy were printed, which soon became classic works for people everywhere in the world, who studied comparative anatomy of vertebrates. The textbooks published by C. Gegenbaur, as well as those by Robert Wiedersheim established also a definite pattern for textbooks of vertebrate anatomy and for reading vertebrate anatomy in the universities. The structure of those textbooks was opened by the study of the integument, followed by skeleton and musculature, and ending by endocrine glands. Every system of organs was described *sub specie evolutionis*. This pattern of textbooks was the climax of perfection, the absolute beauty in teaching comparative anatomy. Even now, after a century of progress one can find in those old textbooks reliable information on general problems and various details of the anatomy of each class of vertebrates, of each organ of the vertebrate body. Therefore, the idea that a textbook on vertebrate anatomy could have been constructed disregarding the Jena tradition would have seem to be a pure illusion. The tradition was reinforced after the unsuccessful work of H. Böker (1935) "Einführung in die vergleichende biologische Anatomie der Wirbeltiere" (Introduction to Comparative Biological Anatomy of Vertebrates), which explained the evolution of the organ systems of the vertebrate body by ecological situations, unfortunately in a speculative manner.

But after the middle of the 20th century, the miracle happened. A new model of thinking in comparative anatomy took the form of a textbook. Three professors of comparative anatomy of vertebrates from the universities of Halle-Wittenberg and of Greifswald published in 1955, at the same publishing house Gustav Fischer in Jena, where all German vertebrate anatomy books were published, an original textbook of vertebrate anatomy, which is reviewed here. It differs by its structure totally from the textbooks of Gegenbaur and of Wiedersheim. The "Kämpfe-Kittel-Klapperstück" is opened by an outline of vertebrate embryogenesis, followed by the anatomy of the locomotory apparatus, being ended by the study of the integument. In this way, the authors have shown that even in a discipline like comparative anatomy, which owes almost all of its ideas to the tradition, where new facts accumulate only slowly, one could write a modern book.

The 5th edition is revised and amplified with new facts and ideas. The frame of subjects was extended from vertebrates to the whole phylum of chordates, the textbook being in fact a comparative anatomy of the chordates. Hemichordata, Urochordata, and Cephalochordata were included in the comparative reviews of the evolution of organ systems. The text is preceded by a checklist of classes, orders, and even families of vertebrates, which allows the student to find easily the taxonomic position of systematic units cited in the text. The textbook is concluded by an outline on the phylogeny of vertebrates. Like its predecessors, the "Kămpfe-Kittel-Klapperstück" remains a work of anatomy dedicated to the elucidation of the macroevolution of vertebrates.

In my opinion, the manual is valuable also because it has only 309 pages. It is a work easy to read. There is no danger for the student to be lost in the enormous quantity of facts and ideas condensed in the 309 pages of the "Leitfaden".

BOGDAN STUGREN

Martin Görner, Hans Hackethal, **Säugetiere Europas** *(Mammals of Europe)*, Deutscher Taschenbuch Verlag, München und Ferdinand Enke Verlag, Stuttgart, 1988, 371 pages with 618 figures in the text.

Unlike bird-watching, there is no "mammal-watching" as a new profession or a hobby in Europe. Therefore, there are not many books on European mammals. The paperback reviewed here on European mammals, written by two zoologists from the GDR (editio princeps 1987 at Neumann Verlag, Leipzig) is an entirely new work dealing with fauna and distribution, and biology of mammals in a comprehensive manner. The check-list comprises 195 species of mammals, living on the continent and in European seas. Some of them are not natives of Europe, being moved by man from other continents, as for instance the Virginia deer *(Odocoileus virginianus)*, a species from North America, today naturalized in Finland and Bohemia. The work is provided with fine colour drawings of all 195 species checked in the faunal list. The drawings were made by Wolfgang Lenck and Eugenie Tanger. These figures are helpful for identification, being made in a strictly naturalistic mode. But the work gives more than exact figures for indentification of species. One can find there maps with geographical ranges for every species, figures of anatomical features (mainly teeth and skulls), which allow a broader look on the systematics of mammals, and also drawings of burrows of mammals. The work includes chapters on zoogeography of mammals in Europe, and on mammal conservancy in Europe. The paperback is provided with bibliographical list, a glossary of technical terms, and a species index (with Latin and trivial German names), and a subject index, too.

BOGDAN STUGREN

Motoo Kimura, **Die Neutralitätstheorie der molekularen Evolution**, Verlag Paul Parey, Berlin, Hamburg, 1987, 303 Seiten, mit 58 Abbildungen und 17 Tabellen.

Das Buch umfaßt 9 Kapitel, die von Zusammenfassung, Schlußfolgerung und einer reichhaltigen Fachliteratur begleitet sind.

In den ersten Kapiteln des Buches wird die historische Entwicklung der Theorien über den Mechanismus der Evolution aufgezeigt. Vergleichende Untersuchungen von Protein- und DNS-Sequenzen beweisen, daß in der Evolution nur ein kleiner Teil der DNS-Veränderungen adaptiv ist, während der größere Teil der molekularen Substitutionen, die phänotypisch stumm bleiben, keinen signifikanten Einfluß auf das Überleben und die Reproduktion hat. Davon ausgehend behauptet die Neutralitätstheorie, daß der Großteil der evolutiven Veränderungen auf molekularer Ebene nicht durch Darwinische Selektion, sondern durch Zufallsdrift von selektiv neutralen oder beinahe neutralen Mutanten hervorgerufen wird.

Der Autor beschreibt die Hauptformen der molekularen Evolution auf Grund der Entwicklungsgeschichte der Wirbeltiere. Somit setzt die Neutralitätstheorie fest, daß Protein- und DNS-Polymorphismen eine Durchgangsphase der Evolution sind und daß solche molekulare Polymorphismen durch die Kräfte der balancierenden Selektion bestimmt werden.

Die richtige Bewertung der Neutralitätstheorie setzt eine genaue Kenntnis des Wesens der natürlichen Selektion voraus. In diesem Sinne werden im Kapitel 6 die Definitionen, die Arten und Wirkungen der natürlichen Selektion im Überblick behandelt. Es führt uns dadurch in die klassische Theorie der Populationsgenetik ein. Zum Großteil setzt sich dieses Kapitel mit der deterministischen Theorie auseinander.

Im folgenden Kapitel werden Ergebnisse aus der molekularen Ebene zur Unterstützung der Neutralitätstheorie verdeutlicht. Eine ziemlich ausführliche Darstellung der stochastischen Theorie der Populationsgenetik, wobei verschiedene Modelle erklärt und entwickelt werden, bildet den Inhalt des 8. Kapitels.

Im Folgenden beschreibt der Autor die möglichen Mechanismen der genetischen Variabilität auf molekularer Ebene, eines der wichtigsten Probleme, mit denen die Populationsgenetik derzeit konfrontiert wird.

Eine Zusammenfassung des ganzen Buches und einige abschließende Bemerkungen bilden das Schlußkapitel.

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ÎNTREPRINDEREA POLIGRAFICĂ CLUJ,
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