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SUMAR – CONTENTS – SOMMAIRE – INHALT

Recenzii — Book Reviews — Comptes rendus — Buchbesprechungen

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ECOLOGY — MEANINGS AND AIMS

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SUMMARY. — In the idea developed here, there are nowadays three different sciences called ecology. It is, firstly, the *theoretical (general) ecology* or *bioecology*, a bioscience based on plant and animal ecology, and on microbiology. Its aim is to discover the fundamental mechanisms in ecosystems. Secondly, it is the *global ecology* or *geoecology*, a geoscience which deals with the interactions between the lithosphere, hydrosphere, atmoshere, biosphere and human society. Thirdly, it is the *ecological engineering*. Its task is to project and form ecosystems, and to conserve and manage environmental resources.

In my opinion, the expression **theoretical ecology,** proposed here, has a more deeper meaning than that of **general ecology** or simply **ecology**. General ecology means a synthesis of plant, animal, and microbial ecology in order to emphasize the common features in the interactions of plants, animals and microorganisms at superorganismic levels with the environment in the ocean, the inland waters, and on the continent. General ecology was defined as „the study of structure and function of nature" [17, p. 4], a systemic science [18], which means that ecology is based on the general systems theory. More recently, ecology was defined as „the scientific study of how animals and plants live the way they do: a study aimed at understanding the basic underlying principles of operation of natural systems" [20, p. 13]. General ecology is a biological discipline, called also *bioecology* [24]. The theoretical ecology is much more than this, because it emphasizes the role of theory, *i.e. of* the general systems theory based on mathematics and modelling for the understanding of fundamental mechanisms at the population and ecosystem level. Like theoretical physics and rational mechanics, theoretical ecology is not an experimental branch of science. There are special branches of ecology which deal with ecological experiments in the laboratory and in the field: plant, animal, and microbial ecology. Theoretical ecology is not only a synthesis of experimental data. It also means the approximation of natural mechanisms with the help of probabilism and, specifically, of Monte Carlo methods. Finally, it is a background for the science of evolution, because ecology is also the study of conditions of the struggle for existence, as Ernst Haeckel [9], the founder of ecology, pointed it out, more than a century ago.

But there is a danger included in these definitions. Theoretical ecology may become a bit much too theoretical. I am referring to the often not necessary formalization of ecology by higher mathematics, by oversophisticated mathematical models of ecological processes, which tell

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nothing to the ecologist, being a purely mathematical symbolism, for the sake of mathematics and not for the approximation of ecological mechanisms [10]. Despite such errors, ecology should not give up working with mathematical models, which are, in certain situations, the only way to advance our knowledge about the operation of ecological systems [14].

Ecology was called an integrative science [18]. Really, ecology integrates results acquired in an experimental way by particular biological disciplines. But it does not integrate disciplines beyond the limits of biological sciences. Therefore, let us also say what theoretical ecology is not. Thus, a branch of ecology, the **human ecology** has different meanings with different authors: a special branch of sociology [2]; the study of interactions between man and environment]5[; the study of structure and function of living nature increasingly transformed by man [6]; the study of "urban ecosystems", defined as "pure cultures of man" [19]. Human ecology is not, and could not be a kind of philosophical anthropology, because it is not a comprehensive science of physical, psychic, and social features of the species *Homo sapeins* L. Human ecology deals with a single feature of the human biology, namely with man's interactions with his physical and biotic, especially microbiological and parasitological environment, *i. e.* with the environmental backgrounds of health and illness [16]. Human ecology is, therefore, indissociably linked to medical sciences [1].

The contemporary trend to identify ecology with a certain Weltanschauung is the worst reverse of the progress and increasing importance of ecology in modern world. Many talented writers [8, 26, 27] have published bestsellers about the future of mankind under the conditions of a deteriorating environment. They expose ecological ideas in poetical or, sometimes, newswriter manners. One cannot learn ecology from such books, as one cannot learn the history of Britain from the novels of Walter Scott. One who publishes a book on the ecological crisis in the modern world is not, *ipso facto,* an ecologist. He only behaves as if he were an ecologist. He may be a talented writer, a brilliant essayist, or, simply, a *sayer,* one who does not carry out research work in science, but only talks about science [7]. On the contrary, the *doers* are effective research workers in science. In ecology, the sayers are authors of vulgarization books, while the doers are authors of short research papers and of scientific monographs. One cannot be an ecologist without working also in a special branch, as botany, zoology, or microbiology. A logical mind is insufficient for becoming an ecologist. One need, first of all, to work with facts, ecology is not a Weltanschauung, it is a discipline of natural sciences [5].

There is also a trend to extend the object of ecology beyond the realm of the living world, in order to integrate the study of Earth's outer layer as a whole into ecology, in other words to integrate physiography, hydrology, climatology, and geochemistry, respectively biogeochemistry. In this way, ecology may loose its nature as a biological science and evolve into a non-biological „superscience", a diluted and superficial knowledge of natural systems [25]. The era of encyclopaedical naturalists as Buffon and Humboldt is over.

The study of interactions between the lithosphere, hydrosphere, atmosphere, biosphere and human society, of interactions on the surface of Earth as a whole, can not belong to ecology. It belongs to **global physical geography,** called today, surprisingly enough, **global ecology** or **geoecology**. This term implies that ecology has done an entirely new set of ideas into geography.

But it is too great a glory for ecology. To tell the truth, global physical geography owes almost nothing to ecology. To the contrary, the principle of interaction, being the basic principle of ecology, was elaborated by the old physical geography, long before the birth of ecology. In the first half of the 19th century A l e x a n d e r v o n H u m b o l d t [12] pointed out, for the first time in the history of science, the unity between Earth's solid crust, water, climate, vegetation and fauna on large continental scale in South and Central America, and in Central Asia. He was the founder, *avant la lettre,* of global ecology. In the second half of the 19th century, a brilliant team of geographers developed his ideas for the whole planet [21—23]. In Romania, global physical geography was developed by M e h e d i n ţ i [15]. The rise of ecology, after 1950, revigorated the old „ecological" traditions of geography, reminded the geographers that there was once a global physical geography, which was revived as global ecology (geoecology) [3, 13, 28]. Unlike theoretical ecology, geoecology integrates into the structural units (geosystems) of Earth's outer layer, human settlements, too.

The study of environment as a whole does not belong to bioecology either. The environment is a part of the geographical envelope of our planet, being therefore a subject of study of the physical geography. Ecology as a biological discipline deals with only a small compartment of the environment: the interactions of living world. The study of environment as a system belongs to **ecological engineering,** an applied ecology, a multidisciplinar science, mainly a technical discipline, closely linked to forestry and water management. It is, therefore, a technological discipline. Typical for ecological engineering is the idea to develop special forest ecosystems, named "pilot forests" or "steering forests", composed of rapid growing tree species, with high productivity and high power to expand by invasion of degraded grounds, being thus able to induce a process of reforestation [4]. Its aims is also to develop a technology of production and reproduction of renewable resources, to ensure their development under optimal conditions [11].

Concluding remarks. The word ecology has today, as it was discussed above, much more meanings than in 1959, when ecology became a synthetic, systemic science. Unfortunately, the meaning of ecology was often misinterpreted as a kind of sociology or philosophical doctrine, a pure speculation which does not need basic knowledge in biological sciences, but only a sharp mind and the art of 'belles lettres'. Ecology is nowadays even the name for the programme of a certain political party in West Germany. I mean the Greens („die Grünen"). A similar situation is known from the history of darwinian doctrine. At the end of the 19th century, a sociological school called itself social-darwinism,

using the name of Darwin as a badge for its political and social ideas. In the end, darwinism survived to our days, while social-darwinism was forgotten. The same will be, I hope, with the future of ecology. Ecology as a science will survive and evolve, while ecologically nuanced theories and bestsellers will disappear in the archives of erroneous ideas.

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STUDIA UNIV. BABEŞ—BOLYAI, BIOLOGIA, XXXIII, 2, 1988

PREOCUPĂRI RECENTE ÎN ALGOLOGIE

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SUMMARY. — Recent Preoccupations in Algology. Some relevant results obtained in algology these last years are summarized in this article with the aim of predict of the probable main trends in algological researches. As the algal flora is not known enough in the world (Romania included), it follows that it should be investigated more intensively (algae being the principal primary producers in waters). These investigations will unavoidably imply more meticulous taxonomical and thorough ecological researches (using sophisticated analytical tools). These researches (and other scientific and social demands), in turn, will stimulate growing algae in pure cultures (developing more complete collections in order to save their genetical heritage) with beneficial effects on taxonomy and having the necessary stocks for biological studies and for future biotechnologies.

Introducere. După intervalul de admirabile promisiuni al anilor 1950—1960 [17] din care s-au finalizat doar cîteva biotehnologii, algologia se află azi într-o intensă fază de acumulare. De altfel, în istoria algologiei a mai existat un înfloritor deceniu la sfîrşitul secolului trecut [10, 33]. Este imposibil de cuprins într-o sinteză succintă toată algologia din cauză că domeniile ei, datorită cercetărilor multi- şi interdisciplinare din ce în ce mai aprofundate, se întrepătrund, astfel încît fiziologia, biochimia şi enzimologia, de pildă, nu se mai pot delimita, mai ales în sens clasic. Şi tocmai ca o caracteristică şi tendinţă esenţială în studiile algologice, ca o consecinţă firească a permanentului progres ştiinţific, rezultatele diferitelor cercetări *in situ* şi în laborator sînt corelate pe multiple planuri şi prin interconexiuni din care se formulează concluzii adecvate matematizării şi computerizării. Cercetările algologice actuale îmbrăţişează toate capitolele de biologie vegetală în general (morfologie, structură, taxonomie, floră, vegetaţie, ecologie, fiziologie, biochimie, genetică, biologie moleculară, enzimologie) alături de cele speciale ei (limnologie, producţie primară) cu repercusiunile practice derivate din ea (culturi, epurarea apelor), nu numai pe plan mondial, ci şi la noi în ţară.

Floră şi vegetaţie. Cercetarea florei şi vegetaţiei algologice este impulsionată prin cel puţin 3 deziderate majore: importanţa algogenofondului, prezenţa algelor în cele mai diverse habitate şi modificările mediului ambiant.

1. Bogăţia speciilor şi varietăţilor de alge este încă departe de a fi cunoscută. Sînt mereu descrişi noi taxoni, iar cei semnalaţi anterior sînt completaţi cu noi date, în toate regiunile lumii unde oamenii se îndeletnicesc cu algologia. Specialiştii apreciază că numărul speciilor ar fi

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de 33.000—50.000 [18, 45], iar în diversele colecții de culturi pure se găsesc vreo 800—2.000 de specii și sușe [6, 100].

Colectarea, izolarea și introducerea în culturi pure a algelor sînt acțiuni inevitabile. Menținerea și dezvoltarea colecțiilor de culturi pure sînt necesare pentru că numai prin ele se poate evita reducerea, îngustarea fondului genetic [97]. Centrul Mondial de Date și Centrul de Resurse Microbiologice (MIRCEN) au lansat o chemare către toate statele lumii pentru ocrotirea și păstrarea genofondului de microorganisme (inclusiv alge), fără de care biotehnologiile noi (între acestea și „photosynthetic technology"), ingineria genetică, gospodărirea mediului ambiant (detoxificarea, reciclarea deșeurilor, purificarea apelor), fixarea N_2, sursele de materii neconvenționale sînt de neimaginat [28, 43, 104]. În cadrul unui amplu proiect germano-thailandez pentru producerea de proteine prin microalge, au fost izolate și introduse în culturi pure, ca pe urmă să fie studiate temeinic, un număr de 269 de specii și sușe de clorofite și 17 cianofite [12]. O modestă colecție de culturi pure de alge există și la Universitatea [72] și Centrul de Cercetări Biologice din Cluj-Napoca.

Cercetările algofloristice de pînă acum nu sînt suficiente pentru o listă certă. Totuși, există și evidențe sigure privind activitatea algologică. Astfel, în Rusia, respectiv în Uniunea Sovietică bibliografia algologică a fost publicată în fiecare deceniu începînd din anul 1901 și pînă în 1983. În acest interval de timp au apărut 13.759 de studii referindu-se la algele de pe teritoriul Rusiei, respectiv U.R.S.S. [56]. În lista algelor publicate din biotopurile României figurau în anul 1956 abia 10 specii de *Scenedesmus*, în 1958 — 16 specii, iar în Conspectul încheiat în anul 1986 erau inserate în total 49 de specii și 60 de varietăți și forme [77, 107, 108].

În mod necesar și concomitent cu studiul florei și vegetației progresează și se perfecționează și taxonomia algelor. Dintre metodele moderne aplicate în sistematica algelor se relevă microscopia electronică. Structura submicroscopică a fost studiată la un număr foarte mare de alge, în diferite stadii ontogenetice și stări fiziologice [52, 83, 84]. Se pare însă că nici aceste studii nu au rezolvat încă problema sistematizării taxonilor dificili. Abundența materialului faptic și aplicarea calculelor matematice în corelarea caracterelor specifice au oferit reconsiderarea multor genuri și specii [22, 53, 54, 81]. Metodele biochimice și de biologie moleculară (activitatea hidrogenazică, nitrogenazică, compoziția și recombinarea acizilor nucleici, căile de biosinteză a aminoacizilor aromatici, constituția moleculară a pigmenților) în determinarea taxonilor (mai ales a infraspeciilor) cîștigă din ce în ce mai mult teren, în special în cazul unor forme cultivate *(Anabaena, Nostoc, Chlorella, Scenedesmus)*, grație avantajelor oferite de culturile pure [47, 64, 109].

Algotaxonomia este frămîntată în prezent mai mult decît altădată atît de incertitudinea determinării speciilor, varietăților și formelor, cît și de inexistența unui sistem filogenetic, actualul sistem (elaborat de P a s c h e r [79]) fiind bazat, în bună parte, pe criterii morfologice. Se preconizează (pretinde) ca în viitor criteriile specifice să fie stabilite

pe baza cunoașterii întregului ciclu ontogenetic, a polimorfismului și variabilității, a aberațiilor ce apar frecvent atît în natură (dar rar dibuite) cît și în culturi de laborator, și pe baza dinamicii morfo-structurale în cadrul populațiilor [31]. Aceste deziderate impun incontestabil culturi pure, și încă sincronizate!

2. *Dinamismul răspîndirii algelor* în cele mai diverse habitate este facilitat nu numai prin dimensiunile lor mici ci și prin adaptabilitatea rapidă. Cercetătorii Institutului Smithsonian [4] au descoperit în regiunea Insulelor Bahama alge care trăiesc permanent la o adîncime de 200 m pînă unde pătrunde abia 0,0005% din lumina solară. În Suedia s-a constatat că și sub gheață (80 de lacuri studiate) pot apare „înfloriri de apă" (produse în preponderență de *Oscilatoria rubescens, Gomphosphaeria naegeliana, Coelosphaeridium kuetzingianum, Aphanisomenon gracile, Aphanothece clathrata, Cyanodictyon gracile)* [75]. Sepcii rare și rarisime, relicte endemice de mare importanță fitogeografică (precum *Cosmarium decedens* var. *carpaticum, Euastrum montanum, E. subalpinum, Staurastrum monticulosum* var. *bifarium)* au fost semnalate și înainte vreme din țara noastră [88]. Mai recent numeroși taxoni de *Chrysophyceae* și *Xanthophyceae* au fost descriși și publicați și din locuri anterior investigate [68, 82—84]. Alga de mare perspectivă științifică și practică *Botryococcus braunii* (diferite sușe, „rase fiziologice") a fost găsită și introdusă în culturi pure de laborator din mai multe biotopuri ale țării (N. Dragoș, 1987, comunicare verbală). Abia după progresele algofloristice se va putea aborda fitogeografia speciilor și a raselor de alge — inevitabile domenii de investigații în viitor [19, 31].

Cunoașterea mai satisfăcătoare a corologiei algelor va diminua redundanța taxonilor noi.

3. *Antropizarea nestăvilită a mediului ambiant* are repercusiuni profunde asupra habitatelor algale, schimbîndu-le stabilitatea cenotică. Se afirmă [39] că populațiile fitoplanctonului natural indică mai bine întîmplările din apele lacurilor decît speciile biotest. Problema acestei metode rezidă în schimbarea continuă a fitoplanctonului [39], și în determinarea, adesea, superficială a taxonilor (de pildă, *Diatoma* spp.). Cantitatea și compoziția cenozelor sînt foarte variabile, determinate de condițiile fizice și chimice ale mediului ambiant [15, 66, 87]. Stabilitatea ecologică a cenozelor algale (de *Diatomeae)* care se instalează pe suporturi artificiale este mai mică decît a acelora formate natural [82]. Alterarea ecosistemelor algale, a spectrului lor specific de către centrale atomo-nucleare (prin radionuclizi și temperatură) a fost în repetate rînduri menționată [19, 20, 39, 50, 63]. Schimbarea algocenozelor este deosebit de evidentă în lacurile de baraj [20, 50]. Ca atare, dispar (poate pentru totdeauna) numeroase elemente sensibile stenotope și invadează (algal bloom) cele tolerante euritope. Este oportun de menționat, în contextul rezultatelor citate *lipsa unei rezervații specific algologice*, omisiune datorată atît necunoașterii în suficientă măsură a algoflorei și vegetației, cît și modestiei specialiștilor (lipsei lor de îndrăzneală) de a prognoza importanța unică a acestui genofond. În lipsa unor habitate nealterate „nu se poate defini în termeni taxonomici, fiziologici și ecosis-

temici noțiunea de ‚natural' fără de care nu pot fi luate în considerare argumentele ecologiștilor" [50].

Concluzia ce rezultă din aceste date și idei nu poate fi alta decît că investigarea (inventarierea) florei și vegetației algologice este necesară pentru descoperirea, cunoașterea speciilor, dintre care apoi să se selecteze cele care par a fi promițătoare pentru culturi intensive și masive (*Anacystis, Synechococcus, Spirulina, Chlorella, Scenedesmus, Dunaliella, Botryococcus* ș.a.) și să se stabilească cele cu valoare indicatoare necesare monitoringului mediului ambiant (*Oscillatoria rubescens, O. agardhii, Anacystis nidulans, Synedra acus* ș. a.) [8, 32, 61] și pentru ocrotirea și păstrarea lor (în rezervații și colecții de culturi pure) ca genofond din care să se selecteze șușele adecvate cercetărilor fundamentale, cultivărilor intensive și masive [12].

Ecologie. Cercetările ecologice, care s-au intensificat în ultimele decenii îndeosebi datorită constatărilor că flora și vegetația algologică este supusă unor schimbări rapide și profunde, mai ales din cauza antropizărilor, ar putea fi evidențiate prin două tendințe mai generale, conturabile prin principiile lor metodologice.

1. Aplicarea mai frecventă a *calculelor matematice* în descrierea, compararea și caracterizarea comunităților algale și încercările de modelare a schimbărilor ce pot surveni în algocenoze, îndeosebi sub efectul factorilor fizici ai mediului. Funcția Shannon pentru diversitatea specifică, coeficientul Jaccard pentru afinitatea comunităților, curba normală obținută pe baza formulei Patrick pentru frecvența speciilor etc. au fost aplicate în studiile cenozelor sfagnofile din Munții Apuseni și Munții Maramureșului, precum și în cele diatomologice ale izvoarelor minerale din Depresiunile Ciucului și Bîrsei [66, 67, 85—87]. Desigur, pentru aceste studii cunoașterea, identificarea precisă a speciilor era o condiție esențială, indiscutabilă. Principiile elaborate de Margalef bazate pe creșterea diversității specifice și biochimice, pe creșterea dimensiunilor medii ale organismelor și pe substituirea ciclurilor biologice au fost aplicate pentru modelarea succesiunii comunităților algale dintr-un lac din Franța [2]. Numai prin valoarea de ATP s-a putut stabili o corelare pozitivă cu evoluția în timp a fitoplanctonului; activitatea ridicată a nitrat-reductazei a fost corelată întotdeauna cu diversitatea specifică scăzută, indiferent dacă în apă era NO_3^- sau NH_4^- [2]. De altfel, teoria succesiunii ecologice are încă puține date experimentale.

2. Aproximarea mai fiziologică și biochimică metodologică și conceptuală a întîmplărilor complexe intrapopulaționale ce se repercutează asupra compoziției (implicit și a calității) și productiviiății comunităților algale (physiological limnology). Este vorba de transpunerea la nivel de ecosisteme a rezultatelor experimentale obținute în condiții de laborator cu una sau cu cîteva specii. Această tendință în cercetările algologice izvorăște, mai cu seamă, din acele constatări conform cărora procesele vitale (absorbția sărurilor, asimilarea carbonului, creșterea și multiplicarea) nu sînt determinate numai de factorii de mediu, ci și de

interacțiunile celulelor populației (mono- sau multispecifice). De-a lungul creșterii și multiplicării, celulele de alge elimină în mediul lor (acvatic sau terestru) diferite substanțe biosintetizate (metaboliți activi începînd cu glicolatul și terminînd cu hormoni, vitamine și toxine) prin care raporturile componentelor cenotice (precum și producția lor primară) sînt modificate. Totalitatea acestor substanțe este cunoscută în ecologia algelor ca „exocrine" [38]. Bazele experimentale ale acestor constatări au fost puse încă în anii 1940—1944 de către P r a t t și colab. [90] care au surprins autoinhibarea unei culturi pure de *Chlorella* la o anumită densitate celulară, cauzată de o substanță denumită „chlorelină". După această primă observație, numeroase experiențe au demonstrat efecte heteroantagoniste produse de „phormidină", „scenedesmină" [89]. Mai recent, interacțiunile biotice din fitoplancton (dintre alge) sînt cuprinse în conceptul de alelopatie (interdependențe, efecte alelotrofice și alelochimice).

Fenomenul de „înflorire a apelor" (albastru-verzui, verde, roșu, galben) este produs de înmulțirea masivă a unor alge, cel mai adesea de cianoficee. Enorma lor cantitate „paradoxală" în medii mai sărace în nutrienți (îndeosebi cu carență de N) se datorește nu numai facultății de fixare a N_2, ci și inhibării speciilor competitoare prin substanțe specifice (macromoleculare biologic active, micromoleculare antagoniste, volatile inhibitoare) excretate în mediu [48]. Mareea roșie care apare periodic în unele zone oceanice (Golful Mexic) și produce stridiile toxice nu este altceva decît înmulțirea masivă a unor dinoflagelate, între care și *Phychodiscus brevis*. Substanțele excretate de către alga albastră *Nannochloris* sp. *(Gomphosphaeria aponina)* de asemenea producătoare de „înflorire" distrug celulele de *Phychodiscus* [69].

Acizi grași nesaturați (linolenic, linoleic, oleic), din celulele de *Chlamydomonas reinhardtii* inhibă creșterea speciilor de *Synechococcus kopoliensis*, *Haematococcus lacustris* și *Botrydiopsis alpina* [105]. Echilibrul dintre speciile *Nitzschia closterium*, *Ochromonas crenata* și *Nephrochloris salina* depinde de proporția elementelor N, P, Si. În caz de N + Si favorabil predomină prima specie, iar în caz de N + P favorabil — celelalte două [102]. În populațiile mixte de *Scenedesmus acutus*, *Sc. intermedius*, *Schizochlamys gelatinosa*, *Keratococcus braunii*, *Tetracystis* cf. *intermedium* și *Stichococcus bacillaris* cea mai viguroasă specie a fost *Schizochlamys gelatinosa* care a fost ușor inhibată numai de către *Tetracystis* cf. *intermedium* [74]. În apele bogate în nutrienți, microfitoplanctonul crește mai rapid și în scurt timp substituie speciife de dimensiuni mai mari [13]. În general, în apele oligotrofe procentul substanțelor excretate de alge este mai mare decît în cele eutrofe și productivitatea fitoplanctonului este pozitiv corelată cu prezența bacteriilor aerobe [21].

Implicații în cercetările de biologie. Progresele făcute în fiziologia algelor sînt într-atît împletite cu ale fiziologiei plantelor încît numai arbitrar, artificial s-ar putea separa cele două domenii. „Ar fi dificil de supraapreciat studiile integratoare ale algelor în investigațiile meca-

nismelor de reglare și dezvoltare la plantele superioare" [5]. Avantajele actuale ale algelor în cercetările fitofiziologice au fost fundamentate prin culturile pure, a căror importanță a fost relevată încă de G r i n ț e s c u [42]: „les cultures pures sont le seul moyen d'étudier d'une façon précise le cycle de développement d'une algue". Această previziune a fost confirmată într-un mod strălucit prin faimoasele experiențe ale lui B a s s h a m și C a l v i n [9], care au constatat că „avantajul inestimabil al culturilor (pure) rezidă, în primul rînd, în reproductibilitatea și cantitatea aproape la discreție a materialului, și în al doilea rînd, în posibilitatea asigurării omogenității materialului datorită stabilizării culturilor". Valoarea algelor ca sisteme model a fost și este continuu augmentată și prin cercetările Institutului Carnegie [5]: „. . . . algele sînt mult mai ușor de manipulat decît plantele superioare. În ele se pot substitui gene cu gene, în genomul lor se pot introduce gene specifice sau alte secvențe de ADN. Astfel, se pot prospecta care anume secvențe de ADN sînt necesare pentru reglarea luminii, sau care sînt regiunile structurale importante ale proteinelor astfel produse . . . Valoarea mare a mecanismelor de reglare (fiziologică) descifrate cu alge nu înseamnă, desigur, că ele sînt întru-totul similare cu ale plantelor superioare".

1. Coeficientul de bioconversie a luminii solare la alge (3—13,3%) este mai mare decît la plantele agricole [71, 112]. La acest avantaj se adaugă că ele sînt în întregime utilizabile. Nu poate fi surprinzător, așadar, că în numeroasele cercetări din domeniul fotosintezei sînt folosite algele. Problemele mai recente din acest domeniu se referă la structura pigmenților asimilatori [16, 36, 40, 117], cinetica reacțiilor electronice dintre cele două fotosisteme [95, 96], transportul de electroni între fotosisteme în funcție de factorii externi [65], modelarea matematică a productivității fotosintetice [35], mecanismul de reglare a fotosintezei prin ficoeritrină în funcție de aprovizionarea cu N la *Synechococcus* [115].

2. Mecanismele enzimatice, prin care sînt transportate sursele de carbon (CO_2, HCO_3^-, CO_3^{2-} în celulă, sînt investigate cu deosebită tenacitate. Carbonul — factor decisiv în fotosinteză, în natură este întotdeauna în cantitate limită. Culturile intensive și masive de (micro-) alge sînt, de regulă, suplimentare cu CO_2 (în concentrație 1,5—5%) ceea ce ridică prețul de cost al biomasei. Studiindu-se (în ultimii ani) mecanismul de absorbție în funcție de cantitatea de CO_2, s-a descoperit că la concentrații mici (0,03%) are loc acumularea lui în celule *(Chlamydomonas)*. S-a stabilit apoi că acest proces de acumulare intracelulară este guvernat de către enzima carboanhidrază. S-a pus în evidență că ea este adaptivă. În celulele de *Chlorella*, ea apare la concentrații mici de CO_2 într-un scurt timp de adaptare a algei la aceste condiții [92]. Cantități mai ridicate de CO_2 inhibă activitatea enzimei în *Porphyridium purpureum*. Sensibilitatea ei pentru HCO_3^- este mărită prin Na^+. În această algă, majoritatea carboanhidrazei celulare este localizată în periplasmă [27]. În celulele de *Coelastrum sphaericum* și *C. cambricum*, carboanhidraza a fost evidențiată în omogenatul celulelor, în fracțiunea proteinelor solubile și în cea a proteinelor legate de membrană. Activitatea fracțiunii din membrană a fost mai

sporită decît cea din fracțiunea proteinelor solubile. Este interesantă constatarea că în *Coelastrum sphaericum* activitatea a fost mult mai mare decît în *C. cambricum* [37].

Dinamica enzimei a fost studiată și la numeroase alte alge albastre, verzi și macroalge brune [1, 23, 70, 76, 78].

Intensele cercetări consacrate carboanhidrazei au ca scop sporirea productivității fotosintetice prin stimularea activității ei și nu prin suplimentarea costisitoare cu CO_2.

3. Nutriție și reglarea metabolismului. Din multiplele probleme referitoare la nutriția algelor par a fi dominante acelea consacrate mecanismelor de absorbție a N și P, bioacumulării diferitelor metale și schimbărilor adecvate nutrienților, respectiv factorilor, (în preponderență) cu rol în căile biosintetice (biosinteze dirijate). Eficiența maximă a absorbției, pînă la 95%, a N și P la *Chlorella pyrenoidosa* a fost determinată la proporția de 1 mg N/l și 0,1 mg P/l [55]. Absorbția N—NO_3^- este în general stimulată de lumină [25]. De altfel, și preferințele algelor față de sursele de N depind de condițiile de mediu. Astfel, majoritatea microalgelor autotrofe preferă formele anorganice de N (NO_3^-, NH_4^+). Pe baza determinării nitrat-reductazei din mediu și din celulă, s-a constatat că diferite specii de diatomee (în plancton și în culturi controlate) preferă NH_4^+ față de NO_3^- [62]. Dar aceste surse pot fi și sînt substituite cu alte forme de azot. Astfel, *Spirulina platensis* utilizează eficient și ureea (pînă la concentrația de 0,22 g/l) în loc de N—NO_3^- [29].

Finalizări mai de perspectivă promit acele cercetări care urmăresc acumularea unor anume substanțe în celule în funcție de nutrienți și de alți factori. Biosinteza glicerolului în specii de *Dunaliella,* dar și în *Chlamydomonas,* a putut fi stimulată prin stres hiperosmotic [11, 41, 46]. Majorarea biosintezei fosfatidilglicerolului în *Tetrahymena thermophila* a fost indusă prin stres termic (cit. [99]). Rata sintezei glicolatului în *Euglena* și alte microalge a fost mărită prin concentrații scăzute de CO_2 [116]. Dacă însă este inhibată biosinteza glicolatului, în celulele de *Chlorella pyrenoidosa* și *Ch. stigmatophora* se acumulează prolină [49]. Bioacumularea de prolină a fost constatată și în *Nannochloris bacillaris* sub efectul acidului L-azetidin-2-carboxilic [111].

Este interesant de menționat în contextul autoreglajului celular, dar și în cel al mecanismului de transport, reglarea intracelulară a pH-ului la alga *Cyanidium caldarium* care și în mediu cu pH de 1,2—8,4 își menține pH-ul intracelular între limitele de 6,8—7,0 [30].

Premize în gospodărirea mediului ambiant. Biomonitoringul apelor poluate este un domeniu în care rezultatele algologiei au căpătat o vastă și promițătoare aplicare. Desigur, problematica nu este nouă (începuturile ei datează din primul deceniu al secolului nostru). Dar pentru perfecționarea procedeelor se efectuează încă și recent numeroase și frumoase experiențe. Dintre elemente, cele mai eutrofizante sînt N și P (NO_3^-, NH_4^+, PO_4^{3-}). Recentele experiențe făcute de Persson [80] au arătat că, în funcție de factorii fizici și chimici, algele (diferite specii și populații) pot încorpora N și P pînă la un grad de 90—95%. Absorbția lor este

însă puternic interferată cu alte elemente poluante, în special ionii metalelor grele. Astfel, Zn ($7{,}5 \times 10^{-3}$ — $1{,}5 \times 10^{-7}$ moli) a inhibat puternic absorbția fosforului la *Selenastrum capricornutum* [58], fiindcă și ionii de Zn, precum și alți ioni metalici, sînt bioacumulați de către celulele de alge. Bioacumularea Zn de către fitoplanctonul unor rîuri din Virginia de Vest (S.U.A.) a depins de temperatura și duritatea apei, precum și de conținutul în Fe, sulfați și oxigen dizolvat în apă [114].

Diferențe specifice semnificative au fost constatate în sorbția Cd la *Stichococcus bacillaris* [103]. Ionii de tehnețiu (Tc) sînt acumulați de către *Chlamydomonas reinhardtii,* dar nu și de către *Dunaliella bioculata* [63]. Specifictatea bioacumulării, respectiv sensibilitatea algelor se modifică și pe parcursul contactului cu elementele toxice. Speciile *Monochrysis lutheri, Isochrysis galbana, Dunaliella euchlora, Phaeodactylum tricornutum* s-au adaptat și la concentrații toxice de Cu, Cd și Zn [51]. Adaptarea, respectiv rezistența algei *Chlorella vulgaris* la fenol, *o*-cresol și guaiacol (100 mg/l) a avut loc grație biosintezei monofenol-monooxigenazei care a catalizat oxidarea celor trei fenoli [106].

Algele acumulează poluanții nu numai din apă, ci și din sol sau chiar din aer. Solul este expus poluării mai ales în caz de irigare cu ape reziduale sau fertilizare cu nămol activ din stațiile de epurare. În aceste cazuri suferă în primul rînd algele fixatoare de N_2 [14]. Algele simbionte din licheni *(Nostoc)* sau libere *(Cyanidium caldarium)* prin acumularea din aer a poluanților gazoși (SO_2, NO_2 ș.a.) contribuie la epurarea aerului [98, 101].

Se apreciază că ocrotirea mediului și tratarea apelor poluate se va pune din ce în ce mai mult pe bază de biotehnologii în următorul deceniu [34]. Tehnologiile actuale, convenționale ale epurării apelor și aerului vor fi schimbate cu biotehnologii; de elaborarea strategiilor lor este preocupată întreaga lume [110].

Biotehnologii. Biotehnologiile bazate pe alge rezultă din înrudirea algologiei cu bacteriologia. „Este dificil de separat botanica plantelor inferioare (în special a cianoficeelor) de bacteriologie, care își au unitatea și existența proprie, fără să se mai amintească aplicațiile lor în medicină și în industrie" [3]. Într-adevăr, principiile cultivării intensive și masive a algelor, în special a microalgelor, sînt similare cu ale bacteriilor. Tehnologia rentabilă, industrială a unor alge (micro- și macroalge) a fost săvîrșită în ultimii 30 de ani [73, 94]. Căutările, atît pentru alge cu biosinteze rentabile și specifice, cît și pentru biotehnologii adecvate, desigur, sînt continue [7]. „Se știe că sistemele de producere a biomasei trebuie dezvoltate în diverse scopuri precum: tratamentul apelor reziduale, producere de hrană pentru pești, producere de chimicale comercializate (glicerol, manitol, lipide), de biochimicale și extragere de pigmenți, precum și producerea de energie prin fermentarea biomasei" [112].

Dintre algele pentru care se depun eforturi de elaborare a biotehnologiilor menționate, în primul rînd: *Botryococcus braunii* cu care se prevede a se biosintetiza hidrocarburi, *Dunaliella salina* pentru glicerol, *Dunaliella bardawil* pentru β-carotină, *Ochromonas danica, Scenedesmus*

obliquus, Navicula pelliculosa pentru diferiți steroli, *Anabaena flos-aquae* ca biomasă pentru producere de metan, *Protosiphon botryoidies, Chlamydomonas reinhardtii* și *Stichococcus* sp. pentru antibiotice, specii de *Nostoc, Anabaena, Cylindrospermum, Mastigocladus, Tolypothrix, Gloeocapsa* pentru fixarea N_2. Pentru rentabilizarea fixării N_2 se apelează și la simbioza *Azolla-Anabaena* [44].

Cu toate că există numeroase tipuri de instalații pentru culturi masive, se construiesc mereu noi tipuri [26, 59, 60, 91, 93, 113]. Un fotobioreactor tubular de tip W a l a c h și colab. [113] a fost pus în funcțiune și la Centrul de Cercetări Biologice din Cluj-Napoca (N. Dragoș, 1987, comunicare verbală).

O problemă permanentă și nerezolvată încă în biotehnologia algelor este recoltarea masei algale [57]. Și acest impediment este unul dintre factorii care stimulează elaborarea biotehnologiilor cu lanțuri trofice scurte și rapide. Un astfel de lanț trofic a fost încercat cu alge → larve de *Culex pipiens molestus* → pești [24].

Concluzii. În cercetările algologice sînt angajați numeroși specialiști din toată lumea. Rezultatele obținute au contribuit la rezolvarea multor probleme fundamentale ale biologiei și prin acestea la progresul general al ei. De asemenea, au fost elaborate și o seamă de biotehnologii aplicate și aplicabile. Condițiile social-economice de viitor vor decide în ce proporție vor fi continuate și fructificate valorile certe care rezidă în algologie.

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EFFECTS OF TEMPERATURE ON GROWTH OF THE GREEN ALGA *BOTRYOCOCCUS BRAUNII* KÜTZING

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SUMMARY. — Experiments were carried out on batch cultures of three *Botryococcus braunii* strains (Bbr 52, Bbr 53 and Bbr 64), at temperatures of 20, 24, 28 and 32°C. Growth was estimated by optical density and dry weight values. The optimum range of temperature varied between 20 and 24°C in the Bbr 52 strain and between 24 and 28°C in the strains of Bbr 53 and Bbr 64. The growth and development of *B. braunii* cultures have been found to depend on temperature and strain.

The green alga *Botryococcus braunii* is the only photosynthetic organism that has so far been found to contain high amounts of hydrocarbons, which, under certain natural conditions, may reach 75% of its dry weight [6, 19]. This alga is thus able to effect bioconversion of solar energy into a chemical product, — solar oil — similar to the fossil one, which feasibly can replace the latter in all its uses [18].

By industrial cultivation of *B. braunii* — a potential source generating „solar hydrocarbons" [4] —, it is presently considered that, on the basis of controlled biosynthesis, all renewable hydrocarbons substitutive for the fossil ones could be obtained.

To optimize microalgal mass cultures, it is essential to devise adequate and efficient biotechnologies, and this implies that physical and chemical growth-determining factors and their correct correlation must be first ascertained.

Experimental results are given in this report, relating to the effect of a temperature range between 20 and 32°C on the growth of *B. braunii* cultures. This effect has been pursued with related species [2, 14].

Material and methods. Experiments were carried on three *B. braunii* strains: Bbr 52 was obtained from the Göttingen University Collection; Bbr 53 and Bbr 64 strains were sampled from the spontaneous algal flora in Romania (Bbr 53 was isolated from the pools at Sălicea, Cluj district, and Bbr 64 from the fish-pond at Cefa, Bihor district).

Tests were performed at 4 temperatures, namely 20, 24, 28 and 32°C. The silicate-free Chu 10 medium [7] was used for growth. The nutritive medium pH varied between 5.8 and 6.0. Only exponential growth-stage cultures were employed for inoculation.

Unstirred and carbon dioxide-free batch cultures were alternatively subjected to 4500 lx fluorescent light/dark cycles of 16 : 8 hours for 35 days.

Growth was recorded by estimating the optical density of the algal suspension, and, based on this, the exponential growth rate (R_E) as well as the minimum generation and doubling time (G) were computed. Also employed in determining the growth index was the biomass accumulation taken as dry weight, estimated gravimetrically.

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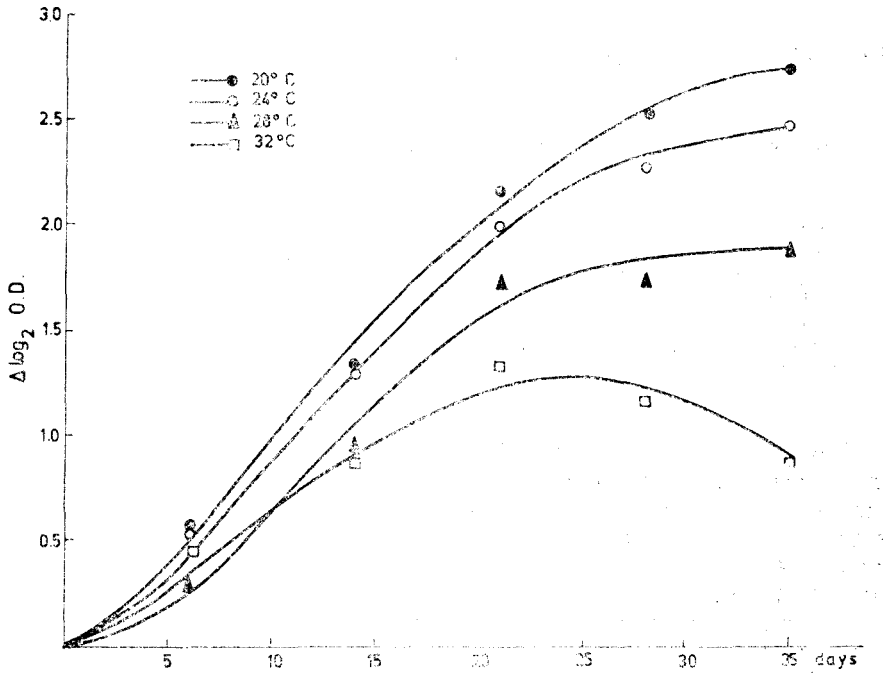

Fig. 1. *Optical density dynamics depending on the incubation temperature of cultures (Bbr 52 strain).*

Data relating to optical density and dry weight were processed according to Sorokin [17].

Results. By analysing the growth curves obtained from optical density data, one finds that subsequent to a 3—6 days latency — depending on strain —, the cultures enter the linear growth phase, the length of which is temperature- and strain-dependent (Figs. 1—3).

In the Bbr 64 strain, the longest linear growth phase (25 days) occurs at temperatures of 24 and 28°C and the shortest (20 days) at 32°C, which also induces short growth phases in the Bbr 52 strain, where growth is diminished and limitation sets in sooner. This strain displays its maximum optical density at temperatures of 20 and 24°C. The Bbr 53 strain is similar to the Bbr 52 strain, with the only mention that its maximum optical density occurred at 24 and 28°C.

Exponential growth rates were correlated with the studied temperatures (Fig. 4), calculated by the optical density logarithms, as follows: maximum growth rate was recorded in the Bbr 53 strain at 24°C, this value greatly surpassing all the others, while minimum values of the exponential growth rate occurred in all strains at 32°C. The other values were intermediate.

Our experiments have once again proved the slow long-lasting growth of *B. braunii* cultures. The minimum G we have recorded also supports

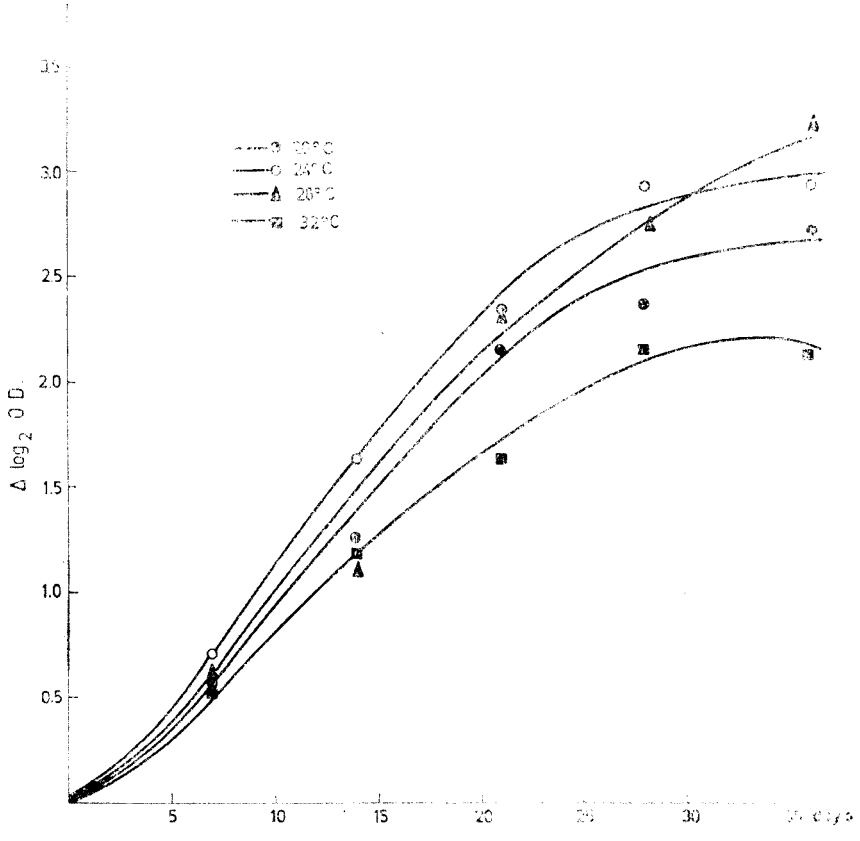

Fig. 2. *Optical density dynamics depending on the incubation temperature of cultures (Bbr 53)*

this idea. The temperature-dependent variation of G in the three strains studied is presented in Table 1.

The maximum generation time occurred in Bbr 52 strain at 32°C (17.64 days) and minimum values in Bbr 53 strain at 24°C (4.27 days). Usually, generation time varied between 9 and 13 days.

Biomass accumulation estimated as dry weight (Fig. 5) was the largest (108.7 mg. 1^{-1}) in Bbr 53 strain at 28°C and in Bbr 52 strain at 20°C, while the minimum value is recorded in Bbr 64 strain at 28°C (36 mg.1^{-1}).

Table 1

The minimum doubling time values (G) depending on temperature in the studied strains

Strains	*G* (days)			
	20°C	24°C	28°C	32°C
Bbr 52	8.81	9.64	9.76	17.64
Bbr 53	8.98	4.27	7.98	15.62
Bbr 64	11.00	12.27	12.88	13.16

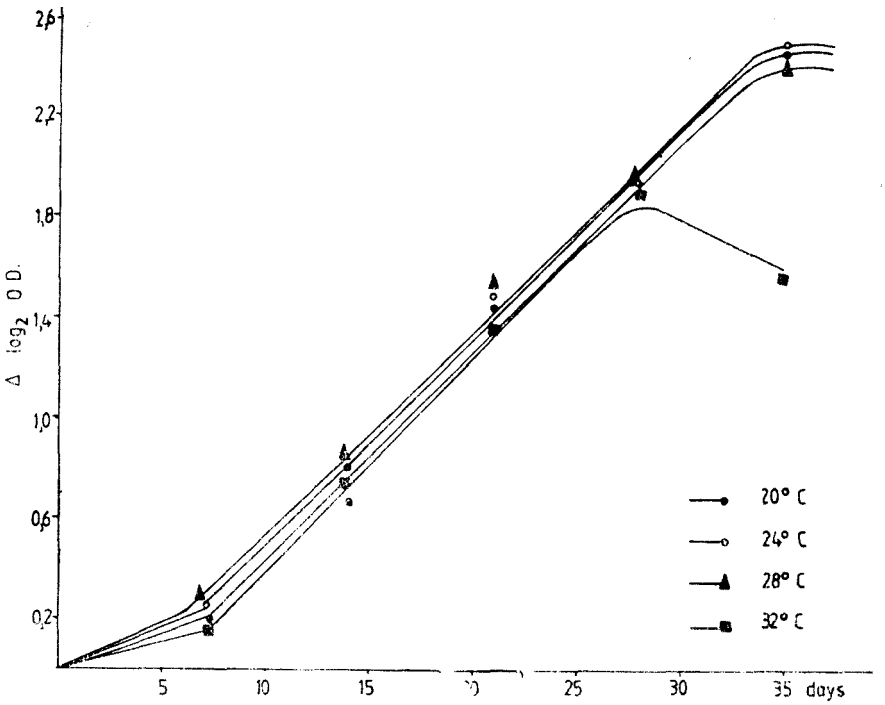

Fig. 3. *Optical density dynamics depending on the incubation temperature of cultures (Bbr 64).*

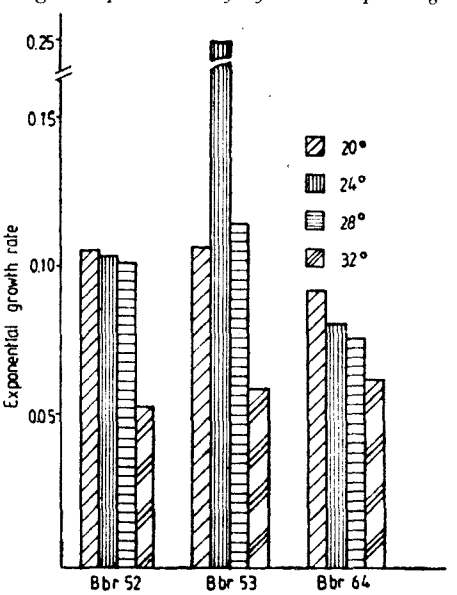

Fig. 4. *Variation of exponential growth rate depending on temperature in the studied strains.*

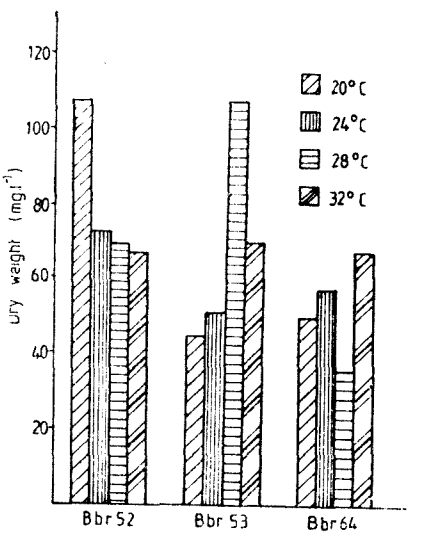

Fig. 5. *Dry weight depending on temperature in the studied strains.*

Although Bbr 64 strain accumulates the smallest amount of dry matter at 28°C, if we take into account the evolution of the other parameters studied and literature data on dry weight, we may consider temperatures between 24 and 28°C as optimum for the growth of this strain. The same temperatures are favourable for Bbr 53 strain, but for Bbr 52 the optimum range is 20—24°C.

Discussion. The effect of temperature on this microorganism has been studied ever since 1890 [13]. Experiments carried out on the species of similar genera revealed that the optimum growth temperature varied from one species to another. The species of the genus *Chlorella* have an enhanced growth at 25, 30 or 39°C [11, 16]. M o s s [12] studied the growth conditions of *Pandorina morum* and found that in laboratory it grew well between 10 and 15°C, while in the open it preferred temperatures between 15 and 20°C. S o e d e r and S t e n g e l [15] advanced the hypothesis that algae may adapt to extreme temperatures and this adaptability may be due to enzyme stability under these circumstances.

Botryococcus braunii (a eukaryote species recorded all over the world in various aquatic habitats) reacts differently to temperature. The general distribution of *B. braunii* and its frequent occurrence as water bloom are environmental premises for its intensive cultivation [1, 8, 10].

Few literature data refer to the growth physiology of this alga [1, 3, 5, 7, 8]. Our results show that the growth and development of *Botryococcus braunii* cultures under various temperature conditions differ from one strain to another, but the limits of these differences are close. In all the strains studied, the temperature of 32°C has levelled off the growth curves sooner, the cultures entering their decline phase more rapidly. Exponential growth rates, estimated by optical density were lowest at 32°C in each of the three strains studied. Our experiments have revealed that growth rates are extremely low in *B. braunii* strains. Consequently, the doubling time (G) registered great values, under the experimental conditions applied the slow growth being thus proved.

The doubling time in Bbr 52 has been found to vary between 8.8 and 17.6 days, which is comparable to that of other species of eukaryote algae: *e.g.* 7.75 h in *Chlorella pyrenoidosa* and 24.3 h in *Monodus subterranea* at 25°C [9]. The shortest doubling time (4.27 days) was recorded in the Bbr 53 strain at 24°C. Possibly, the stirring and carbon dioxide administration might lower the doubling time.

Biomass accumulation in the three strains also suggests the dependence of growth upon temperature. B e l c h e r [1] recorded an accumulation of about 250 mg. l^{-1} dry weight after 16 weeks. Our maximum values reached 108.7 mg. l^{-1} within 35 days. Literature data, supported by our own experiments, have shown that the biological productivity of *B. braunii* is smaller than that of other species of eukaryote algae.

Several aspects are yet unsolved in the cultivation of *Botryococcus braunii:* low growth rate, contamination with other organisms, insufficient data on the hydrocarbon biosynthesis, variable hydrocarbon contents of the biomass, a.s.o. Since this algal species grows slowly, even

very slowly, the achievement of its intensive and profitable cultivation is a complex long-lasting task.

Conclusions. 1. The Bbr 52 strain grows well between 20 and 24°C, while the Bbr 53 and Bbr 64 strains prefer temperatures between 24 and 28°C.

2. The growth and development of *B. braunii* cultures are temperature- and strain-dependent.

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L'AÉROPLANCTON DE PRAID

ZOE BUZ*

SUMMARY. — The Aeroplankton in Praid. Collection of recent pollenical rains in Praid, during the whole vegetation period in two consecutive years (1983—1984) and their correlation with present vegetation reflect with fidelity the closest zonal climax which is represented by oak-hornbeam and hornbeam-beech forests. These findings prove the validity and originality of fossil and subfossil pollenical spectra, the homogeneity of which is the result of multiannual deposition of pollens produced by plant ecosystems in the vicinity of the sedimentation stations.

En vue de connaître les relations entre la composition de la végétation actuelle et son reflet dans les spectres sporo-polliniques courants, nous avons procédé à deux séries de captages hebdomadaires d'aéroplancton à Praid, qui ont compris la période d'anthèse des arbres anémophiles et des plantes herbeuses (15 février- 1 ^{r} août 1983/1984).

Afin de capter le pollen de l'aéroplancton nous avons eu recours à un procédé gravimétrique proche de celui approuvé comme standard par le Comité National pour les tests du pollen atmosphérique dépendant de l'Académie Américaine d'études allergologiques [6, 10].

Les résultats obtenus figurent dans le tableau (Tabl. 1) qui a servi à la réalisation des diagrammes reconstitués de l'aéroplancton recueilli durant les deux années concernées (Fig. 1—3). L'interprétation des résultats de ces captages hebdomadaires reflète les particularités phénologiques et celles de la périodicité de la production de pollen dans les conditions de la distribution étagée actuelle de la végétation de la zone concernée.

Dans le courant des deux dernières semaines du mois de février des deux années on constate la présence des premiers granules sporadiques de pollen de *Corylus, Alnus, Betula* et *Salix*, en proportions infimes, ce qui dénote un transport à des distances plus grandes. Les granules d'aulne et de noisetier apparaissent en quantités plus importantes au mois de mars; en 1983, dans la dernière semaine du mois on a même enregistré les maxima de 22 granules/cm^2 et 10 granules/cm^2, alors qu'en 1984 ces taux maxima étaient enregistrés dans le courant de la première semaine du mois d'avril, comme résultat des conditions météorologiques initialement défavorables. On constate également qu'en 1983 l'anthèse maximale du noisetier est devancée de 7 jours par rapport à celle de l'aulne, tandis qu'en 1984 elles sont concomitantes, favorisées sans doute par les conditions météorologiques, qui expliquent aussi les productions polliniques plus grandes par rapport à 1983 (max. 31 et 36 granules/cm^2).

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Le pollen des deux essences ligneuses anémophiles capté à cette période provient certainement des écosystèmes sylvestres limitrophes, en sorte qu'il ne saurait être question d'un transport à grande distance, mais les taux déficitaires des quantités de pollen captées indiquent qu'il provient de distances au-dessus de 5 km. La participation du noisetier avec 10 et 16% dénote sa présence dans les écosystèmes sylvestres plus rapprochés, à Dealu, tandis que la participation de l'aulne avec respectivement 5 et 14% dans les spectres des années 1983 et 1984 atteste la présence des aulnaies cantonnées le long des ruisseaux et des terrains marécageux de Sîncel. Les courbes inscrites par les taux polliniques des deux essences ligneuses augmentent jusqu'à la fin du mois d'avril, après quoi elles décroissent brusquement au début, puis lentement en raison du planage de longue durée des petits granules légers à rate de sédimentation réduite.

Dans la seconde partie de l'anthèse de ces genres nous avons surpris aussi des granules de pollen de bouleau, de saule et d'orme. En 1983, l'anthèse du bouleau a atteint le maximum de 3 granules/cm^2 pendant la quatrième semaine du mois d'avril, laquelle n'est pas concluante, alors que le maximum retardé de 22 granules/cm^2, surpris dans la deuxième semaine du mois de mai 1984 pourrait être dû aussi à la reflottation du pollen sédimenté. Les maxima enregistrées pour le saule (8 granules/cm^2 dans la deuxième semaine du mois de mars 1983 et 5 granules/cm^2 dans la troisième semaine d'avril 1984) semblent avoir pour cause l'anthèse différenciée dans le temps des différentes espèces de saule. Les fréquentes reflottations du pollen de saule et de bouleau jusque vers la fin du mois de juillet s'expliquent par la longue période de planage du pollen de ces genres, à l'opposé de celui d'épicéa et de sapin. Le fait que les maxima polliniques de ces genres ne coïncident pas avec l'anthèse confirme la constatation que la période de dissémination et plus longue que celle d'anthèse.

Attendu la production riche de pollen du bouleau et du saule entomogames, nous estimons que leur participation pollinique dans les spectres courants, avec des moyennes de, respectivement 6% et 3%, dénote la présence sporadique de ces essences dans les écosystèmes sylvestres limitrophes.

D'une signification aéropalynologique particulière est le pollen des espèces de *Ulmus*, dont la courbe, encore que d'une amplitude moyenne (maxima de 11 et 7 granules/cm^2), n'en indique pas moins la présence de cet arbre dans la région, bien que les sylviculteurs le considèrent aujourd'hui complètement disparu. Nyárády [2] cite à Sovata 4 espèces d'orme. On a pourtant peine à croire à l'hypothèse d'un transport à longue distance dans le cas de l'orme, dont le pollen est relativement lourd. L'anthèse de l'orme a été surprise à partir de la deuxième moitié du mois de mars et elle s'est maintenue à peu près au même pourcentage tout au long du mois d'avril, baissant brusquement au commencement du mois de mai.

Les courbes du pollen de *Carpinus* commencent à monter à la fin du mois de mars 1983 et avril 1984, sans se signaler par des différences

Les spectres aéroplanctoniques hebdomadaire

Anné												1983
Mois	II		III				IV					
Semaine	3	4	1	2	3	4	1	2	3	4	5	1
Corylus	0,4	2,0	3,5	15,0	22,5	14,0	3,5	1,5	1,5	1,5	1,5	0,5
Alnus	—	0,2	0,8	3,0	6,0	10,0	4,0	1,5	3,5	2,0	1,0	0,5
Betula	—	—	—	1,0	3,0	2,0	1,0	1,0	0,5	3,5	2,0	0,5
Salix	0,2	1,0	0,5	8,0	1,0	1,0	1,0	2,0	—	—	—	—
Ulmus	—	—	—	0,5	2,0	9,5	7,0	4,0	11,0	2,0	2,5	0,5
Carpinus	—	—	—	—	0,5	3,5	4,0	15,0	18,0	13,5	8,5	6,0
Quercus	—	—	—	—	—	—	1,0	6,0	8,0	6,5	6,0	7,0
Fagus	—	—	—	—	—	—	—	0,5	2,5	5,0	13,0	6,0
Juglans	—	—	—	—	—	—	—	—	—	0,5	23,0	15,5
Acer	—	—	—	—	—	—	—	—	—	1,5	2,0	—
Pinus	—	—	—	—	—	—	—	—	—	—	1,5	7,0
Picea	—	—	—	—	—	—	—	—	—	—	—	0,5
Abies	—	—	—	—	—	—	—	—	—	—	—	0,5
Tilia	—	—	—	—	—	—	—	—	—	—	—	0,5
Somme AP	0,6	3,2	4,8	27,5	35,0	40,0	21,5	31,5	45,0	36,0	61,0	45,0
NAP	—	—	0,5	—	1,5	—	—	—	—	—	—	5,0
Poaceae	0,5	2,0	3,2	6,0	7,5	5,0	5,0	5,0	5,0	6,5	7,5	3,0
Cyperaceae	—	—	—	—	—	1,0	—	—	—	1,0	1,5	—
Chenopodiaceae	—	—	—	—	—	—	—	—	—	—	—	—
Caryophyllaceae	—	—	—	—	—	—	—	—	—	—	—	—
Asteraceae	—	—	—	—	—	—	0,5	—	—	0,5	—	1,0
Dipsacaceae	—	—	—	—	—	—	—	—	—	0,5	—	—
Fabaceae	—	—	—	—	—	—	—	1,5	—	—	—	—
Apiaceae	—	—	—	—	—	—	0,5	—	—	—	—	—
Liliatae	0,5	—	—	—	—	—	—	—	1,0	—	—	—
Bryales	—	—	—	—	—	1,5	3,0	0,5	0,5	—	—	1,0
Filicales	—	—	—	—	—	—	—	—	—	—	—	0,5
Somme NAP	1,0	2,0	3,7	6,0	9,0	7,5	9,0	7,0	6,5	8,5	9,0	10,5

Anné											1984	
Mois	II		III				IV					
Semaine	3	4	1	2	3	4	1	2	3	4	1	2
Corylus	1,2	1,2	7,0	7,0	18,0	25,5	31,0	19,0	14,0	11,0	2,0	3,0
Alnus	0,3	1,0	4,0	5,1	14,0	25,5	36,5	15,0	3,0	3,0	2,0	2,5
Betula	0,3	0,3	1,0	1,5	4,0	3,0	5,0	6,5	7,5	12,0	6,0	22,5
Salix	0,1	0,5	2,5	0,2	0,2	0,5	1,0	1,5	2,0	5,5	1,0	1,0
Ulmus	—	—	—	0,5	1,2	3,5	4,5	7,5	6,0	7,0	1,5	1,0
Carpinus	—	—	—	0,2	—	1,0	1,5	2,5	3,0	18,5	30,5	42,5
Quercus	—	—	—	—	—	—	—	0,5	2,5	3,5	1,5	7,0
Acer	—	—	—	—	—	—	—	2,0	1,5	0,5	2,0	3,0
Fagus	—	—	—	—	—	—	—	—	1,0	2,0	3,5	33,5
Juglans	—	—	—	—	—	—	—	—	—	—	0,5	2,0
Pinus	—	—	—	—	—	—	—	—	—	—	—	—
Picea	—	—	—	—	—	—	—	—	—	—	—	—
Tilia	—	—	—	—	—	—	—	—	—	—	—	—
Abies	—	—	—	—	—	—	—	—	—	—	—	—
Somme AP	1,9	3,0	14,5	14,5	37,4	59,0	79,5	44,5	40,5	63,0	50,5	118,0

Tableau 1

obtenus a Praid en 1983—1984

V			VI				VII						
2	3	4	1	2	3	4	1	2	3	4	5	Total	%
—	—	—	—	—	—	—	0,5	—	—	—	—	68,0	10,1
—	0,5	—	—	—	—	—	—	—	—	—	—	33,0	5,2
0,5	0,5	1,0	—	—	—	—	—	0,5	—	—	—	17,0	2,6
0,5	0,5	1,5	1,0	0,5	1,0	0,5	—	—	—	—	—	20,2	3,2
—	0,5	—	—	—	—	—	—	—	—	—	—	39,5	6,2
16,5	8,5	1,0	—	—	—	—	—	—	—	—	—	95,0	15,0
11,0	5,0	11,5	3,0	2,5	3,0	0,5	1,5	1,0	—	0,5	—	74,0	11,6
9,0	11,0	7,0	—	—	—	—	—	—	—	0,5	—	54,5	8,5
40,5	16,0	3,5	0,5	—	—	—	—	—	—	—	—	99,5	15,8
—	—	—	—	—	—	—	—	—	—	—	—	3,5	0,5
34,0	53,0	10,5	2,5	1,0	1,5	—	1,0	—	—	0,5	—	112,5	18,8
1,0	1,5	2,0	0,5	0,2	—	—	—	—	—	—	0,5	6,2	0,9
1,0	2,0	1,0	0,5	—	—	—	—	—	—	—	—	5,0	7,0
—	—	0,2	1,0	1,5	2,0	1,0	1,0	1,0	0,5	0,5	—	9,2	1,4
114,0	99,0	39,2	9,0	5,7	7,5	2,0	4,0	2,5	0,5	2,0	0,5	637,1	60,3
1,5	3,5	2,5	2,0	5,5	2,5	1,5	1,5	—	2,5	2,5	1,0	31,5	8,0
5,0	20,0	30,5	22,5	23,5	17,5	9,0	11,0	7,5	5,0	4,0	2,0	213,7	51,5
—	2,5	4,5	21,5	3,5	5,0	4,0	5,5	3,5	3,0	3,0	1,0	60,5	15,0
2,5	4,0	3,0	2,5	3,5	2,0	1,0	1,5	1,5	1,0	—	1,5	24,0	6,0
1,0	8,5	5,0	5,0	2,5	1,0	0,5	—	—	—	—	—	23,5	5,7
1,5	1,5	2,5	2,0	0,5	0,5	1,0	0,5	0,5	1,5	1,0	0,5	15,5	4,0
—	4,0	—	2,0	0,5	—	—	0,5	—	—	0,5	—	8,0	2,0
—	—	—	—	—	—	—	1,5	2,5	8,5	—	—	14,0	3,5
—	—	—	0,5	1,5	—	—	—	—	—	1,0	—	3,5	1,0
—	—	—	—	—	—	—	—	—	—	—	—	1,5	0,5
—	0,5	—	0,5	1,0	—	—	0,5	—	—	0,5	—	9,5	2,5
—	—	—	—	—	—	—	—	—	—	1,0	—	1,5	0,5
11,5	44,5	48,5	58,5	42,0	28,5	17,0	22,5	15,5	21,5	13,5	6,0	408,7	39,7

V			VI					VII						
3	4	5	1	2	3	4	5	1	2	3	4	5	Total	%
1,5	0,5	—	—	—	—	—	—	1,0	—	—	—	—	132,9	16,1
1,5	1,5	1,0	1,0	—	2,0	—	—	—	—	—	—	—	118,9	14,5
3,5	2,0	2,0	1,0	—	1,0	—	—	1,0	—	—	1,0	1,0	82,1	10,0
1,5	0,5	1,0	1,5	1,0	2,0	—	—	—	—	—	—	—	23,5	3,0
—	—	—	—	—	—	—	—	—	—	—	—	—	32,7	4,0
9,5	7,5	3,5	0,5	—	—	—	—	—	—	—	—	—	120,7	14,5
14,5	13,5	10,5	16,5	3,0	5,0	5,0	5,0	5,0	—	1,0	—	—	92,0	11,2
1,0	0,5	—	—	—	—	—	—	—	—	—	—	—	10,5	1,2
17,5	13,0	20,0	3,0	—	—	2,0	2,0	—	—	—	—	—	97,5	11,8
2,5	11,5	4,0	1,0	—	—	—	—	—	—	—	—	—	21,5	2,6
1,0	14,5	27,0	13,0	2,0	2,0	2,0	2,0	1,0	4,0	4,0	1,0	—	73,5	9,0
0,5	0,5	0,5	0,5	—	—	—	1,0	—	1,0	—	—	—	4,0	0,5
—	—	—	—	1,0	2,0	1,0	2,0	1,0	3,0	—	—	—	10,0	1,2
—	—	—	—	—	—	—	1,0	1,0	—	—	—	—	2,0	0,2
54,5	65,5	69,5	38,0	7,0	14,0	8,0	13,0	10,0	8,0	5,0	2,0	1,0	821,8	58,0

Anné											1984	
Mois	II		III				IV					
Semaine	3	4	1	2	3	4	1	2	3	4	1	2
NAP	0,3	1,0	—	0,2	1,2	1,0	2,5	8,5	2,0	5,5	3,0	6,0
Poaceae	—	0,5	2,2	1,5	1,2	1,5	2,5	2,0	3,5	11,5	3,0	4,0
Cyperaceae	—	—	—	—	—	—	—	—	1,0	3,0	—	—
Chenopodiaceae	—	—	—	—	—	—	—	—	—	—	—	—
Caryophyllaceae	—	—	—	—	0,5	—	—	—	—	—	—	—
Dipsacaceae	—	—	—	—	—	—	—	—	—	—	0,5	—
Asteraceae	—	—	—	—	—	2,0	—	2,0	—	—	0,5	—
Fabaceae	—	—	—	—	—	—	—	—	2,0	2,5	—	—
Apiaceae	—	0,5	0,5	—	—	—	—	1,5	0,5	—	—	—
Lamiaceae	—	—	—	—	—	—	—	—	—	—	—	—
Rosaceae	—	—	—	—	—	—	—	0,5	0,5	—	—	—
Liliatae	—	—	—	—	—	—	—	1,0	—	4,0	—	—
Lycopodiales	—	—	—	—	—	0,5	—	—	—	—	0,5	0,5
Bryales	—	—	—	—	—	—	—	—	1,5	1,5	—	—
Filicales	—	—	—	—	—	—	—	—	—	—	—	—
Somme NAP	0,3	2,0	2,7	1,7	2,9	5,0	5,0	15,5	11,0	28,0	7,5	10,5

significatives en ce qui concerne la fluctuation de la production de pollen de cette essence forestière (95 et 92 granules/cm^2). Nous estimons que l'anthèse du charme a été mieux surprise en 1984. Le maximum de 42 granules/cm^2 pendant la deuxième semaine du mois de mai vient à l'appui de l'idée que, cette année, la production pollinique a été supérieure à celle de 1983, laquelle, bien qu'ayant démarré plus tôt (18 granules/cm^2 dans la troisième semaine d'avril), n'a pas accédé au même niveau quantitatif maximal. Le captage massif par sédimentation du pollen de charme ayant lieu en pleine floraison, au mois de mai, nous supposons que les premiers granules captés en mars et au début du mois d'avril proviennent sans doute du Bassin Transylvain, avant l'anthèse du genre sur le territoire investigué [5, 7].

À partir de la première semaine d'avril 1983 et de la deuxième semaine du même mois, en 1984, nous avons surpris des granules de pollen de *Quercus*. Les maxima, relativement proches quant au nombre et à l'intervalle de temps, de 11 granules/cm^2, surpris durant la deuxième et la quatrième semaine du mois de mai 1983, et de 14 à 16 granules/cm^2 (troisième semaine de mai et première semaine de juin 1984) attestent que l'anthèse des différentes espèces de chêne et de rouvre des environs de Sovata a eu lieu au mois de mai, les premiers messagers de ce genre provenant sans doute de très loin, du Bassin Transylvain, compte tenu de la direction des vents. Ses deux courbes bimaximales révèlent un décalage phénologique entre les anthèses des différentes espèces de *Quercus*, son pollen apparaissant fréquemment sous 2 ou 3 formes et tailles différentes, témoignant des différences entre les géniteurs.

Fagus, présent dans les écosystèmes forestiers des environs de Praid, a son anthèse après le chêne. Le pollen du hêtre atteint à peine un maximum de 13 granules/cm^2 dans le courant de la cinquième semaine d'avril

Tableau 1 (cont.)

V			VI					VII						
3	4	5	1	2	3	4	5	1	2	3	4	5	Total	%
6,0	3,5	5,5	—	—	—	—	—	1,0	—	—	—	—	47,2	8,0
1,0	2,0	10,0	10,0	25,0	38,0	24,0	32,0	20,0	24,0	13,0	14,0	13,0	269,4	43,6
1,5	1,0	1,0	2,5	6,0	3,0	6,0	9,0	4,0	3,0	2,0	4,0	2,0	49,0	8,2
—	—	3,5	1,5	3,0	2,0	—	—	3,0	6,0	—	1,0	—	20,0	3,3
—	—	—	2,5	1,0	1,5	3,0	1,0	1,0	3,0	1,0	2,0	2,0	18,5	3,1
—	—	1,0	—	—	—	—	3,0	—	—	1,0	1,0	—	6,5	1,1
—	—	0,5	1,0	1,0	1,0	1,0	2,0	1,0	2,0	1,0	1,0	—	16,0	2,7
—	—	—	—	2,0	7,0	16,0	17,0	11,0	6,0	—	25,0	21,0	107,5	18,1
0,5	1,5	—	—	1,0	2,0	—	—	—	—	—	—	—	8,0	1,3
—	—	—	—	—	15,0	1,0	—	—	—	—	14,0	1,0	31,0	5,2
—	—	—	1,5	—	2,0	—	—	—	—	—	—	1,0	5,5	0,9
—	—	—	—	—	—	—	—	—	—	—	—	—	5,0	0,8
—	—	—	—	—	1,0	—	—	1,0	—	—	1,0	—	4,5	0,7
—	—	—	1,0	—	1,0	1,0	—	1,0	2,0	1,0	2,0	3,0	15,0	2,5
—	—	—	—	—	1,0	—	—	—	2,0	—	—	—	3,0	0,5
9,0	8,0	21,5	20,0	39,0	74,5	52,0	64,0	43,0	48,0	19,0	63,0	43,0	596,1	42,0

1983 et de 33 granules/cm^2 pendant la deuxième semaine du mois de mai 1984, attestant que la production pollinique diffère d'une année à l'autre en fonction des facteurs climatiques complexes et variables, l'accroissement quantitatif n'étant pas le même pour tous les genres. Un exemple significatif nous est fourni par le pollen du pin, dont l'amplitude a été beaucoup plus grande en 1983 qu'en 1984, à l'inverse du hêtre. Nous attribuons le deuxième maximum pollinique du hêtre, surpris en 1983 (11 granules/cm^2 dans la troisième semaine du moi de mai), aux hêtraies de montagne plus éloignées de 5 km de la station de captage, dont le pollen a été véhiculé par le vent, encore qu'il ne soit pas exclu que l'aspect bimodal de la courbe soit dû à l'intervention de conditions climatiques plus sévères durant la période entre les deux maxima, caractéristique du climat du territoire investigué.

Les pourcentages moyens aéroplanctoniques du pollen de charme (14,5—15 granules/cm^2), de chêne (11,2—11,6 granules/cm^2) et de hêtre (8,5—11,8 granules/cm^2) concordent pleinement avec la conclusion suivante découlant de l'étude de la végétation actuelle du territoire investigué: les portions boisées de Sovata, moins celles de Praid, appartiennent à des climax zonaux représentés par *Querco petraeae-Carpinetum betuli, Carpino-Fagetum silvaticae* et *Melampyro bihariensi-Carpinetum betuli*.

Dans ces spectres, le pollen de *Acer* est représenté à un taux faible, ce qui correspond à sa faible représentation dans les écosystèmes mentionnés. Ses maxima ne dépassent guère 2 granules/cm^2 durant la cinquième semaine du mois d'avril 1983 et 3 granules/cm^2 dans la deuxième semaine de mai 1984.

Dans le cadre des spectres aéroplanctoniques courants et à côté des traits de la végétation zonale suggestivement reconstituée à partir de la participation saisonnière des espèces qui composent les phytocoenoses

de l'étage des feuillus, apparaît aussi la surreprésentation de certaines espèces cultivées qui ne participent pas à la composition du tapis végétal naturel, tel le cas du noyer. Dans la deuxième semaine de mai 1984, le pollen de *Juglans* compte à peine 11,5 granules/cm^2, ce qui indique une production pollinique plus faible par rapport à l'année précédente, quand il atteint le maximum de 40,5 granules/cm^2.

Dans nos spectres aéroplanctoniques, le pollen des conifères est plutôt faiblement représenté par rapport à la distance de la station de captage, distance qui est généralement plus grande que 5 km, mais aussi à participation plus réduite que le pollen des feuillus dans les écosystèmes sylvestres du plateau Sovata—Praid—Dealu. L'épicéa et le sapin, en nombre réduit, sont présents à Sovata sous forme de plantations ornementales; aussi considérons-nous que le pollen capté pourrait provenir — toujours en quantité réduite — des associations *Pulmonario rubro—Abieti—Fagetum, Oxalo—Piceetum abietis, Vaccinio-Piceetum abietis* et *Sphagno—Piceetum abietis* situées à une distance de quelque 15 km en ligne aérienne.

Le fait que *Pinus* est le mieux représenté relève de plusieurs causes: la production pollinique très grande du géniteur, le poids spécifique plus petit de ses granules, permettant aux granules de planer plus longtemps, et surtout la proximité de la station de captage d'une plantation de pin rouge et de pin noir *(Poo-Pinetum silvestris),* située non loin de Praid. Nous soutenons que la plus grande partie du pollen capté provient des plantations qui peuplent presque tous les versants nord-ouest des prolongements presque parallèles du plateau vulcanique vers le Bassin de Transylvanie, et en moindre mesure de la seule pinède naturelle située sur le marais oligotrophe Ruţ au centre du plateau.

La courbe du pin qui, en 1983, domine avec ses 18% les autres essences forestières, s'accroît brusquement dès la première semaine du mois de mai jusqu'à la troisième semaine, quand elle atteint le maximum de 53 granules/cm^2, et décroît encore plus brusquement, alors qu'en 1984 le maximum de 27 granules/cm^2 pendant la quatrième semaine de mai ne se détache pas sensiblement de la semaine précédente et suivante avec 14 et 13 granules/cm^2.

Si l'on peut considérer que l'anthèse du pin des zones limitrophes appartient à la deuxième moitié du mois de mai, la prolongation de la présence de son pollen dans le spectre (faiblement représenté quant au nombre) jusqu'à la quatrième semaine de juillet ne pourrait s'expliquer qu'en l'attribuant au pollen transporté depuis de grandes distances, à savoir les monts Gurghiu et Harghita, où l'anthèse est sensiblement retardée en raison des conditions climatiques plus sévères.

Le pollen de *Picea* est faiblement représenté à partir de la première semaine du mois de mai 1983, les maxima ne dépassant pas 2 granules/cm^2.

Le pollen de *Abies,* encore plus lourd que celui d'épicéa, a également été enregistré au mois de mai 1983 et dans le courant de la dernière semaine de juillet ainsi que dans la première semaine de juillet 1984. La présence déficitaire du pollen de sapin est directement liée à son transport depuis de grandes distances.

La dernière anthèse d'arbres (entomogame) enregistrée dans des spectres a été celle du tilleul. Nous avons surpris le pollen de *Tilia* à des taux de 1,2 et 1,4% aux mois de juin et de juillet 1983 et 1984. Quoiqu'il ne soit présent que sporadiquement dans les spectres de la végétation némorale du plateau investigué, sa présence dans les spectres de l'aéroplancton est décisive pour démontrer comment on doit interpréter les pourcentages de cet arbre dans les sédiments organo-minéraux des marais Podul de Hîrtie, Ramura Corundului, des aulnaies et des sphaignaies de Sîncel et même ceux du Lac Mic-Dealu.

En tant que reflet de la position de la station de captage dans un territoire presque déboisé, occupé par des cultures agricoles (seigle, maïs, pomme de terre), avec des intercalations de prés mésophiles, apparaît dans les spectres la fraction NAP, à savoir le pollen des plantes herbeuses. Au cours des deux années sur lesquelles portent nos investigations, le pollen des herbes est présent à un taux moindre par rapport aux arbres, représentant 39 et, respectivement, 42% du total de la somme AP plus NAP. La valeur inférieure de la fraction NAP est directement proportionnelle avec la capacité plus réduite du pollen des plantes herbeuses de planer et d'entraîner dans l'aéroplancton. Ces constatations ne réduisent toutefois en rien la signification de la fraction NAP et lui confèrent même un plus d'ampleur [1].

Le pollen NAP est apparu très tôt dans les spectres, mais les valeurs subunitaires qui le représentent nous portent à croire qu'il est à attribuer aux reflottations de l'année précédente. Les courbes NAP commencent à monter en même temps que décroît l'amplitude de la courbe AP, dans la deuxième partie du mois d'avril, tandis que leurs amplitudes s'accroissent pendant les mois de mai, juin et juillet. Les maxima les plus élevées ont été enregistrées pour le pollen de *Poaceae* et de *Cyperaceae*. Parmi les familles de plantes herbeuses représentées dans les spectres nous citons: *Fabaceae, Lamiaceae, Chenopodiaceae, Apiaceae, Caryophyllaceae,* et parmi les spores les plus fréquemment rencontrés ceux de *Bryales* et, plus rarement, de *Filicales* et *Lycopodiales*.

À la lumière de ces données, la participation significative du pollen de plantes herbeuses indique la présence de prés et de cultures de céréales dans le voisinage immédiat du substrat sédimentaire d'où a été reconstitué le profil pollinique.

Conclusions. Des résultats obtenus se dégage la conclusion que la fraction du pollen des arbres anémophiles (près de 60%) trouve son expression dans la composition qualitative et quantitative des spectres polliniques, une expression nettement plus régionale que les prés à plantes herbeuses qui disposent d'une capacité plus réduite d'entraînement dans l'aéroplancton [8].

L'accroissement de l'amplitude de la courbe saisonnière de la somme du pollen de plantes herbeuses (NAP) coïncide avec l'amplitude de la courbe de la somme du pollen des arbres (AP) durant la première semaine du mois de juillet.

Les conséquences du climat plus sévère de la région ont influé sur la dynamique des phénophases, produisant un sensible retard de l'anthèse prévernale et vernale des arbres anémophiles.

Dès l'achèvement de l'anthèse des arbres anémophiles, à la fin du mois de mai, la courbe du pollen d'arbres baisse en faveur de la courbe du pollen de plantes herbeuses. Les données météorologiques quotidiennes faisant défaut, nous ne sommes pas à même d'expliquer certains phénomènes caractéristiques telle que la quantité réduite de pollen par cm^2 par rapport à celle dont font état des études antérieures [9]. Nous considérons néanmoins que les taux numériques du pollen de toutes les espèces sont nettement plus bas en raison, avant tout, du degré élevé d'humidité et de nébulosité spécifique à la région, qui ne permettent pas la propagation dans l'atmosphère de grandes quantités de pollen [3]. La circonstance est due, en deuxième lieu, à l'emplacement de la station de captage à environ 15 m du sol dans la direction des vents soufflant de l'ouest, qui sont prédominants dans la région. Or, l'existence d'une corrélation entre la turbulence de l'atmosphère et la quantité de pollen de l'aéroplancton est un fait connu. Mentionnons en troisième lieu que la quantité réduite de pollen de l'aéroplancton est due à l'éloignement relativement important des phytocoenoses sylvestres de la station de captage; il est également bien connu que la fraction AP diminue à mesure de l'éloignement des regions boisées [4].

Il résulte du tableau que les arbres *Ulmus, Juglans, Pinus, Picea* et *Abies* se sont signalés par une production pollinique accrue en 1983, tandis que *Corylus, Alnus, Betula, Salix, Carpinus, Quercus, Fagus, Acer* et *Tilia* ont produit davantage de pollen en 1984. Il en découle la conclusion que la production pollinique des arbres, loin d'être uniforme est très oscillante d'une année à l'autre. Il s'ensuit que les spectres polliniques fossiles qui apparaissent comme étant homogènes ne sont rien d'autre que des dépôts multiannuels de pollen produit par les écosystèmes végétaux environnants.

Il ressort de l'analyse des diagrammes de l'aéroplancton annuels que l'anthèse des arbres et des plantes herbeuses est variable d'une année à l'autre, d'une saison à l'autre, en fonction des facteurs climatiques. Le graphique des sommes AP et NAP révèle que la région est dominée par des écosystèmes sylvestres, le pollen AP représentant en moyenne 59,1%, tandis que le polen NAP ne représente que 40,9% du total de la somme pollinique.

Le spectre pollinique d'une aire de captage de 1 cm^2, exposé durant cinq mois, reflète très fidèlement l'existence qualitative et quantitative des divers types de forêt des alentours de Praid. Les deux spectres (1983 et 1984) reflètent le climax local le plus proche représenté par les quercocharmaies et les carpino-hêtraies (en excluant la surreprésentation du noyer et du pin plantés).

Les captages d'aéroplancton réalisés dans les circonstances de la distribution actuelle de la végétation illustrent avec fidélité les aspects fondamentaux des circonstances dans lesquelles ont eu lieu la propagation et la sédimentation des masses polliniques; ils constituent en outre

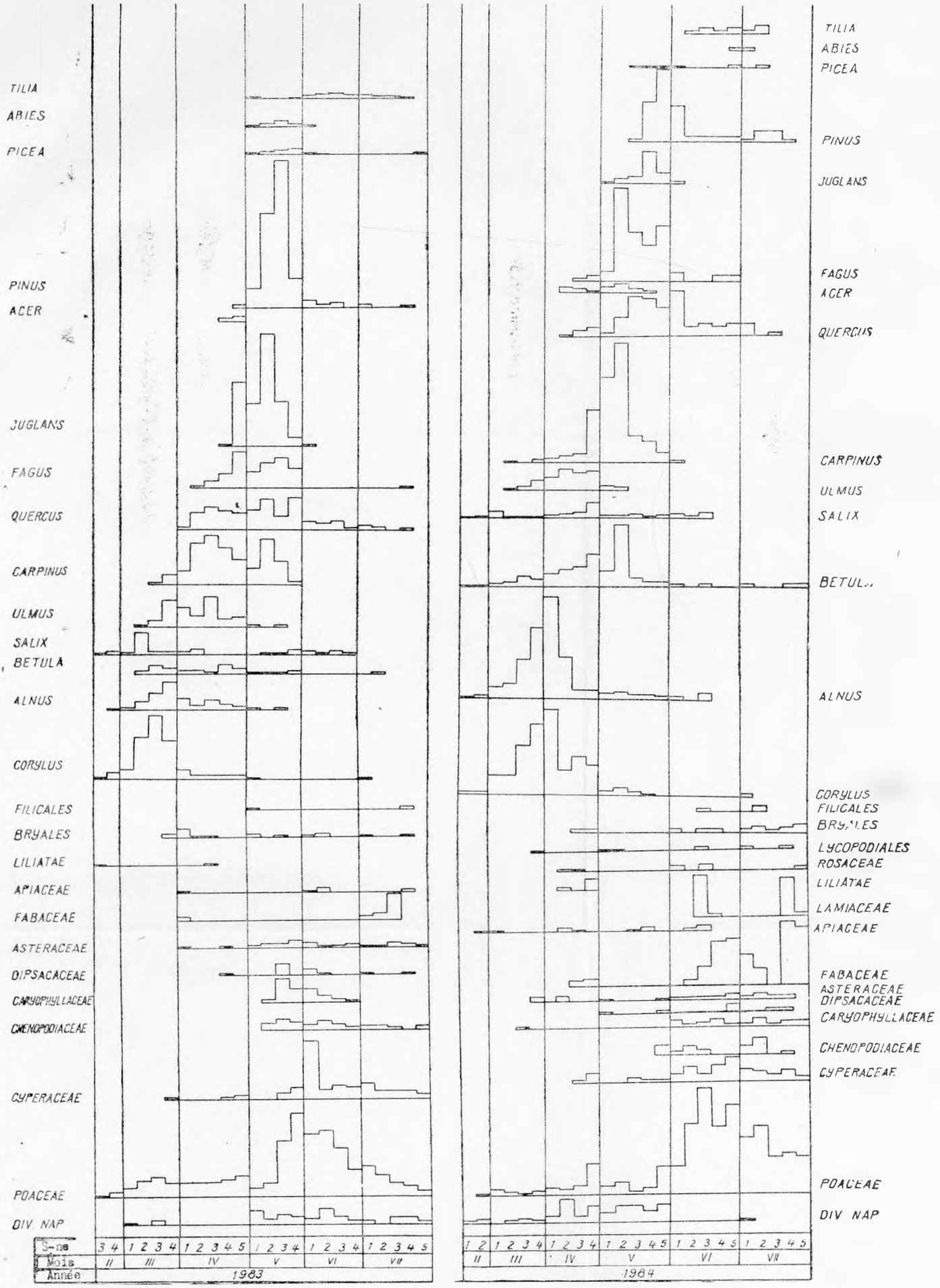


Fig. 1. *Les diagrammes aéroplanctoniques obtenus à Praid en 1983—1984.*

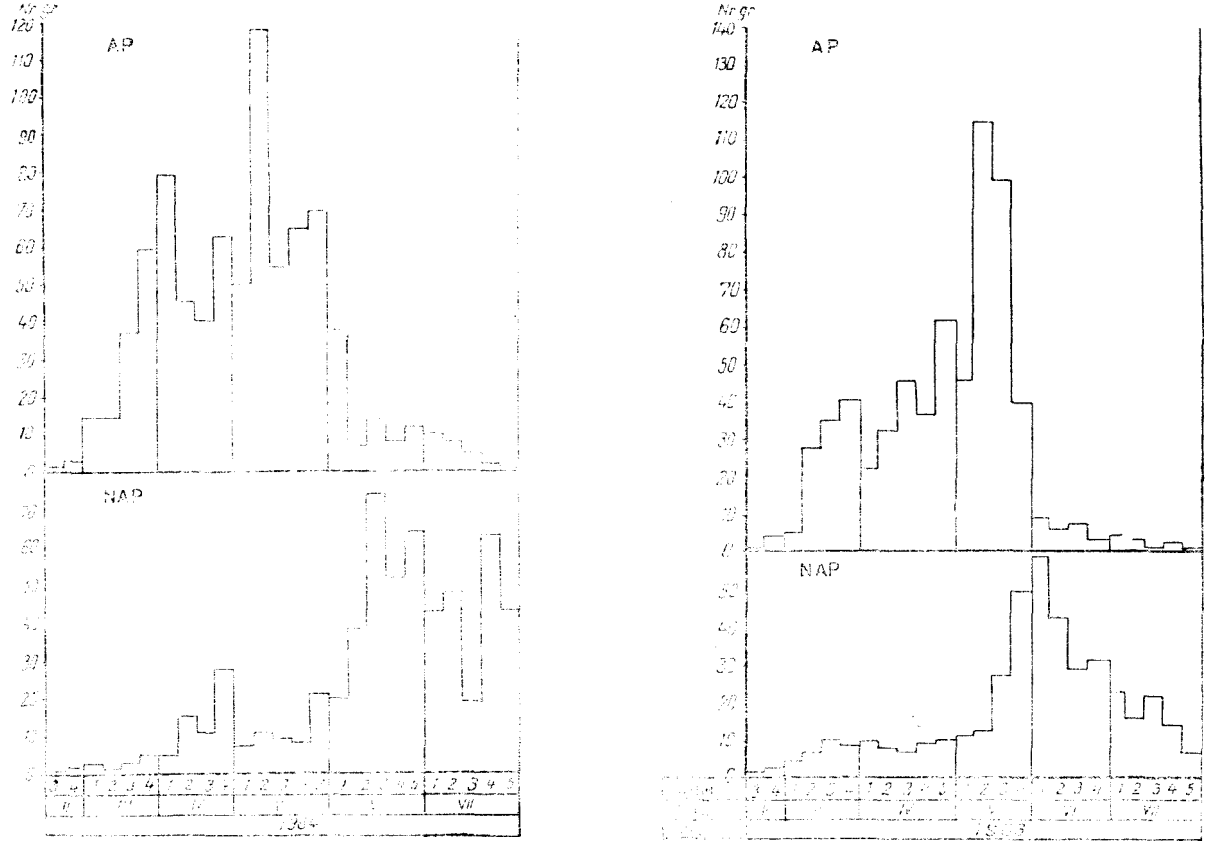


Fig. 2. *La variation hebdomadaire de la densité du pollen dans l'aéroplancton de Praid.*

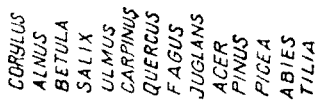
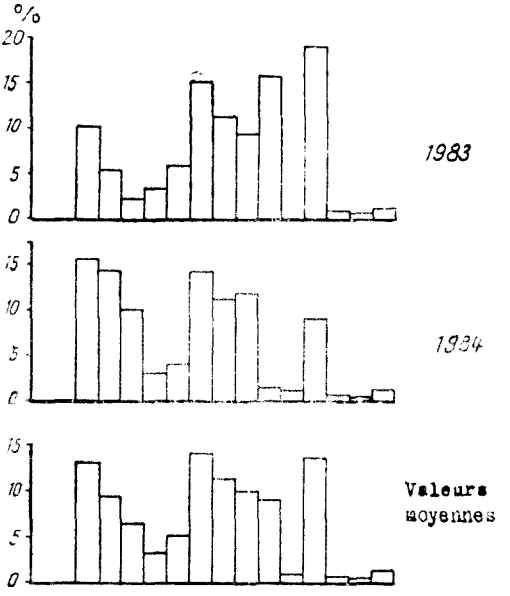


Fig. 3. *La participation (en %) annuelle et moyenne du pollen des arbres dans les spectres aéroplanctoniques obtenus à Praid.*


%
20
15
10
5
0
1983
15
10
5
0
1984
15
10
5
0
Valeurs
moyennes

une preuve irréfutable de la valabilité et de l'originalité des spectres polliniques fossiles et subfossiles.

Si l'on compare la participation (en p. 100) du pollen AP et NAP dans les spectres aéroplanctoniques de Praid avec les mêmes résultats obtenus des synusies des mousses de douze marais analysés (hormis les surreprésentations), on remarque que ces fréquences polliniques ne diffèrent entre elles dans la majorité des phytotaxons que de $\pm 5\%$, taux dépourvu de signification dans l'interprétation phyto-historique internationale.

Les présentes données sporo-polliniques actuelles, obtenues dans la partie nord-ouest du pays, offrent des points d'appui pour l'établissement de l'appartenance géobotanique du territoire investigué à l'étage némoral des feuillus. En tant que tel, le plateau volcanique Sovata—Praid—Dealu doit être considéré, dans son ensemble, comme une province de la zone de forêt dans les limites de laquelle la végétation herbeuse xérophile de type steppique a un caractère intrazonal.

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SUR QUELQUES DIPLOPODES DE LA PENINSULE IBÉRIQUE ET DU NORD DE L'AFRIQUE

TRAIAN CEUCA*

SUMMARY. — On Some Diplopods from the Iberian Peninsula and the North of Africa. The paper presents the species: *Macellolophus excavatus* Verh. from Spain, which is also cited from Algeria; *M. breuili* n. sp. from Cueva de la Doña Trinidad — Spain; *Origmatogona jacetanorum lagari* n. ssp. from Avenc de la Font del Julibert — Spain, and *Glomerellina convolvens africana*, n. ssp. from El Kef — Tunisia.

POLYDESMOIDEA

Genre *Macellolophus* Verh. 1931

Le genre *Macellolophus* a été décrit par Verhoeff comme genre unique de la famille *Macellolophidae*, d'après les quelques exemplaires que le prof. J. Bolivar (Madrid) a collecté du lieu dit „Zabernes" (Tabernes?) du sud-est de l'Espagne, mais sans connaître exactement la localité d'où provenait le matériel qui a servi à la description de *Macellolophus excavatus*. Verhoeff a hésité plus de 20 ans avant de publier son travail, parce que il doutait que cette espèce „tropicale" aurait été vraisemblablement trouvée en Espagne. Il ne l'a fait qu'en 1931, lorsqu'il est entré en possession d'un individu ♀ provenant de la localité éspagnole Cartagena, d'après lequel il décrit aussi l'espèce *Macellolophus hispanicus* [10].

En 1968, Hoffman [2] inclu dans cet intéressant genre *Polydesmus diadema*, que Gervais avait décrit en 1836 des environs du Gibraltar. Hoffman est d'avis que cette espèce appartient certainement au genre *Macellolophus* et qu'elle pourra même représenter un ancien synonyme de l'une des deux espèces de Verhoeff, mais il ne fait aucune mention sur *Macellolophus panousei* décrit par Schubart en 1961 de Talasse M'Tane — Maroc [6].

En ce qui suit, nous signalons la présence de *M. excavatus* également dans le nord de l'Afrique, en Algérie, et nous donnons la description de l'espèce nouvelle *Macellolophus breuili* trouvée dans une grotte toujours du sud de l'Espagne.

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Macellolophus excavatus Verh. 1931

Nous avons identifié cette intéressante espèce dans la collection „Biospeologica" de l'Institut de Spéologie de Cluj-Napoca; elle provient de la Grotte des Beni-Add, située au voisinage de la commune d'Aïn-Fezza, canton de Tlemcen, département d'Oran — Algérie. Altitude: 1100 m. Vingt exemplaires, dont 5♂♂, 10♀♀ et 5 juvéniles, ont été collectés le 11 mai 1919 par C. Arambourg et R. Jeannel (Biospeologica 1017) [3].

Il convient de remarquer que cette espèce, que Verhoeff considère comme "tropicale", est une forme épigée en Espange et cavernicole en Algérie, quoi-qu'il est possible que les recherches futures démontrent qu'elle vit ici en dehors des grottes [8].

On doit mentioner le fait que les gonopodes (Fig. 1) des exemplaires algériens se caractérisent par le fait que leur partie terminale (le solénomérite) est moins courbée et que le petit lobe sousterminal est plus étroit. De même, le solénomérite du télopodite gonopodial, delimité par le pli (*x*), n'est compris que $1^1/_2$ fois dans la longueur du gonopode tandis que chez les exemplaires espagnoles, cette région est comprise deux fois dans la longueur du reste du télopodite gonopodial.

Macellolophus excavatus Verh. 1931 doit donc être considéré comme une espèce nouvelle pour la faune de l'Algérie. On peut affirmer que le sud de l'Espagne représente probablement la partie la plus septentrionale de l'aire de distribution du genre *Macellolophus*, qui pourra être mieux représenté dans la zone, moins étudiée, du nord-ouest de l'Afrique.

Macellolophus breuili n. sp.

Mâle: longueur = 12 mm; largeur = 2,5 mm. Femelle: longueur = = 14,5 mm; largeur = 3 mm.

Ont été collectés 18 exemplaires (6 ♂♂ et 12 ♀♀) de la Cueva de la Doña Trinidad, située à mi-chemin entre Carratraca et Ardales, termino municipal d'Ardales, partido de Campillos, provincia de Málaga, dans le sud de l'Espagne. Leg. H. Breuil, le 16 mars et 27 avril 1918 (Biospeologica 932).

Le corps, formé de 20 segments, est d'une couleur terreuse, avec de faibles nuances de rouille plus claire que chez *M. excavatus*. Sur tout le corps, y compris la tête, on observe de nombreux petits tubercules, dont la disposition est bien irrégulière. La tête est en grande partie couverte par l'énorme bouclier cervical, lui imprime une position ventrale et non pas en prolongement du corps. Comme d'habitude, les antennes ont les articles 2—5 relativement courts et de la même longueur, tandis que le 7-ème article est évidemment plus long. Comme chez l'espèce précédente, le bouclier cervical est grand, de forme demi-circulaire, avec les bords relevés, ceux-ci dépassant antérieurement et laté-

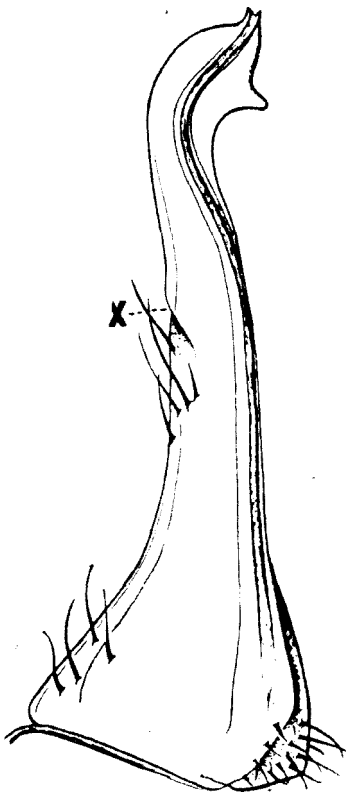

Fig. 1. Macellolophus excavatus *Verh. 1931*. Gonopode gauche d'un exemplaire ♂ d'Algérie, vue postérieure. *x* — Pli délimitant le solénomérite de la région basale du télopodite gonopodial.

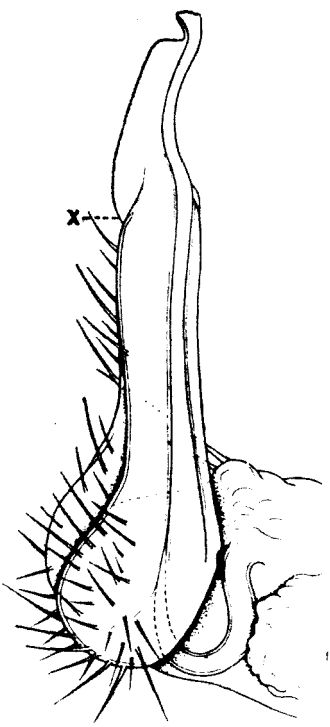

Fig. 2. Macellolohus breuili *n.sp.* Gonopode droit d'un exemplaire ♂ de la Cueva de la Doña Trinidad d'Espagne, profil interne. *x* — Même signification que pour la Fig. 1.

ralement la tête. De même, les ailes latérales, bien développées, de chaque ségment sont obliquement relevées et ont les angles postérieurs de plus en plus aigus.

Les gonopodes (Fig. 2) ont, comme chez l'espèce précédente, une constitution bien simple (selon Verhoeff, ils seraient secondairement simplifiés), en se caractérisant par l'absence d'une branche latérale, à savoir le tibiotars gonopodial. La partie terminale (le solénomérite) a la forme d'une lame faiblement bombée, pourvoue à son extrémité d'un petit entonnoir dans lequel s'ouvre le canal séminal gonopodial. La partie basale du télopodite gonopodial, armée de nombreuses soies, est délimitée de celle terminale, comme chez *M. excavatus*, par un pli evident *(x)*. La petite corne coxale, bien développée, pénètre assez profondément dans la zone coxale du canal séminal.

Affinités: la distinction entre *M. excavatus* Verh. 1931 et *M. breuili* n.sp. peut facilement être faite non seulement par la taille plus faible de cette dernière, mais aussi par la conformation des gonopodes. On ne peut pas faire de références en ce qui concerne *M. hispanicus* Verh. 1931, qui a été insuffisamment décrit d'après un seul exemplaire ♀, quoique Hoffman [2] est d'avis qu'il ne serait pas surprenant de constater, lorsqu'on arrivera a connaître les caractères du mâle, que *M. hispanicus* appartient en réalité à un genre à part [4]!

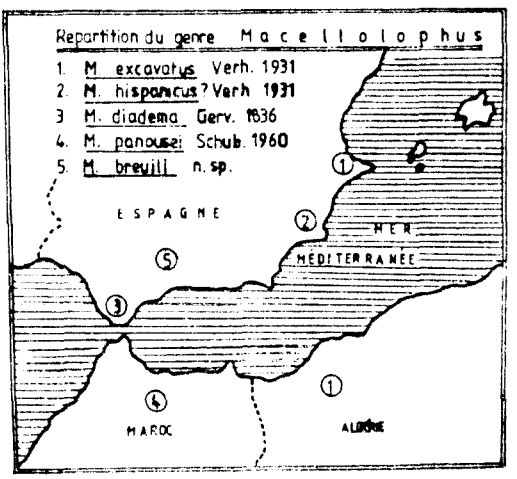

Fig. 3. *Repartition du genre* Macellolophus *Verh. 1931.*

Tous les quatre? (trois) espèces: *M. excavatus*, *M. hispanicus?*, *M. diadema* et *M. panousei* [6] sont des formes épigées, tandis que *M. breuili* est, peut être, cavernicole (Fig. 3 — carte).

ASCOSPERMOPHORA

Fam. *Anthogonidae*

Origmatogona jacetanorum lagari n.ssp.

Longueur = 6 mm ; largeur = 0,5 mm. Trois exemplaires (1 ♂, 1 ♀, 1 juv.) ont été collectés de l'Avenc de la Font del Julibert Vimbodi, Tarragona, le 17 janvier 1971. Leg. A. Lagar.

La coloration du corps est semblable à celle de la sousespèce typique *Origmatogona jacetanorum jacetanorum* Mauriès 1964, à l'exception d'une bande brune, transversale, située entre les deux champs triangulaires d'ocelles. Le bouclier cervical n'a que 4 tubercules sétigères. Comme d'habitude, les tergites ont 3 + 3 soies longues. Sur les tergites on peut observer un faible réseau.

Les gonopodes antérieurs (Fig. 4) ont les angiocoxites *(a)* fortement allongés du côté distal, avec les pointes courbées en sens postéro-médial et relativement aigues, de sorte qu'ils ne se touchent pas, que par leurs bases [4]. Les lames postérieures, qui ne sont soudées ici que par la partie basale des angiocoxites, ont les zones terminales *(x)* nettement distinctes par rapport aux angiocoxites et différenciées: une partie apicale large, demi-circulaire, courbée vers son milieu et pourvue à l'ex-

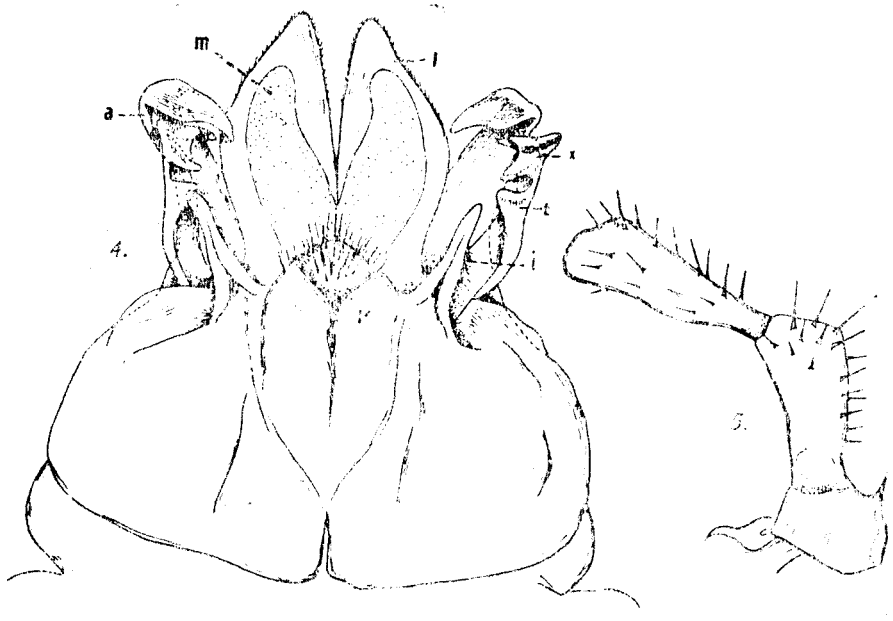

Fig. 4 — 5. Origmatogona jacetanorum lagari *n.ssp.* 4 — Pièce gonopodial, vue postérieure. *a* — Angiocoxites. *t* — Prolongements des télopodites. *l* — Colpocoxites antérieurs. *l'* — Renflements paramédians. *m* — Masse opaque. *t* — Lobe triangulaire. *x* — Partie terminale de la lame postérieure. 5 — Gonopodes postérieurs (paragonopodes).

térieur d'un éperon conique, arrondi, sous lequel se trouve un lobe triangulaire large et une partie basale soudée après l'angiocoxite.

Les colpocoxites antérieurs *(l)*, situés entre les angiocoxites *(a)*, se présentent comme deux pièces hautes et larges, avec les pointes relativement aigues, ayant chacune une zone *(m)* opaque*.

Le syncolpocoxite postérieur, placé plus bas, est fortement bombé, étant pourvu dans sa partie distale de deux renflements paramédians *(l')*, flanqués de deux prolongements *(i)* — assimilés aux télopodites — qui sont ici larges, aigus et à orientation divergente. A l'encontre de la sousespèce *O. j. jacetanorum* Mauriès entre ces deux renflements il y a un lobe arrondi, évidemment poilu.

Les gonopodes postérieurs (Fig. 5) ou les paragonopodes sont rudimentaires, étant formés comme d'habitude dans ce genre, de seulement trois articles.

Chez la femelle, les caractères sont fort semblables à ceux de la sousespèce typique, les petites différences étant non significatives.

Il est intéressant de mentioner que, en 1975 (?)** dans le travail *„Diplópodos cavernícolas nuevos y poco cocidos d'España . . .“*, J. P.

* Afin de rendre plus facile la comparaison avec la sousespèce typique *O. j. jacetanorum*, nous avons indiqué les différentes parties des gonopodes avec les mêmes lettres que M a u r i è s [4].

** Le tiré-à-part ne contient pas l'année d'apparition ni le titre de la revue

Mauriès et M. Vicente signalent (p. 115) la présence dans la même grotte (Avenc de la Font del Julibert), de laquelle provient notre sousespèce *Origmatogona jacetanorum lagari*, non pas d'une forme nouvelle, mais bien celle d'*O. jacetanorum* Mauriès 1964 (c'est-à-dire la sousespèce typique *O. j. jacetanorum);* il convient donc de revoir les gonopodes de l'exemplaire ♂ collecté par M. Rodriguez, le 10 avril 1971. Il faut noter aussi le fait que, dans le travail comprenant la description de l'espèce *O. jacetanorum* [4], celle-ci est encadrée dans la famille *Xistrosomidae*, tandis que plus tard, après 1970, elle est encadrée dans la famille *Anthogonidae* (sans aucune explication).

Afin de mieux relever les différences, nous donnons ci-dessous la parallèle des caractères distinctifs des deux sousespèces:

Origmatogona jacetanorum jacetanorum Mauriès 1964 [4]	*Origmatogona jacetanorum lagari* n. ssp.
— longueur = 6,5 mm; largeur = 0,6 mm;	longueur = 6 mm; largeur = 0,5 mm;
— sans bande brune entre les deux champs ocellaires;	— avec une large bande brune entre les deux champs ocellaires;
— les gonopodes antérieurs ont les colpocoxites sveltes, avec les pointes relativement arrondies et la zone opaque relativement peu développée;	— les gonopodes antérieurs ont les colpocoxites larges, avec les pointes relativement aigues et la zone opaque plus développée;
— les lames postérieures des angiocoxites ont trois formations: une dent apicale, une sousapicale et une lame hyaline dentée;	— les lames postérieures des angiocoxites n'on que deux formations: une lame demi-circulaire, courbée au milieu, pourvue d'un éperon conique et d'un lobe large;
— entre les deux renflements paramédians de la face postérieure de l'angiocoxite il n'y aucune formation;	— entre les deux renflements paramédians de la face postérieure de l'angiocoxite il y a un lobe arrondi, poilu;
— les deux prolongements qui flanquent les renflements de l'angiocoxite sont courts;	— les deux prolongements qui flanquent les renflements de l'angiocoxite sont longs et divergents;
— dans la partie basale, postérieure de angiocoxite il y a deux crêtes fortement chitinisées (p);	— dans la partie basale, postérieure de l'angiocoxite il n'y a pas de crêtes chitinisées;
— sous ces crêtes il y a deux prolongements paramédians (g).	— les deux prolongements paramédians manquent.

Comme son congénère *Origmatogona catalonicum* Ribaut, décrit toujours de la province de Tarragona, la sousespèce *O. j. lagari* est une forme également cavernicole, malgré le fait que la sousespèce typique paraît être — conformément aux affirmations de son auteur — une forme épigée.

PLESIOCERATA

Fam. *Glomeridae* (*sensu* Mauriès 1975) [5]

Glomerellina convolvens africana n. ssp.

Mâle: longueur = 5 mm; largeur = 2 mm. Femelle: longueur = 7 mm; largeur = 4 mm.

On été collectés 6 exemplaires: 1 ♂ + 3 juv. le 6 janvier 1909 et 1 ♂ + 1 ♀ le 25 avril 1909, de la Le Kef (El Kef), Tunisie, avec la mention *End.* (probablement endogé). Le nom de collecteur n'est pas mentionné. L'échantillon ne fait pas partie de la Collection „Biospeologica", mais il est inventarié à côté d'autres diplopodes dans le bocal portant le numéro 69 de cette collection [1].

La couleur du corps est fortement altérée par la longue conservation en alcool; les tergites sont à peu près transparents, ce qui empêche de faire une comparaison avec la sousespèce typique *Glomerellina convolvens convolvens* Verh. 1910, décrite d'Italie [9]. Les ocelles, encore pigmentés, forment une rangé de quatre, au-dessous de laquelle il y en a encoré un. Le bouclier cervical, de forme demi-circulaire, est depourvu de stries transversales.

La 17-ème paire de pattes est rudimentaire chez le mâle, n'étant formée que de deux articles, dont la disposition est divergente (Fig. 6).

La 18-ème paire de pattes du mâle se caractérise dans ce genre par le très grand développement des coxae. Celle-ci sont ici évidemment plus grandes, avec l'angle latéral (externe) nettement arrondi et non pas aigu (Fig. 7), comme chez la sousespèce typique d'Italie.

Les télopodes de la 19-ème paire de pattes du mâle (Fig. 8) ont généralement le même aspect que chez la sousespèce typique. Les préfémurs des télopodes ont pourtant la face postérieure visiblement granulée; de même, les tarses ont sur la moitié distale de la face interne de nombreux petits tubercules, ce qui constitue une caractéristique de cette sousespèce. Tous les articles des télopodes sont plus au moins poilus. Le lobe du syncoxite est petit, arrondi et placé postérieurement et non pas antérieurement, comme le figure Verhoeff ([9], Fig. 265, p. 667*). Les deux prolongements latéraux du syncoxite sont relativement longs et ont les points très poilues et faiblement courbées en arrière; tout le syncoxite est couvert d'un fin poil. Enfin, la fente inférieure du syncoxite est très profonde et a la forme d'une ogive, tandis que chez la forme italienne elle est à peine esquissée.

Affinités: Le genre *Glomerellina* Silv. 1908 jusqu'à présent endémique en Italie et les îles avoisinantes et représenté par *G. laurae* Silv.

* Il paraît que Verhoeff a indiqué d'une manière erronée le sens de la figure qu'il donne, car, quoiqu'il est évident que celle-ci représente la face postérieure des télopodes, il écrit: „von vorn betrachtet".

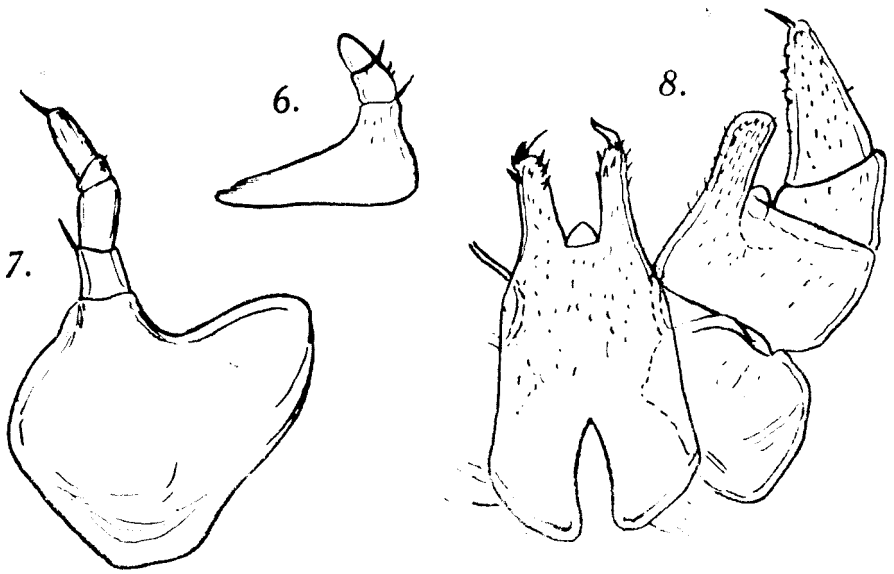

Fig. 6 — 8. Glomerellina convolvens africana *n.ssp.* 6 — Patte gauche de la 17-ème paire chez le mâle. 7 — Patte droite de la 18-ème paire chez le mâle. 8 — Moitié droite des télopodites (19-ème paire de pattes) chez le mâle, vue antérieure d'une exemplaire de Tunisie.

1908, *G. convolvens* Verh. 1910 et *G. molisia* Verh. 1932 [11] est commenté par Strasser [7], qui montre que les différences entre ces „formes" peuvent être incertaines.

On observe facillement qu'il y a une ressemblence frapante avec la sousespèce typique *Glomerellina convolvens convolvens* Verh. Les caractères distinctifs entre les deux sousespèces sont les suivants:

Glomerellina convolvens convolvens Verh. 1910 [9]	*Glomerellina convolvens africana* n. ssp.
— longueur: ♂ = 4,5 mm; ♀ = 5,5 mm;	— longueur: ♂ = 5 mm; ♀ = 7 mm;
— les pattes de la 17-ème paire du mâle sont parallèles et portent une petite soie terminale;	— les pattes de la 17-ème paire du mâle sont divergentes et dépourvues de soie terminale;
— la 18-ème paire de pattes du mâle a les coxae grandes, avec les bords externes formant un angle aigu;	— la 18-ème paire de pattes du mâle a les coxae visiblement plus grandes et à bords externes arrondis;
— les télopodes ont la face antérieure des articles glabre, à l'exception des prolongements digitaux des fémures;	— les télopodes ont la face antérieure des articles, y compris du syncoxite, plus ou moins poilue;
— les articles tarsaux ont la face interne de la moitié distale lisse;	— les articles tarsaux portent sur la face interne de la moitié distale de nombreux petits tubercules;

— les faces postérieures des préfémurs sont lisses;	— les faces postérieures des préfémurs sont microgranulées;
— les prolongements du syncoxite sont relativement courts;	— les prolongements du syncoxite sont relativement longs et faiblement courbés en arrière;
— la fente inférieure du syncoxite est peu profonde.	— la fente inférieure du syncoxite est très profonde et a la forme d'une ogive.

Comme d'autres diplopodes et certains représentants d'autres groupes d'animaux, cette espèce, considerée jusqu'à présent endémique en Italie (par sa sousespèce typique *G. convolvens convolvens)*, prouve une fois de plus (par *G. convolvens africana)* pour la première fois dans la faune de Tunisie, l'existence dans le passé géologique éloigné d'une liaison entre la Sicilie et l'Afrique du Nord.

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FIELD RESEARCHES ON THE BEHAVIOUR OF THE EUROPEAN CORN BORER, *OSTRINIA NUBILALIS* HBN. *(LEPIDOPTERA: PYRALIDAE)*, IN RELATION TO SYNTHETIC PHEROMONE BLENDS

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SUMMARY. — Data concerning field researches on European corn borer synthetic pheromone blends in the Cluj-Napoca zone (North-Western Romania) are presented. 97:3 Z/E11-tetradecenyl acetate at 50 µg dose was the best blend capturing the largest number of *Ostrinia nubilalis* male moths with a good specificity. There were no statistical differences when the two basic compounds of the pheromone were placed both on the same support and on distinct ones. The efficacy of synthetic pheromone baits was short (3—4 days). Tetradecyl acetate (14:Ac) had no effect on capture size. E9-tetradecenyl acetate (E9-14:Ac), another crude pheromone compound [9], inhibited almost statistically significantly the male catches, but 11-tetradecinyl acetate (11—14 : Ac), cited as inhibitor [12], had no significant inhibitory effect, at the percentages tested here. Catch number increased from the low size plants to the corn plants and inside the corn field, proving the role of the corn plants as a place of sex meeting and egg-laying for *O. nubilalis*. The relation between catches and yield losses caused by the European corn borer is also discussed.

The European corn borer, *Ostrinia nubilalis* Hbn. is considered one of the most important pests due to its widespread and the severe damages it causes. It is an oligophagous species damaging mostly corn, but also potatoes, peppers, hemp as well as certain weeds. In corn, its caterpillar attacks both ears and stalk, causing the breakdown or physiological debility of the plant [20, 21, 24].

The modern strategies in controlling this pest involve more and more the use of pheromones. The pheromone traps restrict chemical treatments by their application only in the critical periods of the species, with maximum control results; it may also increase the efficiency of control by biological methods.

A n g l a d e [2] quotes data according to which *cis* (Z) 11-tetradecenyl acetate was found to be a sex attractant for *Argyrotaenia velutinana* and had a stimulating effect on *O. nubilalis* males. K l u n and R o b i n s o n [13] demonstrated an increase of male attraction if small amounts of *trans* (E) 11-tetradecenyl acetate were added to the Z isomer.

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Chemical analysis of the crude pheromone extract showed the presence of 4 compounds: Z11-tetradecenyl acetate (Z11—14:Ac), E11-tetradecenyl acetate (E11-14:Ac), E9-tetradecenyl acetate (E9-14:Ac), and tetradecyl acetate (14:Ac) [9]. Laboratory and field researches proved that Z and E11-14:Ac have an attractive role for *O. nubilalis* males in ratios specific for varied populations. E9—14:Ac was found to be inhibitory, while no effect was determined for 14:Ac [11].

This paper deals with the results of our field researches carried out on *O. nubilalis* with various synthetic sex pheromone blends. It concerns: the ratio of pheromone compounds with optimum attractivity for the European corn borer, pesting our zone; dose effect on attractivity; the role of bait age in male attraction; the importance of the evaporation of pheromone compounds on distinct supports, compared to those on the same support; the role of 14:Ac; the role of E9—14:Ac and 11-tetradecinyl acetate (11—14 : Ac), cited as inhibitors [11, 12]; the specificity of pheromone captures; the influence of the crop type and the distance inside the corn field on the number of captured males and the relation of the captures with damage levels under the environmental conditions of the tested zone.

Materials and methods. Researches were carried out on corn fields near Cluj-Napoca (North-Western Romania) in 1987. The experiment used 14 pheromone blends (Table 1), from which 13 variants were made and tested by randomized blocks (Fig. 1 a, b). Each variant was replicated 5 times, each time deeper inside the corn field, following the plot diagonal, in order to eliminate the influence of a possible group arrangement of the borer populations. Sixty-five baited traps were run on the whole. The distance between the traps on the same row was 40 m and 100 m between rows. The traps used, standard-size, Montedison type (Tetratrap), made in the Cluj-Napoca Institute of Chemistry, were hung at 1.25 m above the ground on wooden supports. A bait was placed in the centre of the sticky

Table 1

Pheromone blends tested in Ostrinia nubilalis
(variants N_7 — N_{10} were combined as in Fig. 1 b)

Variant	Compound proportion :					Dose/bait (μg)
	Z11—14 : Ac	E11—14 : Ac	14 : Ac	E9—14 : Ac	11—14 : Ac	
N_1	97	3	10	—	—	15
N_2	97	3	10	—	—	50
N_3	97	3	10	—	—	100
N_4	97	3	10	—	—	500
N_5	3	97	10	—	—	100
N_6	50	50	10	—	—	100
N_7	100	—	—	—	—	100
N_8	—	100	—	—	—	1
N_9	—	—	—	100	—	1
N_{10}	—	—	—	—	100	1
N_{11}	97	3	—	—	—	50
N_{12}	3	97	1000	—	—	1100
N_{13}	97	3	1000	—	—	1100
N_{14}	97	3	1000	—	—	1050

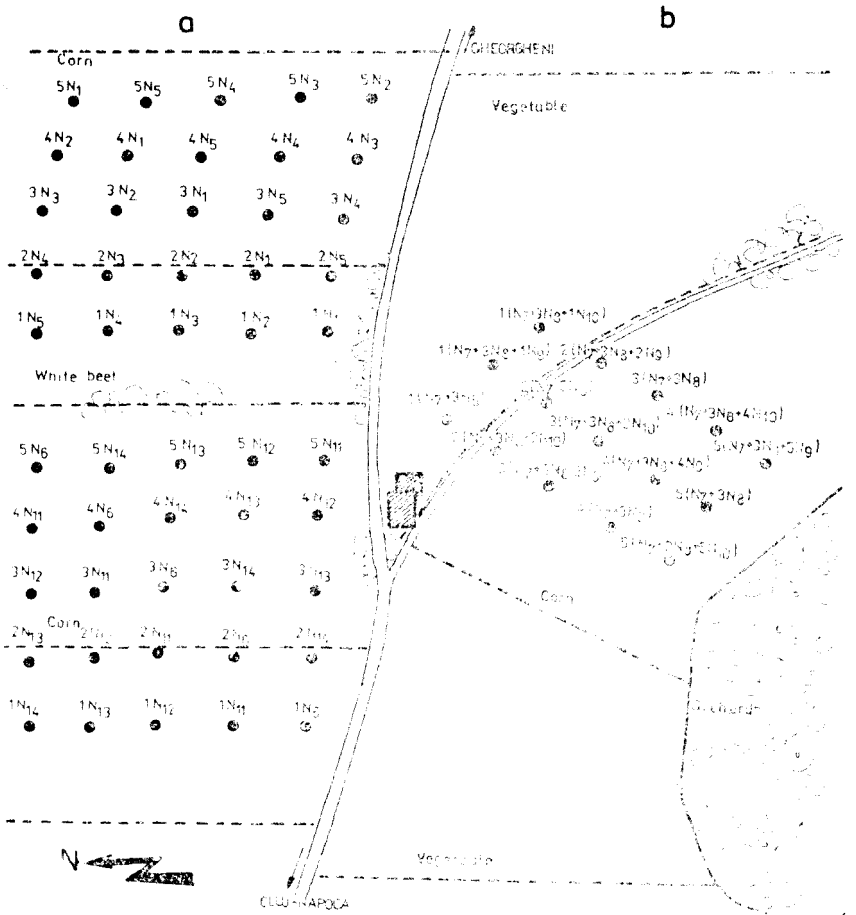

Fig. 1. *Trap laying scheme of the tested variants in the Cluj-Napoca area (North—Western Romania).*

bottom plate of each trap. It consisted of a rubber stopper on which the formulated pheromone compounds were applied in indicated doses (Table 1). The pheromone compounds were synthetized in the Cluj-Napoca Institute of Chemistry by using an original method [5]. Gas chromatographic analysis (OV 17.2 mx 4 mm Ar 0.35 at 180°C, t_R = 20.6 min.) indicated 95% purity of the compounds. Isomer ratio was established by means of capillary column gas chromatography (CW 20 M — 50 m, 170°C, 140 KN/m², Z:t_R =9.4 min., E:t_R =9.0 min.), indicating over 99.8% isomer purity. Before application on stoppers, the pheromone compounds were diluted in dichloromethane. Baited traps were placed in the field on 3 July, a few days after the beginning of the flight recorded in a warning cage. Each trap was checked twice a week, counting and removing the caught moths. The baits and sticky plates were changed after two weeks (17 July), and 15 traps, on which the inhibitory effect of E9-14:Ac and 11—14: Ac was watched, functioned with the same baits during the whole test period (3 July — 3 August). Data were statistically analysed by using the „t" test.

Table 2

Number* of *O. nubilalis* males captured with the pheromone variants tested

Variant	Number of males captured on: 6.VII	8.VII	13.VII	17.VII	22.VII	25.VII	29.VII	3.VIII	Total	D.M.	D.M.$_{(3+4)}$
N_1	7.0	0.6	1.2	0.8	10.2	3.2	1.2	0.2	24.4	0.82	2.46
N_2	8.6	1.4	1.6	0.2	21.8	3.2	1.6	0.4	38.8	1.29	4.29
N_3	8.8	1.2	1.4	2.0	13.0	6.4	1.0	0.2	34.0	1.11	3.11
N_4	2.2	1.4	2.6	1.2	11.0	2.6	0.6	0.6	22.2	0.74	2.06
N_5	0.6	0.0	0.8	0.0	0.0	0.0	0.2	0.0	1.6	0.05	0.08
N_6	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.01	0.00
N_{11}	4.4	1.8	1.4	0.4	13.2	6.4	2.6	0.2	30.4	1.01	2.51
N_{12}	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.01	0.00
N_{13}	3.4	2.0	2.6	1.2	16.0	3.8	2.4	0.8	33.0	1.10	3.49
N_{14}	4.5	2.5	2.8	0.5	13.5	6.7	2.5	0.0	33.0	1.10	2.57
$N_7 + 3N_8$	4.0	0.6	1.4	0.2	1.8	1.2	1.4	—	10.6	0.41	1.33
$N_7+3N_8+(1-5)N_9$	0.6	0.0	1.4	0.2	0.4	0.2	0.2	—	3.0	0.12	0.20
$N_7+3N_8+(1-5)N_{10}$	1.2	2.2	1.2	0.6	1.0	0.0	0.4	—	6.6	0.25	0.40

* It represents the means of 5 replicates. D.M. — Daily means = Mean numbers of males/trap/night for the whole capture period. D.M.$_{(3+4)}$ — Mean numbers of males/trap/night for the first checks performed on the 3rd and 4th days after laying the baits.

Results and discussion. The data registered from all the tested variants during the flying period (3 July — 3 August) of *O. nubilalis* adults are presented in Table 2. We shall analyse the data according to the studied aspects.

I. *Aspects concerning the pheromone compounds. a) Optimum ratio of Z and E11—14:Ac isomers in the synthetic pheromone blend.* The variants N_3, N_5 and N_6 (Table 2) representing the isomer ratios 97:3, 3:97 and 50:50, respectively, at the same dose, were attractive as follows: majority of the males (95%) were caught with 97:3 Z/E11—14:Ac; Z/E11—14:Ac in the ratio 3:97 caught 4.45% and in the ratio 50:50 caught only 0.55% of the males. These data show a genetically stable Z pheromone strain [4, 10], occurring in the tested zone. Our results correspond to those communicated for 1973 and 1974 from the same zone [13], when 96.5% and 96.6% of the *O. nubilalis* males, respectively, were caught by using the 97:3 Z/E isomer ratio.

Similar data on European corn borer were raported from many European and North American areas [2, 7, 12, 18], showing a wide spread of this pheromone strain. The strain responding to E+small amounts of Z pheromone is restricted to Italy [4, 6] and New York county [14, 16, 18]. In other North American counties the two borer strains occur sympatrically [3, 6]; here the males also respond to 50:50 and other close ratios of the two isomers, suggesting hybrid population occurrence.

The 97:3 Z/E isomer blends were set on the same support (N_3) or on distinct ones (N_7+3N_8), with the baits in the middle of the sticky plate, and no statistical difference was recorded for the period until changing

the baits (17 July). This indicates the lack of influence of pheromone conditioning on the number of the males caught.

b) *Dose effect on attractivity.* Starting from previous unpublished data of our research group on the capture of *O. nubilalis*, where 97 : 3 Z/E11—14:Ac blend was found to be more attractive, we tested the dose effect on attractivity for this ratio only. Four doses were used: 15, 50, 100 and 500 µg, representing the variants N_1, N_2, N_3 and N_4, respectively (Table 1).

Statistical analysis of the results obtained in these variants (Table 2) was made both for the whole capture period (Fig. 2, shaded part of the columns) and for the first check period after laying the baits (Fig. 2, whole height of the columns), because of the quick decrease of bait efficaciousness, which we observed during the tests; we shall detail this aspect in another part of this paper.

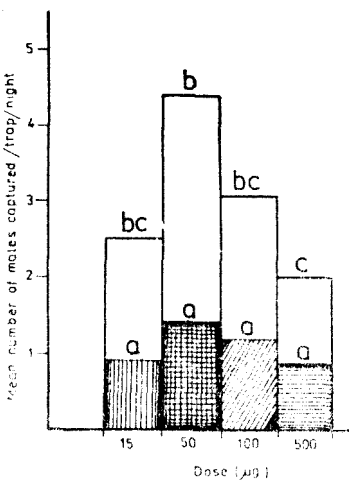

Fig. 2. *Daily means of males per trap related to* Ostrinia nubilalis *synthetic pheromone dose.*
Shaded part of the columns — Daily means over the whole period.
Whole height of the columns — Daily means in the period until first check after laying the baits.
Columns marked with the same letter are not significantly different at 5% level according to the "t" test.

The traps baited with 50 µg synthetic pheromone captured the largest number of males we recorded, this being the optimum dose according to our findings. The catch number decreased with dose increase. Literature data show that varied pheromone doses have been tested on *O. nubilalis*. Klun and Robinson [12] and Oloumi-Sadeghi *et al.* [15] used the dose of 14 µg pheromone mixed with olive oil and applied on filter paper, the baits being changed daily. Klun *et al.* [7], Klun and co-operators [8] and Showers *et al.* [18] indicated the 100 µg dose of pheromone on rubber supports as the best for field catches. Doses ranging between 3.6 and 896 µg pheromone tested in the field indicated a decrease in attractivity with dose increase and no moth was captured above 224 µg (the pheromone blend being mixed with olive oil and applied on filter paper) [13]. However, there are cases when *O. nubilalis* was caught at pheromone doses over 224 µg: at 750 µg [3], at 300 µg placed on orthosilicon rubber septa [6], at doses of 1,000 and 10,000 µg put on rubber and polyethylene [2]. Voinyak *et al.* [25] indicated the 2,000 µg dose as having the best catches. We also captured male moths with the 500 µg dose, but at a significantly lower level as compared with the 50 µg dose catches.

c) *Role of bait age in male attraction.* Bait efficacy duration is an important aspect for the accuracy of capture estimation related to the level of moth population in pest control. The data in Table 2 show an important decrease in the number of males caught after the first check

period of the traps, 3—4 days after the bait laying. This was the case of all effective variants (with 97:3 Z E11—14:Ac) including the best dose (50 μg). Statistical analysis indicates significant differences between the first catches and the following ones. It results that synthetic *O. nubilalis* pheromone baits lose very quickly their ability to attract males regardless of the pheromone dose. This conclusion may be consolidated and argued with the results described by Kennedy and Anderson [6] who found statistically significant differences between one and two week old baited traps; these differences did not occur when the baits were changed twice a week. These authors generally concluded that the level of catches was inversely correlated with the time the traps were kept in field. Cardé *et al.* [3] also pointed out unaccountable statistically significant decreases in the number of caught moths, although adult moths could be observed close to the traps. Anglade [2] captured 92 of the 102 moth males he recorded in the first two checkings, performed every 5th day (the experiment lasting 28 days), although he used the 10,000 μg dose. With the 1,000 μg dose, 37 of the 44 moths captured were recorded in the first 5 days. In other papers, daily change of the baits was communicated [12, 13, 15].

We are interested whether the natural sex pheromone of *O. nubilalis* loses its attractivity just like the synthetic one. As borer moths are generally crowded in grassed zones neighbouring corn fields [22] and are stimulated visually or by certain ecological and physiological factors, others than sex activity, the quick loss of pheromone efficacy may be interpreted as an adaptive reaction of the species in order to avoid self disorientation. Further field researches with natural extract pheromone should be done for understanding this aspect.

d) Role of tetradecyl acetate (14 : Ac). Tetradecyl acetate, a crude natural pheromone compound, was tested in a close natural ratio (10 μg in 110 μg pheromone blend) and in a larger dose (1,000 μg in 1,100 μg blend) and compared to the pheromone with no 14:Ac, representing the variants N_2, N_{11} and N_{11}, respectively (Table 1). Statistical analysis of data (Table 2) for these variants showed no significant differences (Fig. 3). Consequently, 14:Ac does not influence the number of males captured in traps with Z/E11—14:Ac. This accords with Klun *et al.* [11] who, by laboratory and field researches on the role of pheromone compounds, registered in males similar percentages of response to pheromone both with and without 14:Ac. Kochansky *et al.* [14] also used 14:Ac in studies on the E strain of the European corn borer in USA, without remarking any statistical differences in capture size related to this compound. This compound may have a role in a courtship behaviour phase.

e) Role of E9-tetradecenyl acetate (E9—14:Ac). Statistical analysis of the results of variants N_7+3N_8 and $N_7+3N_8+(1—5)N_9$ (Table 2) revealed the inhibitory role of E9-14:Ac, cited as a crude natural pheromone compound [9]. The inhibition of male attraction to Z E11—14:Ac induced by E9—14:Ac approached the 5% significance level in our tests (Fig. 4).

E9—14:Ac had been previously presented as an inhibitor by Klun *et al.* [12]. They showed that this compound inhibited male attraction

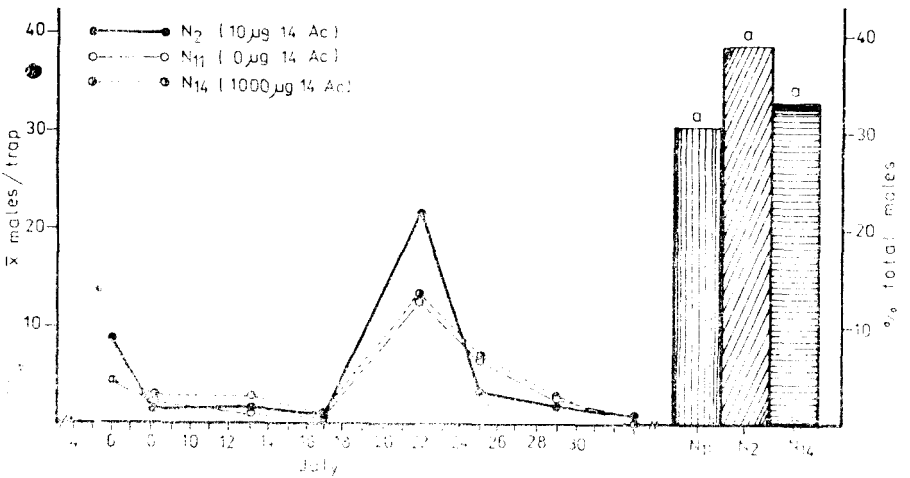

Fig. 3. *14 : Ac effect on the* Ostrinia nubilalis *male captures in traps baited with 97 : 3 Z/E11 — 14 : Ac.*

$\bar{x}$ — Mean of 5 replicates. a — Values not differing at $P = 0.05$ according to the "t" test.

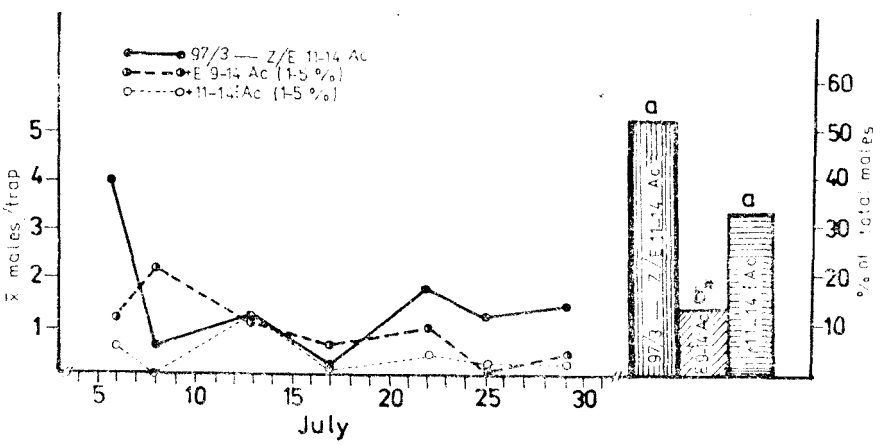

Fig. 4. *E9—14 : Ac and 11—14 : Ac effect on the* Ostrinia nubilalis *male attraction by 97 : 3 Z/E11 — 14 : Ac.*

$\bar{x}$ — Mean of 5 replicates.

Columns marked with the same letter are not significantly different at 5% level according to the "t" test.

* The difference approached the 5% significance level.

when used in mixture with any other pheromone compound, and produced a progressive decrease from 14.2 to 2.2 males per trap, when increasing its dose from 0 to 9 µg. These authors also showed that E9—14:Ac was a strongly suppressing element of copulation in the natural borer

Table 3

Capture specificity

Species	Males captured in variants									
	N_1	N_2	N_3	N_4	N_5 ♀	N_6 ♀	N_{11}	N_{12}	N_{13}	N_{14}
O. nubilalis	122	194	170	111	8	1	152	1	165	132
Other species	4	5	6	4	33	6	1	7	7	1
Specificity %	96.52	97.42	96.47	96.40	19.50	14.30	99.35	12.50	95.16	99.25

population as it inhibited both long-range orientation and the precopulatory behaviour of males.

f) Role of 11-tetradecinyl acetate (11—14 Ac). 11-Tetradecinyl acetate, an analogue with a triple bond of the major compound of *O. nubilalis* pheromone, was previously presented by K l u n and R o b i n s o n [12] as a possible inhibitor of pheromone attraction. In our tests (N_7+ $+3N_8+(1—5)N_{10}$ variant, Table 2), the compound did not present any statistically significant inhibitory effect (Fig. 4). We must state that unlike the cited authors, who obtained long-range male inhibition and a strong decrease in field captures by adding 11—14 Ac to the attractant in 1:1 ratio, we used only 1—5% 11—14 Ac and, therefore, our results are not quite comparable to theirs.

g) Specificity of the pheromone captures. Specificity data for the tested pheromone blends are presented in Table 3. There is a good specificity to all the tested variants with 97:3 Z E11—14:Ac ratio. The best specificity was obtained for the 50 µg pheromone dose variants (N_2, N_{11}, N_{14}). Among captured species other than *O. nubilalis*, the great number of caught moths belonged to *Autographa gamma (Lepidoptera: Noctuidae)*, which developed large populations under the conditions of 1987, the captures being therefore considered as accidental.

Concerning *O. nubilalis* pheromone specificity, K l u n *et al.* [7] showed that the two basic compound isomers, Z and E11—14:Ac, also attract in definite proportions other *Lepidoptera* species: *Argyrotaenia velutinana* (to pheromone containing up to 7% E isomer in Z11—14:Ac), *Ostrinia obumbratalis* (to 50:50 Z E11—14:Ac ratio).

h) Influence of crop type and distance inside the corn field on the number of males captured. Each variant tested was replicated 5 times in a different position from the edge of the corn field (Fig. 1). The redistribution of the capture results for effective variants (with 97:3 Z/E isomer ratio) depending on trap position are presented in Table 4. It may be generally ascertained that the number of captured males increases from the low size crop (white beet, vegetable marrow) to the corn field and inside the corn field, with a slight positive deviation of the number of captured males corresponding to the corn field edge (edge effect). The statistical analysis of data indicated significant differences between the capture on low size crop and the captures on corn field. These data point

Table 4

Ostrinia nubilalis **captures with effective pheromone variants related to trap position outside or inside the corn field**

Distance from the corn field edge	Total capture	Means/ distance	%	Means/ crop	%	Crop
40 m outside	136	19.43	47.7a**	19.43	56.48	Low size
Corn field edge	222	31.71	77.89ab			
40 m inside	207	29.57	72.63ab			
80 m inside	196*	32.67	80.25ab	34.40	100.00	Corn
120 m inside	285	40.71	100.00b			

* No data for N_4 at 80 m inside the corn field.
** Means marked by the same letter are not significantly different at 5% level according to the "t" test.

out the importance of the corn field as a meeting place for copulation of the borer moths.

This finding agrees with that of Stockel *et al.* [21, 22] who proved that the adults of *O. nubilalis* move from their emerging places to a corn field, attracted by visual and olfactive means and crowd in low size crops or grassed zones adjacent to the corn field, from where they make really daily „mouvements pendulaires" to the middle of the corn field, where they copulate and lay eggs. Unlike this, Showers *et al.* [19] and Sappington and Showers [17] showed that the sex activity of the borer moths occurs generally in grassed places located at distances shorter than 100 m from a corn field. Relative to the influence of corn plants on the distribution of borer moths, Umeozor *et al.* [23] and Anderson *et al.* [1] have observed that the first generation prefers the spring potato culture, while the second one prefers the corn field as the latter has a greater size. The American researchers generally placed the pheromone traps out of corn fields [3, 6, 8, 11—13, 15, 18]. Our researches have shown that, in the test area, better results were obtained in borer moth management by laying pheromone traps inside the corn field.

II. Relation between capture and damage levels under the environmental conditions of the test area. Besides pheromone tests, we watched the moth emergence curve on biological material collected in the field and kept in a warning cage, and also the biology of the species under the climatic conditions of 1987 (Fig. 5). In September we established the attack frequency and intensity on the experimental plots, recording a frequency (F) of 54.5% and an intensity (I) of 1.79 larvae plant. The result was an attack degree of 9.75%. With a transformation coefficient of 0.5, a loss degree of 4.88% was calculated.

Estimating the corn yield to 8,000 kg/ha, it results that the European corn borer attack caused a yield loss of 390 kg ha.

Considering the best variant (N_2) for the attractivity period (D.M. (3+4), Table 2), the above-calculated loss in production corresponds to a 4.29 males trap night level of pheromone catches.

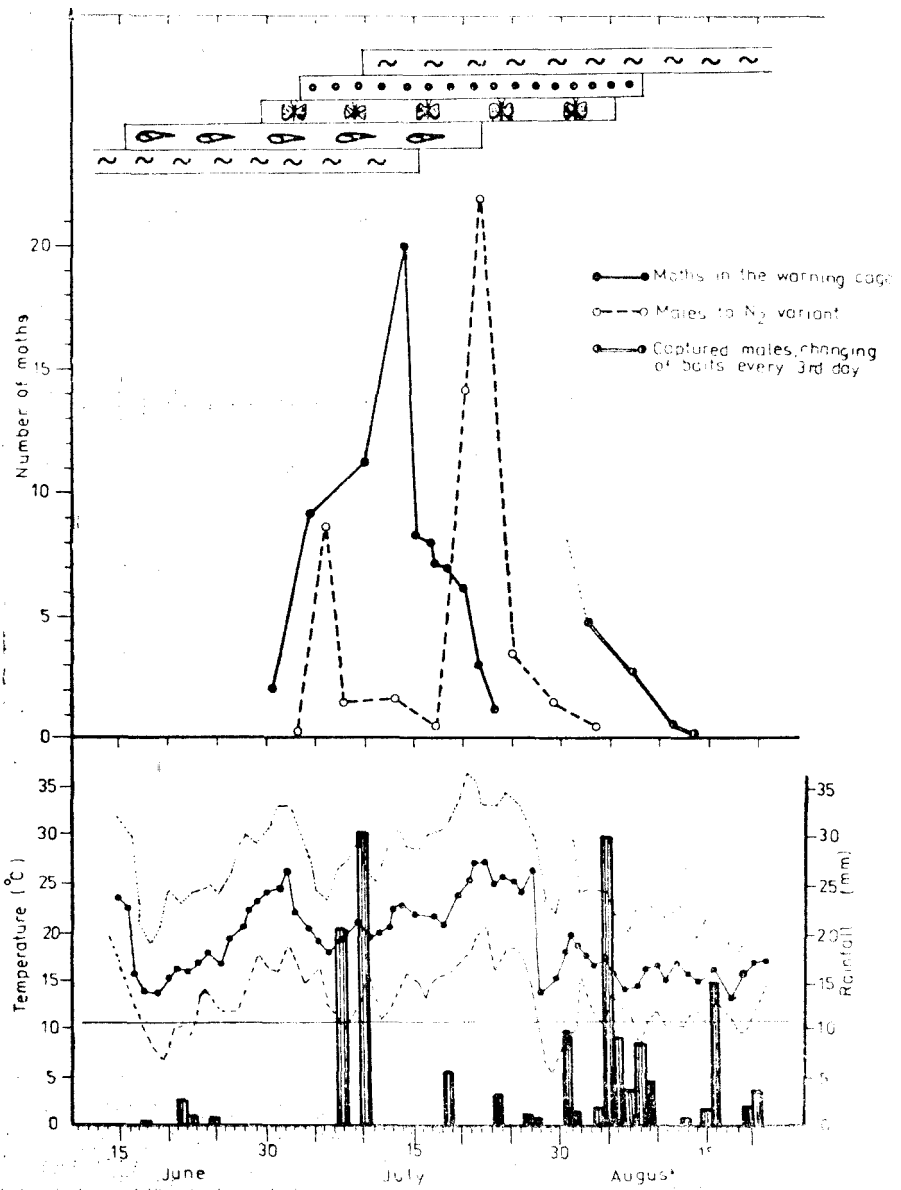

Fig. 5. *Bioclimogram of* Ostrinia nubilalis *developing under the conditions of 1987 and the emergence curves in a warning cage and in field in the* N_2 *pheromone variant.*

Our results agree with those of U m e o z o r *et al.* [24] who found a yield loss of 4.1-54.3% on corn plots in Eastern North Carolina, and showed that each borer hole brought about a yield loss of 102.72—465.79 kg/ha. These data were established by plant analysis in field, whereas our

results show the relation between pheromone catches and the subsequent yield loss, an easy and warning way of estimating the potential loss in production that European corn borer can cause.

Conclusions. In the Cluj-Napoca area (North-Western Romania), the European corn borer belongs to the Z strain (responsive to 97:3 Z:E11—14:Ac) which has a wide spread in Europe and North America. There are no statistical differences when the two basic compounds of the pheromone are placed both on the same support and on distinct ones. The best pheromone dose was 50 μg, determining the capture of the largest number of *O. nubilialis* males; the catches with this dose differed significantly from those obtained with the 500 μg dose.

The efficacy of pheromone baits was short (lasted only 3—4 days) which is in agreement with literature data. The possibility that the natural pheromone may quickly lose its efficacy as an adaptive reaction of the species, selected in order to avoid self disorientation, is suggested.

Tetradecyl acetate (14:Ac), a crude pheromone compound, showed no effect on the number of males captured.

E9-Tetradecenyl acetate (E9—14:Ac), also a crude pheromone compound, exhibited an inhibitory effect on capture of males.

11-Tetradecinyl acetate (11—14:Ac), indicated as an inhibitor, did not show any significant level of inhibition when used in the ratio tested by us.

A good specificity was recorded for the variants with 97:3 Z/E phenomone isomer ratio.

Catch number increases from low size plants to corn plants and inside the corn field. This reveals the role of the corn fields as a place of sex activity and egg-laying for *O. nubilalis*.

The size of pheromone captures in *O. nubilalis* is related to subsequent damages. This relation may be very useful in taking warning decision for the treatments.

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EVIDENCING OF A SEX ATTRACTANT BY A SCREENING TEST IN *EUXOA HASTIFERA* DONZEL *(LEPIDOPTERA: NOCTUIDAE : NOCTUINAE)*

IOAN COROIU* and LÁSZLO RÁKOSY**

SUMMARY. — The presence of the species *Euxoa hastifera* Donzel in the Romanian fauna was established by means of sex attractants. The males were attracted by a mixture of Z5-decenyl acetate and Z7-dodecenyl acetate. These substances were not attractive when tested alone. The attractivity was higher with the increase in the dose of Z5-decenyl acetate up to 25 μg; the presence of Z7-dodecenyl acetate in the mixture was compulsory, but no correlation could be found between its partial dose and the attractivity of mixture. The specificity of the compounds tested was influenced by the sometimes large capture of males belonging to other Noctuid species, such as *Agrotis segetum* Den. et Schiff., *Emmelia trabealis* Scop., *Autographa gamma* L., etc. Under the conditions of the Transylvanian Plateau, the only flight period of *E. hastifera* males in a year has been found to cover about a month, starting with the last decade of August.

During the field experiments of 1985, when the attractivity of certain synthetic sex pheromone variants was tested for *Agrotis segetum* males [3], a relatively large number of *Euxoa hastifera* males was also captured in the traps. Those results showed that the latter males were attracted by Z5-decenyl acetate (Z5-10:Ac) and or Z7-dodecenyl acetate (Z7-12:Ac), while Z9-dodecenyl acetate (Z9-12:Ac) proved to be inhibitory.

The frequency of *E. hastifera* is extremely low [4] and so far there have not been any doubtless recordings in the Romanian fauna [8]; neither have there been literature data on the composition of its specific sex pheromone or sex attractant. We, therefore, undertook our researches on the sex attractant of this species.

The present paper deals with the attractivity and specificity of certain compounds for *E. hastifera* males, the optimum attractive dose and the dynamics of male flight under the conditions of the Transylvanian Plateau (Romania).

Material and methods. Experiments were carried out by a screening test in a vegetable area neighbouring Cluj-Napoca, between 1986—1987. The substances tested, alone or combined, were Z5-10:Ac, Z7-12:Ac and Z9-14:Ac (Table 1). The compounds used in the 9 experimental variants have been synthetized by the Institute of Chemistry in Cluj-Napoca. The compounds were charged on penicillin-bottle rubber stoppers in modified sticky Montedison traps [10]. The traps were set at 80—100 m from one another and 100—120 cm above the ground. Data were recorded once every 3—6 days.

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Table 1

Composition and doses of synthetic sex attractants used for capturing Euxoa hastifera **males in 1986 and 1987**

Variants	Year of testing	Compounds (μg)			Total dose (μg)
		Z5—10 : Ac	Z7—12 : Ac	Z9—14 : Ac	
E	1986	17	—	—	17
B	1986	17	8	—	25
B_1	1986	34	16	—	50
B_2	1986	8	17	—	25
B_3	1986, 1987	25	125	—	150
B_4	1986	50	50	—	100
U	1986	—	50	50	100
V	1987	—	125	—	125
U_1	1987	—	125	50	175

The 1985 results [3] showed that *E. hastifera* is a monovoltine species and its males have a short flight period (about a month), with a maximum in the first decade of September (Fig. 1). This is why the experiments of 1986 and 1987 were carried out only in September.

Results and discussion. The variants with synthetic sex attractants tested in 1986 contained Z5-10:Ac alone, Z5-10:Ac mixed with Z7-12:Ac in several doses and ratios, and Z7-12:Ac mixed with Z9-14:Ac (Table 1). The compounds were mixed according to the results obtained in 1985 [3].

In variant B_1, in which the partial doses of Z5-10:Ac and Z7-12:Ac of variant B were doubled, the number of *E. hastifera* males captured significantly increased (17 in B_1, as compared to 9 in B) (Table 2). On the other hand, the reversed proportion between the compounds of va-

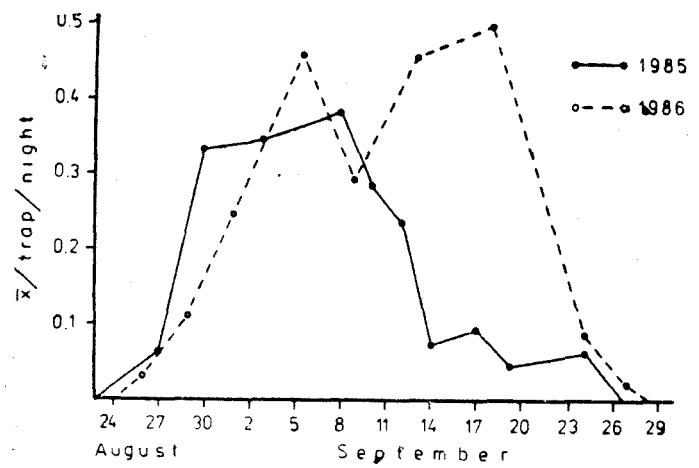

Fig. 1. *Period and dynamics of the flight of* Euxoa hastifera *males in 1985 and 1986 (Cluj-Napoca, Romania).*

Table 2

Captures of Euxoa hastifera **males and specificity of variants tested in 1986** (September, 1—24; 3 traps/variant)

Species	Variants						
	E	B	B_1	B_2	B_3	B_4	U
Euxoa hastifera	—	9	17	2	23	21	4
Agrotis segetum	—	26	20	23	21	19	46
Mamestra suasa (dissimilis)	—	1♀	1♀	—	—	—	1♀
Noctua pronuba	—	1♀	—	1♀	1♀	—	1♀
Caradrina clavipalpis	—	—	—	1	2	—	—
Emmelia trabealis	18	1	4	—	2	25	—
Specificity %*	—	25.0	41.5	7.7	47.9	32.3	8.0

* In calculation of specificity, only the number of captured males has been taken into consideration.

riant B (marked as variant B_2) obviously diminished the captures. The maximum number of *E. hastifera* males was recorded in traps of variants B_3 and B_4, where the partial dose of each compound exceeded 25 μg (excepting Z5-10:Ac, the partial dose of which in variant B_3 was equal to 25 μg). Z5-10:Ac tested alone (variant E) proved to be completely inefficient, although its dose (17 μg) was identical with the partial dose used in variant B. The mixture of Z7-12:Ac and Z9-14:Ac (variant U) was attractive but less males were captured than in the efficient variants.

The researches carried out in 1987 used variant B_3 (the most attractive variant in 1986) as standard in testing variant V and U_1 (Z7-12:Ac alone and mixed with Z9-14:Ac, respectively) (Table 1). This time, in variant B_3 19 *E. hastifera* males were captured, while variants V and U_1 were completely inefficient (Table 3).

The experiments allow the conclusion that neither of the compounds (Z5-10:Ac and Z7-12:Ac) tested separately was attractive for *E. hastifera* males. Their mixture was found to be more and more attractive with

Table 3

Captures of Euxoa hastifera **males and specificity of variants tested in 1987** (September, 2—26; 4 traps/variant)

Species	Variants		
	B_3	U_1	V
Euxoa hastifera	19	—	—
Agrotis segetum	187	1	1
Emmelia trabealis	348	—	—
Autographa gamma	3	421	358
Noctua orbona	—	2	1
Caradrina clavipalpis	—	—	3
Specificity %	3.4	—	—

the increase in the partial dose of Z5-10:Ac to about 25 μg; above this limit, the attractivity slightly decreased. The presence of Z7-12:Ac in mixtures is compulsory, but no clear-cut correlation could be found between its partial dose and the attractivity of the mixture. The fact that only 4 males were captured in variant U in 1986 (Z7-12:Ac + Z9-14:Ac) suggests that the sex attractants in *E. hastifera* may be more complex from a chemical point of view.

Specificity was influenced in these variants by the sometimes large capture of other Noctuid species that are sensitive to the sex pheromone or attractant complex containing the three compounds tested. It is also worth considering that *E. hastifera* is very rare in this zone and, consequently, the number of males captured was smaller than in the case of some other species.

The large number of *Agrotis segetum* males captured in most variants was due to the fact that all the three compounds tested on *E. hastifera* also belong to the pheromone system of the former species [1, 2, 11]. The presence of *Emmelia trabealis* males in traps with Z5-10:Ac confirms that this compound is the sex attractant of this species [6], its minimum atttractive dose being 17 μg. Z7-12:Ac is the only sex attractant for *Autographa gamma* males that has been identified so far [5], and our findings support this idea; we have also noticed the highly inhibitory effect of Z5-10:Ac on Z7-12:Ac in attracting the males of this species. Few males of *Noctua orbona* and *Caradrina clavipalpis* were recorded, but Z7-12:Ac has been found to atttract both these species (I. Coroiu — unpublished data). An extremely low number of Noctuid females was also recorded, a phenomenon also observed in previous experiments [9], probably due to the impurity of compounds [7].

In *E. hastifera,* the total number of males captured was small, but enabled us to estimate flight dynamics for 1985 and 1986, by summing up the results of the most attractive variants. Thus, the flight curve in 1985 was established according to variants B, C and D [3], when 129 *E. hastifera* males were captured while variants B_3 and B_4 (Table 2) were used for the curve in 1986. The data recorded in 1987 were not processed, as the number of males captured was too small. The flight period for males was estimated to be short (about a month), from the last decade of August till the second part of September (between 27.08—24.09. in 1985 and 26.08—27.09 in 1986) (Fig. 1). The flight periods of the two years studied overlap almost perfectly and display a similar pattern of curves.

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STUDIA UNIV. BABEŞ—BOLYAI, BIOLOGIA, XXXIII, 2, 1988

THE EFFECTS OF $HgCl_2$ ON THE AGGRESIVE BEHAVIOUR OF *BETTA SPLENDENS*

JOZSEF HALLER*

SUMMARY. — An aggressivity test was used to evaluate the behavioural effects of a toxicant on fish. The effects of 1 ppm concentration of $HgCl_2$ on *Betta splendens* were more drastic than those of a 2-week inanition. The far-reaching consequences that the behavioural modifications may have for the species are discussed. The adequacy of *Betta splendens* and of the described test for rapid evaluation of mercury pollution of waters is stressed.

Mercury is a general toxicant. In fish it causes severe alterations in gill morphology and function [9] and damages also the accessory respiratory organs [11]. It was shown that mercury modifies protein and carbohydrate metabolism of the tissues, and it has also hormonal effects [4]. These changes occurred in mercury poisoning affect the behaviour of animals. Mercury vapours have an inhibitory effect on conditioned avoidance response in rats [7].

The present experiment tested the behavioural effects of $HgCl_2$ (1 ppm) in a short-term (1 hour) static test in *Betta splendens* as well as the sensitivity of the used behavioural test.

Materials and methods. Young male *Betta splendens* (mean weight 922 ± 83 mg) served as test animals. The fishes were kept in small tanks of 0.5 liter water volume; the temperature of the water was 22—24°C; the water was cleaned periodically.

The aggressive behaviour of the fishes was evaluated according to the mirror test described in [1]. The following parameters were determined: the latency period (*i.e.* the time elapsed between the appearance of mirror image to the start of the aggressive activity); the duration of the first aggressive encounter; the duration of the strongest display pattern (erection of the gill covers doubled by the bending of the caudal fin). Measurements were done once every second day to avoid the appearance of habituation.

Measurements performed with 12 animals during 8 days gave the control values. Thereafter, the animals were divided into two groups. Six of the 12 fishes were submitted to the action of $HgCl_2$; 100 ml water from the tanks was removed, and 100 ml $HgCl_2$ solution was added so that the final concentration of $HgCl_2$ in the tanks reached 1 ppm. The remaining 6 fishes were submitted to a 2-week inanition. In the first case the behavioural test was performed after an hour, in the second case after the inanition period.

Mean values and standard errors were calculated for each parameter. The statistical significance of differences between mean values was calculated according to the Fischer test.

Results and discussion. The effects of the $HgCl_2$ treatment and of the inanition are presented in Table 1.

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Table 1

Behavioural effects of a 2 week inanition and those of a 1 ppm $HgCl_2$ solution in *Betta splendens* (mirror test)

Parameters	Control	Experimental groups	
		Intoxicated	Inanitiated
Latency period	18.2 ± 1.8 (48)	437 ± 46** (16)	10.2 ± 3.9* (6)
Duration of the first encounter	94.8 ± 10.7 (48)	5.2 ± 3.5** (6)	44.1 ± 4.2* (6)
Duration of the strongest display pattern	44.1 ± 4.9 (48)	—	38.2 ± 4.2 (6)

Values (mean ± SE) are given in seconds.

* — Significant difference at $p < 0.025$. ** — Significant difference at $p < 0.005$. The number of determinations is given in brackets.

In the group submitted to the action of $HgCl_2$ (at 1 ppm concentration for one hour at 22°C) we noticed an approximately 23-fold increase of the latency period, an approximately 18-fold shortening of the first aggressive encounter and a total lack of the strongest display pattern.

The inanition caused a shortening of latency time and of the first aggressive encounter. The differences are statistically significant; the duration of the first aggressive encounter as well as the latency period are approximately twice as smaller in the inanitiated group than in the control.

The inanition was not very severe for fish. Generally, fish can survive even after an inanition of several years [10]. The reduction of the aggressive encounter period could be due to the insufficiency of energy reserves. The correlation between energy metabolism and aggressive behaviour in *Betta splendens* has been shown in [6]. Shortening of the latency period could be a logical effect of inanition, since it is known that the aggressivity in *Betta splendens* is related to territorial behaviour [3, 5]; territorial aggression could be enhanced by diminishing resources.

The applied dose of $HgCl_2$ was larger than LC_{50} values of several species, these being lower than 1 ppm [2, 9] (we have not found LC_{50} values of $HgCl_2$ for *Betta splendens* in the literature), but exposure time was much shorter than that of the known LC_{50} values; it seems plausible that the intoxication of the experimental fishes was not severe. However, the effects caused by the 1 ppm $HgCl_2$ were much more drastic than the effects of the 2-week inanition.

The constancy of the results of behavioural measurements was high enough to consider that the test used is suitable for experimental analyses. The sensitivity of the test proved to be high; the behavioural effects procentually were stronger than the biochemical effects noticed in [4], when using identical $HgCl_2$ concentration and exposure time. Wether our behavioural test is appliable in the case of other heavy metal pollutants will be the subject of further research; we mention that it was

shown in the literature that fishes are very sensitive to heavy metals and they could become test animals for such kind of water pollution [8].

Our results also show that a non-lethal concentration of heavy metal pollutant may cause severe behavioural alterations. The modification of behaviour can affect the fish reproductive capacity (in our case the aggressivity of male *Bettas* is related to the defence of eggs and fry). Thus, a species may disappear from an area, not because the individuals are killed but due to modifications in their behaviour. We think that this possibility must be considered, when the permissible levels of some pollutants are calculated.

Conclusion. The concentration of 1 ppm of $HgCl_2$ causes severe alterations in the behaviour of *Betta splendens*. These alterations in the behaviour could affect the reproductive capacity of the species. The used behavioural test gives sufficiently constant results, and it is sufficiently sensitive to be suitable for experimental work.

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STUDIA UNIV. BABEŞ—BOLYAI, BIOLOGIA, XXXIII, 2, 1988

VERTEILUNG VON AMPHIBIEN UND REPTILIEN AUF HÖHENZONEN IM RETEZAT—GEBIRGE

IOAN GHIRA* und BOGDAN STUGREN**

SUMMARY. — Distribution of Amphibians and Reptiles on Altitudinal Zones in the Retezat Mountains. As it results from the study of material collected in 1987, the herpetological fauna of the Retezat Mountains is composed of 5 species of amphibians and 8 species of reptiles. Two new species for this mountainous massif are recorded here, namely *Bufo bufo* and *Lacerta agilis*. The Yellow-Bellied-Toad (*Bombina variegata*) reaches in the Retezat its highest altitudinal point in the Carpathian Ridge, of 1 870 m above sea level. The herpetofauna comprises only two typical stenozonal species (*L. vivipara* at the timberline, and *Natrix natrix* in the lowlands). Euryzonal are only *Bombina variegata*, *Rana temporaria* and *Anguis fragilis*.

An der oberen Waldgrenze wurden im Retezat-Gebirge bisher 3 Amphibien- und 2 Reptilienarten nachgewiesen [17]. Für die Herpetofauna der niedrigen Höhenlagen sind Literaturangaben spärlich [5, 6] und meistens nur als „Retezat-Gebirge" vermerkt, so daß man daraus keine Verteilungsliste auf Höhenzonen zusammenstellen kann.

Auf Grund des vom 1. Autor im Jahre 1987 gesammelten Materials, das im Kreismuseum Deva aufbewahrt ist, wird hier der Versuch getan die fehlende Verteilungsliste der Herpetofauna auf Höhenzonen für das Retezat aufzustellen. Das Material wurde auch nach der in der Herpetologie üblichen Technik [20] abgemessen.

Ergebnisse. Die Artenliste für das gesamte Retezat umfaßt 5 Amphibien und 8 Reptilien. Dazu gehören von den **Amphibien:** 1. *Triturus alpestris* (Laur.); 2. *Tr. vulgaris* (L.); 3. *Bombina variegata* (L.); 4. *Bufo bufo* (L.); 5. *Rana temporaria* L. **Reptilien** umfassen 4 Echsen und 4 Schlangen, nämlich: 6. *Lacerta agilis* L.; 7. *L. vivipara* Jacquin; 8. *Podarcis muralis* (Laur.); 9. *Anguis fragilis L.;* 10. *Elaphes longissima* (Laur.); 11. *Natrix natrix* (L.); 12. *Vipera ammodytes* (L.); 13. *V. berus* (L.).

Bei der Beschreibung der Arten wird auch die Gesamtbiomasse (GB) jeder Population, sowie die Standortbelastung (SB), auf eine Fläche von 250 m^2 bezogen, angeführt.

Triturus alpestris (Laur.). Wie schon früher mitgeteilt [17], steigt im Retezat-Gebirge die Häufigkeit des Alpenmolches mit der Höhenlage an. Im Juni 1987 fanden wir nördlich der Gebirgswiese „Cîmpu lui Neag" innerhalb der Nadelwaldstufe, auf dem Kalksteingelände, bei 1 000 m ü. M. nur 1 Exemplar. Jedoch oberhalb der Waldgrenze, im Bereich der Alpenmatte „Şaua Plaiu Mic", auf Granodiorit-Substrat wurden

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Tabelle 1

Körperpropertionen des Alpenmolches (Triturus alpestris (Laur.)) und des Teichmolches (Tr. vulgaris (L.)) aus dem Retezat-Gebirge L. = Longitudo (Körper-Länge), L. cd. = Longitudo caudae (Schwanz-Länge) (alle Masse in mm).

Spezies	Fundort	L.	L. cd.
Tr. alpestris	Cimpu lui Neag	78	32
„ „	Şaua Plaiu Mic	90	41,5
„ „	„ „ „	99	40
„ „	„ „ „	95	40
„ „	„ „ „	93	39,5
„ „	„ „ „	88	39
„ „	„ „ „	93	42
Tr. vulgaris ♂♂	Cimpu lui Neag	83	41
„ „	„ „ „	76	36
„ „	„ „ „	90	50
„ „	„ „ „	71,6	35,6
„ „	„ „ „	71	35
„ „	„ „ „	68,5	32
„ „	„ „ „	66	31
Tr. vulgaris ♀♀	„ „ „	73	36
„ „	„ „ „	69	31
„ „	„ „ „	68	31
„ „	„ „ „	68	31
„ „	„ „ „	66	29
„ „	„ „ „	64	28
„ „	„ „ „	63	28
„ „	„ „ „	66	30
„ „	„ „ „	66	31

im Juni 1987 insgesamt 16 Stücke erbeutet (Tabelle 1), mit einer GB= 26,7 g und SB = 0,10 $g.m^{-2}$.

Bombina variegata (L.). Wir fanden din Gelbbauchunke sowohl oberhalb der Waldgrenze, als auch in der Nadelwaldstufe. Auf der Alpenmatte „Şaua Plaiu Mic", erreicht die Spezies (Reihe von 7 ♂♂, Tabelle 2) ihre höchste Höhenlage bei 1 870 m ü. M. im Retezat und wohl auch im ganzen rumänischen Sektor des Karpatenbogens. Aus dem westlichen Teil der Ukraine wird die Gelbbauchunke bei 1900 m ü.M. gemeldet [14]. Der von uns früher mitgeteile Fundort oberhalb der Waldgrenze [17] liegt erheblicher niedrig, bei 1 650—1 700 m ü. M. Die uns vorliegende Reihe wird durch GB = 33,6 g und SB = 0,13 $g.m^{-2}$ charakterisiert. In der Nadelwaldstufe fanden wir die Gelbbauchunke bei den Klausen „Cheile Butei" auf Kalkstein, bei 1 000 m ü. M. (GB = 58,6 g; SB = 0,23 $g.m^{-2}$).

Bufo bufo (L.). Die Erdkröte wurde bisher aus dem Retezat nicht gemeldet. Wir besitzen 2 Exemplare (Tabelle 2) von den Klausen „Cheile Butei" bei 1 000 m. ü. M., im Juni 1987 gesammelt (GB = 183,6 g; SB = 0,73 $g.m^{-2}$).

Rana temporaria L. Der Grasfrosch ist im Retezat sowohl im Hochgebirge als auch in der Nadelwaldstufe zu Hause. Unser Material (Tabelle 3) stammt aus mehreren Fundorten. Oberhalb der Waldgrenze fanden wir den Grasfrosch auf dem Kalksteingelände bei 1 900—2 000 m ü. M. (GB = 175,6 g; SB = 0,70 $g.m^{-2}$), aber auch auf Granodiorit-Substrat im Bereich des Nationalparks Retezat, bei 1 950—2 000 m ü. M. (GB = 68,35 g; SB = 0,27 $g.m^{-2}$). In der Nadelwaldstufe kommt der Grasfrosch nur auf Kalksteingelände vor bei den Klausen „Cheile Butei" bei 1 000 m ü. M. (nur 1 Stück) und bei „Cimpusel" bei 1 100 m ü. M. (6 ♂♂ und 1♀; GB = 202 g; SB = 0,80 $g.m^{-2}$).

Lacerta agilis L. Die Zauneidechse ist kein Gebirgstier. Die Art kann aber auch in höher gelegenen Lagen vorkommen. Aus dem Retezat wurde sie bisher nicht gemeldet. Die Art wurde aber unweit des Retezats, im Tal des westlichen Jiu-Flusses bei Vulcan gefunden [6]. Unser Material, bloß 3 ♀♀ und 1 Jungtier, stammt aus der Nadelwaldstufe (Tabelle 4; GB = 47,3 g; SB = 0,18 $g.m^{-2}$) Steinbruch „Păroasa" auf Kalksteingelände, bei 1 000—1 100 m ü. M.

Tabelle 2

Körperproportionen der Gelbbauchunke (Bombina variegata (L.)) **und der Erdkröte** (Bufo bufo (L.)) **aus dem Retezat-Gebirge** KRL – Kopf + Rumpf – Länge. F. – Femur – Länge. T. – Tibia – Länge (alle Masse in mm).

Spezies	Fundort	KRL	F.	T.
Bombina variegata ♂♂	Şaua Plaiu Mic	41	17	16,5
,, ,,	,, ,, ,,	32,5	17	15,5
,, ,,	,, ,, ,,	39	18,5	17
,, ,,	,, ,, ,,	40	18	17
,, ,,	,, ,, ,,	40	14,5	15
,, ,,	,, ,, ,,	38	15	16,5
,, ,,	,, ,, ,,	39	17	16
Bombina variegata ♂♂	Cheile Butei	44	15,5	17
,, ,,	,, ,,	44	17	18
,, ,,	,, ,,	41	14	15
,, ,,	,, ,,	40,5	16,5	16
,, ,,	,, ,,	40	17	16
Bombina variegata ♀♀	,, ,,	45,5	16	15,5
,, ,,	,, ,,	39	14	15,5
,, ,,	,, ,,	42	13,5	16
,, ,,	,, ,,	43,5	16	16
Bufo bufo	Cheile Butei	91	33	33
,, ,,	,, ,,	74	37	32

Lacerta vivipara Jacquin. Im Retezat haben wir die Bergeidechse nur im Hochgebirge gefunden, nie aber in der Nadelwaldstufe. In aderen Gebirgszügen der Karpaten kommt die Spezies auch in niedrigen Höhen-

Tabelle 3

Körperproportionen des Grasfrosches (Rana temporaria **L.**) **aus dem Retezat-Gebirge** (Erklärungen s. Tabelle 2)

Fundort	KRL	F.	T.
Oberhalb von Şaua Plaiu Mic	75	38	41
,, ,, ,, ,, ,,	64	32	33
,, ,, ,, ,, ,,	71	35	37
,, ,, ,, ,, ,,	61	32	37
,, ,, ,, ,, ,,	60	30	32
,, ,, ,, ,, ,,	49	26	28
Cheile Butei	49,5	25	27
Wissenschaftliches Reservat Retezat	52	23	30
,, ,, ,,	63	30	30,5
,, ,, ,,	65,5	32	33
Cimpuşel	70,5	35	37,5
,,	69,5	39,5	42
,,	66	33,5	36,5
,,	72	37	40
,,	75	35,5	39,5
,,	73,5	37	40

lagen vor [15]. Hier wird ein Material vorgelegt (Tabelle 4), das aus dem Hochgebirge stammt und zwar aus dem Kamm des Kalksteingeländes, zwischen der „Piatra Iorgovanului" und dem Berg „Albele", bei 1 800—2 000 m ü. M., im Juli 1987 (GB = 19,2 g; SB = 0,07 $g.m^{-2}$) gesammelt.

Podarcis muralis (Laur.). Aus dem Retezat schon mehrmals aus niedrigen Höhenlagen gemeldet [16, 18], erreicht die Mauereidechse hier die Nadelwaldstufe bei den Klausen „Cheile Butei" (Tabelle 4; GB = 24,5 g; SB = 0,10 $g.m^{-2}$). Aus den Verbreitungsangaben dieser Art in Rumänien [6] geht hervor, daß sie im Karpatenbogen im Hügellande und in mittleren Gebirgshöhen vorkommt. In Jugoslawien [11] erreicht *P. muralis* die obere Baumgrenze, in den Pyrenäen sogar die Höhenlage von 2 700 m ü. M. [8].

Tabelle 4

Körperproportionen der Eidechsen aus dem Retezat-Gebirge KRL— Kopf + Rumpf-Länge. Cd. — Longitudo caudae (Schwanzlänge). L. p. — Longitudo pilei (Pileus-Länge) (alle Masse in mm). * — regenerierter Schwanz.

Spezies	Fundort	KRL	Cd.	L. p.
Lacerta agilis	Cîmpu lui Neag	88	127	18,5
,, ,,	,, ,, ,,	80	103	17,5
,, ,,	,, ,, ,,	72	63*	16
,, ,,	,, ,, ,,	45	67	11,5
L. vivipara	Şaua Plaiu Mic	60	51*	11
,, ,,	,, ,, ,,	58	52*	11
,, ,,	,, ,, ,,	54	47*	10
,, ,,	,, ,, ,,	50	83	10
,, ,,	,, ,, ,,	51	31*	10
,, ,,	,, ,, ,,	50	63	10,5
Podarcis muralis ♂♂	Cheile Butei	60	—	16
,, ,,	,, ,,	53	109	12
,, ,,	,, ,,	53	—	14
Podarcis muralis ♀♀	,, ,,	61	103	13
,, ,,	,, ,,	60	75	14
Podarcis muralis juv.	,, ,,	45	76	11

Anguis fragilis L. Die Blindschleiche erreicht im Retezat die untere Stufe der Koniferenzone, wo sich Fichten mit Buchen vermengen, so bei „Cîmpuşel" in etwa 1 100 m ü. M. (1♂) und auch bei den Klausen „Cheile Butei" (2♀♀ ; GB = 38,85 g; SB = 0,15 $g.m^{-2}$). Wir besitzen aber auch 1 ♂, das aus dem Hochgebirge, von 1 900 m ü. M. oberhalb von „Şaua Plaiu Mic" stammt (Tabelle 5). Somit ist bewiesen worden, daß die Blindschleiche im Retezat-Gebirge stellenweise die obere Waldgrenze überragt.

Für das Retezat ist *A. fragilis* ohne nähere Fundortangabe gemeldet worden [4]. Die Spezies soll in Rumänien im Allgemeinen in Hügel- und Gebirgslandschaften vorkommen [6], wobei keine genaue Höhenlagen angegeben sind. Aus anderen Gebirgszügen ist die Blindschleiche aus Höhenlagen bekannt, welche die 1 000 m ü. M.-Linie überragen: in

Tabelle 5

Körperproportionen der Blindschleiche (Anguis fragilis **L.) aus dem Retezat-Gebirge**

Erklärungen s. Tabelle 4. Sq. – Squamae (Anzahl der Querreihen der Schuppen um die Körpermitte) (alle Masse in mm).

Fundort	Geschlecht	KRL	Cd.	Sq.
Oberhalb von Şaua Plaiu Mic	♀	129	104	31
Bei Cimpuşel	♂	159	104	28
Cheile Butei	♀	124	150	29
,, ,,	♀	102	100	30

Nordanatolien bei 1 350 m ü. M. [13], auf dem Kaukasus an der oberen Waldgrenze und in den alpinen Matten [2]. In den Waldkarpaten (UdSSR) bewohnt die Blindschleiche alle Höhenzonen, von den Tieflandseichenwäldern bis zu dem Krummholz [19]. In Österreich wird die Blindschleiche auch in einer Höhe von 2 400 m ü. M. angetroffen [7]. Was die Rassenangehörigkeit der Blindschleiche aus dem Retezat betrifft, so kann man unser Material, auf Grund der hohen Anzahl der Schuppenreihen (29—31) in die Unterart *A. fragilis colchicus* Nordm. einreihen. Übrigens, gehören die Südkarpaten zu dem Verbreitungsgebiet der Unterart *colchicus* [16].

Es wurde aber hervorgehoben, daß trotz der Verschiedenheit der Lebensstätten in denen die Spezies vorkommt, kein Zusammenhang zwischen den Umweltbedingungen und den morphologischen Merkmalen der Blindschleiche besteht [3].

Elaphe longissima (Laur.). Die Äskulapnatter wurde aus mehreren Fundorten des Retezat-Gebirges gemeldet [1, 12, 18]. Der hier mitgeteilte Fundort, der Punkt „Casa Verde", liegt im Tal des Riul Mare, außerhalb des Retezat-Nationalparks, jedoch innerhalb der Grenzen des Retezat-Gebirges. Die Höhenlage ist niedrig (800 m ü. M.), das Substrat — Kristalline Schiefer. Wir besitzen davon 2 Exemplare (Tabelle 6), 1♂ und 1♀ von 496,5 g und bzw. 360,5 g. Daraus folgt SB = 3,82 $g.m^{-2}$.

Tabelle 6

Körperproportionen der Schlangen aus dem Retezat-Gebirge

Erklärungen s. Tabelle 4 (alle Masse in mm).

Spezies	Fundort	KRL	Cd.
Elaphe longissima ♂	Casa Verde	1 070	220
Elaphe longissima ♀	,, ,,	945	185
Natrix natrix	Cheile Butei	235	47
,, ,,	,, ,,	242	45
,, ,,	,, ,,	405	78
,, ,,	,, ,,	460	98
Vipera ammodytes ♀	Cheile Cernişoarei	685	56

Natrix natrix (L.). Unsere Ringelnattern, insgesamt 4 Stücke, wurden bei den hier schon oft erwähnten „Cheile Butei" im Juni 1987 gesammelt (GB = 41,3 g; SB = 0,16 g.m^{-2}).

Vipera ammodytes (L.). Die Sandotter wurde aus mehreren Fundorten des Retezats gemeldet [6]. Wir besitzen nur 1 ♀ von 118,65 g (Tabelle 6), das von den Klausen „Cheile Cernișoarei" stammt (im Oktober 1987 gesammelt).

Vipera berus (L.). Die Kreuzotter, wie schon bekannt [17], ist im Retezat keine seltene Schlange. Wir teilen hier einen weiteren Fundort mit, oberhalb der Waldgrenze, im Kalksteingelände, zwischen „Șaua Piatu Mic" und der Schutzhütte „Cabana Buta", bei 1 800—2 000 m ü. M., wo wir im September 1987 nur 2 Jungtiere erbeutet haben.

Diskussion. In der hier veröffentlichten Artenliste der Herpetofauna aus dem Retezat-Gebirge, fehlt nur eine, in der Literatur [6] erwähnte Art, welche von uns nicht gefunden wurde: die Glattnatter (*Coronella austriaca* Laur.). Diese Species wird im Allgemeinen für das Retezat, ohne genaue Fundortangabe, angeführt. Ob die Glattnatter im Retezat tatsächlich vorkommt, läßt sich ohne Belegestücken nicht entscheiden.

Die Beziehungen der Herpetofauna zu den Höhenlagen ergibt sich aus der vergleichenden Analyse der Areale, auf Grund der von uns angesammelten Belegestücken. Einige Arten, so z. B. *Triturus vulgaris* und *Elaphe longissima* besiedeln nur niedrige Höhenlagen. Es sind demgemäß stenozonale Formen im Sinne von H o l d h a u s und D e u b e l [10] und H e s s e [9]. *Bufo bufo* erreicht die 1 000 m ü. M.-Linie, mehrere Höhenstufen übergreifend. Dasselbe ist für *Lacerta agilis* und *Podarcis muralis* gültig. Die meisten Arten besiedeln mehrere Höhenlagen. Jedoch nur *Bombina variegata*, *Rana temporaria* und *Anguis fragilis* besiedeln das Retezat von niedrigen Höhenlagen bis in das Hochgebirge oberhalb der Waldgrenze. Nur diese Arten sind streng euryzonal. *Vipera berus* bevorzugt höhere Lagen, indem sie sowohl an das Hochgebirge als auch an die Nadelwaldstufe gebunden ist. Es ist demgemäß keine streng euryzonale, aber auch keine streng stenozonale Form. Streng stenozonal sind hier eigentlich bloß *Lacerta vivipara* für das Hochgebirge und *Natrix natrix* für Tieflandslagen. Merkwürdig scheint uns das Fehlen der Wechselkröte (*Bufo viridis* Laur.). Diese eurytope und euryzonale Art ist sonst in dem Karpatenzug in verschiedenen Höhenlagen anzutreffen [5].

Schlußfolgerungen. Die Herpetofauna des Retezat-Gebirges umfaßt insgesamt 13 Arten (5 Amphibien und 8 Reptilien), von denen bloß 3 Arten, nämlich *Bombina variegata*, *Rana temporaria* und *Anguis fragilis* typisch euryzonale Formen sind, während alle andere Arten an eine oder zwei Höhenstufen gebunden sind. *Lacerta vivipara* und *Natrix natrix* sind aber stenozonale Formen. Ferner melden wir einen Höhenrekord für *B. variegata* im Retezat und in dem Karpatenbogen im Allgemeinen. Als im Retezat neu aufgefundene Arten sind hier *Bufo bufo* und *L. agilis* gemeldet.

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ENZYMOLOGICAL STUDY OF MUDS FROM SALT LAKES IN TURDA (CLUJ DISTRICT)

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SUMMARY. — Twelve salt lakes located within the perimeter of the city of Turda were classified on the ground of 7 enzymatic and nonenzymatic catalytic activities of their muds (phosphatase, catalase, nonenzymatic H_2O_2 — splitting, TTC reduction in nonautoclaved and autoclaved muds without or with glucose addition), in the period May 1986 — September 1987. In all, 86 mud samples were analyzed. The results obtained made possible the classification of the lakes into 3 categories. The first category comprises the Pepenaru and Sulfuros lakes, the muds of which are the most active. Six lakes (Privighetorii, Ştrand, Tarzan, Csiky, Bătrînilor and Durgău) with muds of medium activity form the second category. The third category comprising the Tineretului, Rotund, Marinel and Ocna lakes are characterized by the least active muds.

Enzymatic activities in lake muds and especially in salt lake muds have been studied only to a less extent so far [1, 2, 4, 6, 8]. No enzymological data on the muds of salt lakes located within the perimeter of the city of Turda (Cluj district) are available.

The present paper describes studies carried out with the aim to classify the Turda salt lakes on the ground of the enzymatic and nonenzymatic catalytic activities of their muds.

Material and methods. Twelve salt lakes were studied. Five of them (Durgău, Sulfuros, Ocnei, Marinel and Rotund) belong to the Valea Sărată — Ocnele Vechi zone, while the other 7 (namely, Tarzan, Csiky, Privighetorii, Tineretului, Bătrînilor, Ştrand and Pepenaru) are located in the Băile Romane zone. This zone also comprises an area called Sărătura which is covered by mud but at present lacks a water table.

The data specifying the investigation period and the number of mud samples analyzed are given in Table 1. One can see from this table that 2 to 5 series of mud samples were collected from each lake (one series/season), in the period 6.V.1986 — 1.IX.1987.

Each sample was centrifuged at 4,000 rotations/min for 30 min. The supernatant was discarded. Parts of the sediment were analyzed to determine the following enzymatic activities: phosphatase (hydrolysis of disodium phenylphosphate), catalase (splitting of H_2O_2 into H_2O and O_2) and dehydrogenase (reduction of 2, 3, 5-triphenyltetrazolium chloride, TTC, without or with glucose addition). Other parts of the sedimented mud were inactivated through autoclaving at 120°C for one hour/day in three successive days. The inactivated mud was used to determine its nonenzymatic H_2O_2-splitting and TTC-reducing activities. The methods used for determining enzymatic and nonenzymatic catalytic activities in mud samples are adaptations of the methods of soil enzymology [3, 5, 7]. Dry matter content of sedimented mud was determined through drying at 105°C for 72 hours.

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Table 1

List of the investigated lakes with data concerning the investigation period and number of mud samples analyzed

Zone	Lake	Date of mud sample collection	Number of seasons in which muds were sampled	Number of mud samples analyzed
Valea Sărată — Ocnele Vechi	Durgău	1986 (6.V; 21. VII; 29. X)	3	9
	Sulfuros		3	3
Băile Romane	Tarzan		3	9
	Csiky		3	9
	Privighetorii		3	3
Valea Sărată — Ocnele Vechi	Ocnei	1986 (6. V; 21. VII; 29. X) 1987 (4. V; 15. VII; 1. IX)	4	8
Băile Romane	Tineretului		5	7
	Bătrînilor		5	14
	Ştrand		5	10
Valea Sărată — Ocnele Vechi	Marinel	1987 (4. V; 15. VII; 1. IX)	3	3
	Rotund		3	6
Băile Romane	Pepenaru		3	3
	Sărătura		2	2

Phosphatase activity is expressed as mg phenol/2.5 g mud (dry matter)/24 hours at 37°C, catalase and nonenzymatic H_2O_2-splitting activities as mg H_2O_2/1.5 g mud (dry matter)/one hour at 20°C, and TTC reduction as mg triphenylformazan/0.5 g mud (dry matter)/24 hours at 37°C.

The analytical data were processed statistically. Mean values and variation coefficents of activities as well as the enzymatitc indicator of mud quality were calculated. For establishing the significance of differences the multiple „t" test was used as indicated by S a c h s [9].

Results. Comparison of the 12 Turda lakes and the Sărătura mud was carried out according to 3 criteria: 1. intensity of activities, *i.e.* mean values of the activities of mud samples in the May 1986 — September 1987 period; 2. minimum variability of activities, *i.e.* variation coefficients of the activities of mud samples in the 1986—1987 period, and 3. enzymatic indicator of mud quality in this period.

Comparison of lakes according to the criterion of the intensity of enzymatic and nonenzymatic catalytic activities of their mud samples in the May 1986 — September 1987 period. Mean values of the activities are presented in Table 2, and results of the comparison are summarized in Table 3.

These results prove that, from *enzymological* viewpoint, the most active lakes are Pepenaru and Sulfuros which occupy once or twice the first 3 positions for each of the 4 enzymatic activities studied. They are followed by the Ştrand and Privighetorii lakes, situated on the first 3 positions for two activities (phosphatase and catalase, and TTC reduction

Table 2

Mean values of the enzymatic and nonenzymatic catalytic activities of mud samples in the May 1986 — September 1987 period

Zone	Lake	Phosphatase activity	Catalase activity	Nonenzymatic H_2O_2-splitting	TTC reduction			
					Non-autoclaved mud		Autoclaved mud	
					Without glucose	With glucose	Without glucose	With glucose
Valea Sărată — Ocnele Vechi	Durgău	6.280	31.725	46.854	6.555	7.155	2.560	2.550
	Sulfuros	11.087	94.487	39.884	10.731	22.883	1.454	2.039
	Ocnei	1.715	24.185	21.739	1.107	1.297	0.085	0.139
	Marinel	1.553	36.583	19.335	0.570	1.207	0.050	0.069
	Rotund	1.737	28.510	22.246	1.390	1.685	0.176	0.228
Băile Romane	Tarzan	4.177	37.963	41.619	6.346	6.256	3.342	3.646
	Csiky	8.255	54.183	40.732	6.724	9.437	1.844	1.670
	Privighetorii	3.867	28.271	60.454	9.656	10.586	6.208	5.572
	Tineretului	7.775	40.191	39.718	3.079	3.942	1.311	1.114
	Bătrînilor	6.170	61.029	37.376	6.120	9.936	1.704	1.945
	Ştrand	23.302	69.233	33.848	4.699	3.334	1.726	1.643
	Pepenaru	17.630	98.401	57.046	6.992	18.920	7.579	5.864
	Sărătura	1.284	27.142	35.397	4.112	4.375	1.941	1.440

Table 3

Position of lakes according to the criterion of the intensity of enzymatic and nonenzymatic catalytic activities of mud samples, expressed as mean values, in the May 1986 — September 1987 period

Activity	Position												
	1	2	3	4	5	6	7	8	9	10	11	12	13
ENZYMATIC													
Phosphatase	Ştrand	Pepenaru	Sulfuros	Csiky	Tineretului	Durgău	Bătrînilor	Tarzan	Privighetorii	Rotund	Ocnei	Marinel	Sărătura
Catalase	Pepenaru	Sulfuros	Ştrand	Bătrînilor	Csiky	Tineretului	Tarzan	Marinel	Durgău	Rotund	Privighetorii	Sărătura	Ocnei
TTC reduction in non-autoclaved mud, without glucose	Sulfuros	Privighetorii	Pepenaru	Csiky	Durgău	Tarzan	Bătrînilor	Ştrand	Sărătura	Tineretului	Rotund	Ocnei	Marinel
TTC reduction in non-autoclaved mud, with glucose	Sulfuros	Pepenaru	Privighetorii	Bătrînilor	Csiky	Durgău	Tarzan	Sărătura	Tineretului	Ştrand	Rotund	Ocnei	Marinel
NONENZYMATIC													
H_2O_2-splitting	Privighetorii	Pepenaru	Durgău	Tarzan	Csiky	Sulfuros	Tineretului	Bătrînilor	Sărătura	Ştrand	Rotund	Ocnei	Marinel
TTC reduction in autoclaved mud, without glucose	Pepenaru	Privighetorii	Tarzan	Durgău	Sărătura	Csiky	Ştrand	Bătrînilor	Sulfuros	Tineretului	Rotund	Ocnei	Marinel
TTC reduction in autoclaved mud, with glucose	Pepenaru	Privighetorii	Tarzan	Durgău	Sulfuros	Bătrînilor	Csiky	Ştrand	Sărătura	Tineretului	Rotund	Ocnei	Marinel

without and with glucose, respectively) and on positions 8—11 for the other two activities. The Csiky, Bătrînilor, Tarzan, Durgău and Tineretului lakes are intermediary, occupying positions 4—10 for the 4 activities. The least active muds were sampled from the Sărătura area and the Marinel, Rotund and Ocnei lakes, situated on positions 8—13.

As to the *nonenzymatic catalytic activities,* the Pepenaru, Privighetorii, Tarzan and Durgău lakes are situated on the first 4 positions for each of the 3 nonenzymatic activities studied. The Csiky, Sulfuros, Bătrînilor, Ștrand and Tineretului lakes and the Sărătura mud are intermediary as they occupy positions 5—10. The Rotund, Ocnei and Marinel lakes are the least active (positions 11, 12 and 13).

It should be emphasized that the enzymatically most active lake, Pepenaru, proved to be most active also in respect of the nonenzymatic catalytic activities. Similarly, the Privighetorii lake is active from both viewpoints. The Tarzan and Durgău lakes are enzymatically intermediary but very active if the nonenzymatic catalytic activities are considered. The Sulfuros, Ștrand, Csiky, Bătrînilor and Tineretului lakes show an intermediary potential from both viewpoints. The Sărătura mud and the Rotund, Marinel and Ocnei lakes are the least active also from both points of view.

Comparison of the lakes according to the criterion of the minimum variability of enzymatic and nonenzymatic catalytic activities of their mud samples in the May 1986 — September 1987 period. The variation coefficients, expressed in percentages, are specified in Table 4. Minimum variability of the enzymatic activities in mud samples may be interpreted as maximum stability of the lake from a biological point of view, as the enzymatic activities in mud are related to the life of lake, the enzymes being produced by living organisms.

Results of the comparison of lakes according to the criterion of minimum variability are presented in Table 5. One can deduce from this table that, from *enzymological* viewpoint, the most active is the Tarzan lake, occupying positions 2—4 for each of the 4 activities studied. The Pepenaru and Privighetorii lakes are less stable; they present a special situation as their position is good for some activities (1 or 2 and 1 or 5, respectively) and bad for others (10—12). The Csiky, Rotund, Durgău, Tineretului and Ștrand lakes are of medium stability as they occupy positions 1—9. Least stable are the Bătrînilor, Sulfuros, Marinel and Ocnei lakes, being situated on positions 3—12.

In respect of the *nonenzymatic catalytic activities,* the Privighetorii lake proved to be the most stable, as its position is 1 for each of the 3 nonenzymatic activities determined. The Tarzan and Csiky lakes also manifest a pronounced stability (positions 2—4). Medium stability characterizes the Rotund, Durgău, Sulfuros, Bătrînilor, Tineretului and Ștrand lakes occupying positions 2—10. The least stable lakes are Pepenaru, Marinel and Ocnei, being situated on positions 9—12.

It is evident that the enzymatically most stable lakes, Tarzan and Csiky, are stable also in respect of the nonenzymatic catalytic activities. The Privighetorii lake is of medium stability from enzymatic point of

Table 1

Variation coefficients of the enzymatic and nonenzymatic catalytic activities of mud samples in the May 1986 — September 1987 period (%)

Zone	Lake	Phosphatase activity	Catalase activity	Nonenzymatic H_2O_2-splitting	TTC reduction			
					Non-autoclaved mud		Autoclaved mud	
					Without glucose	With glucose	Without glucose	With glucose
Valea Sărată — Ocnele Vechi	Durgău	45.23	24.67	26.81	46.72	41.23	82.13	74.36
	Sulfuros	47.73	58.83	26.54	55.72	75.23	137.01	125.45
	Ocnei	43.85	30.81	46.51	111.93	112.66	282.95	237.58
	Marinel	25.96	40.60	43.27	99.13	117.12	173.21	173.46
	Rotund	15.54	42.31	16.64	50.95	36.25	136.01	113.25
Băile Romane	Tarzan	30.23	27.85	22.39	42.76	28.91	37.68	41.68
	Csiky	38.77	33.68	25.78	36.16	33.61	50.68	47.01
	Privighetorii	118.11	68.58	1.12	23.82	37.24	25.90	18.08
	Tineretului	38.04	41.84	33.80	54.75	51.77	162.80	158.12
	Bătrînilor	56.43	29.67	38.10	79.99	97.83	129.99	118.78
	Ştrand	31.42	22.66	42.89	74.95	93.46	140.76	132.95
	Pepenaru	17.62	48.05	46.85	100.72	19.96	173.21	153.25

Table 5

Position of lakes according to the minimum variability of the enzymatic and nonenzymatic catalytic activities of mud samples in the May 1986 — September 1987 period

Activity	Position											
	1	2	3	4	5	6	7	8	9	10	11	12
ENZYMATIC												
Phosphatase	Rotund	Pepenaru	Marinel	Tarzan	Ștrand	Tineretului	Csiky	Ocnei	Durgău	Sulfuros	Bătrînilor	Privighetorii
Catalase	Ștrand	Durgău	Tarzan	Bătrînilor	Ocnei	Csiky	Marinel	Tineretului	Rotund	Pepenaru	Sulfuros	Privighetorii
TTC reduction in non-autoclaved mud without glucose	Privighetorii	Csiky	Tarzan	Durgău	Rotund	Tineretului	Sulfuros	Ștrand	Bătrînilor	Marinel	Pepenaru	Ocnei
TTC reduction in non-autoclaved mud, with glucose	Pepenaru	Tarzan	Csiky	Rotund	Privighetorii	Durgău	Tineretului	Sulfuros	Ștrand	Bătrînilor	Ocnei	Marinel
NONENZYMATIC												
H_2O_2-splitting	Privighetorii	Rotund	Tarzan	Csiky	Sulfuros	Durgău	Tineretului	Bătrînilor	Ștrand	Marinel	Ocnei	Pepenaru
TTC reduction in autoclaved mud, without glucose	Privighetorii	Tarzan	Csiky	Durgău	Bătrînilor	Rotund	Sulfuros	Ștrand	Tineretului	Marinel	Ocnei	—
TTC reduction in autoclaved mud, with glucose	Privighetorii	Tarzan	Csiky	Durgău	Rotund	Bătrînilor	Sulfuros	Ștrand	Pepenaru	Tineretului	Marinel	Ocnei

view and very stable if the nonenzymatic activities are considered. The Durgău, Rotund, Tineretului, Sulfuros, Ştrand and Pepenaru lakes are characterized by medium stability from both viewpoints. The lowest stability is a property of the Bătrînilor, Marinel and Ocnei lakes.

Comparison of the lakes according to the criterion of the enzymatic indicator of mud quality. The relative mean values and the enzymatic indicator of mud quality are shown in Table 6, while the results of the comparison of lakes on the ground of the enzymatic indicator of mud quality are presented in Table 7. One can deduce from this table that the most active mud, *i.e.* the mud with the highest values of the enzymatic indicator of mud quality, was sampled from the Pepenaru lake. The next positions are occupied by the muds of the Sulfuros and Privighetorii lakes. The muds of the Ştrand, Tarzan, Csiky, Bătrînilor, Durgău and Tineretului lakes and the Sărătura mud are situated on positions 4—10. The least active muds originated from the Rotund, Marinel and Ocnei lakes (positions 11—13).

The lakes were compared also by taking into account the significance of the differences between the relative mean values of the enzymatic and nonenzymatic catalytic activities in mud samples. The results of this comparison (Fig. 1) show that the Pepenaru lake does not differ significantly from the Sulfuros lake, but it differs significantly from the other lakes. The differences between the Sulfuros lake and the Privighetorii, Ştrand, Tarzan and Csiky lakes are not significant, but the comparison of the Sulfuros lake with the Bătrînilor, Durgău, Tineretului, Rotund, Marinel and Ocnei lakes and the Sărătura area revealed significant differences. No significant differences were found between the Privighetorii lake on one side and the Ştrand, Tarzan, Csiky, Bătrînilor and Durgău lakes, on the other. At the same time, the Privighetorii lake differs significantly from the Tineretului, Rotund, Marinel and Ocnei lakes and the Sărătura area. The Ştrand, Tarzan, Csiky, Bătrînilor and Durgău lakes are not significantly different, but they differ significantly from the Rotund, Marinel and Ocnei lakes. The Tineretului, Rotund, Marinel and Ocnei lakes and the Sărătura area, when compared with each other, do not show any significant differences.

Based on this comparison, we can group the studied lakes into 3 categories. The first category comprises the Pepenaru and Sulfuros lakes, the muds of which are the most active. Six lakes (Privighetorii, Ştrand, Tarzan, Csiky, Bătrînilor and Durgău) with muds of medium activity form the second category. The third category comprising the Tineretului, Rotund, Marinel and Ocnei lakes and the Sărătura area are characterized by the least active muds.

Synthesis of the results of the comparison of lakes according to the criteria of intensity and minimum variability of the enzymatic and nonenzymatic catalytic activities of mud samples and of the enzymatic indicator of mud quality in the May 1986 — September 1987 period. Comparison of the lakes according to the criterion of the intensity of activities (Tables 2 and 3) has shown that the „best" lakes, *i.e.* the lakes the

Table 6

Relative mean values and enzymatic indicator of mud quality

Zone	Lake	Phosphatase activity	Catalase activity	Nonenzymatic H_2O_2-splitting	TTC reduction				Enzymatic indicator of mud quality
					Non-autoclaved mud		Autoclaved mud		
					Without glucose	With glucose	Without glucose	With glucose	
Valea Sărată – Ocnele Vechi	Durgău	26.95	32.24	27.50	61.08	31.27	33.78	43.48	306.3
	Sulfuros	47.58	96.02	65.97	100	100	19.18	34.77	463.52
	Ocnei	7.36	24.58	35.96	10.31	5.67	1.12	2.37	87.37
	Marinel	6.66	37.18	31.98	5.31	5.27	0.66	1.18	88.24
	Rotund	7.45	28.97	36.80	12.95	7.36	2.32	3.89	99.74
Băile Romane	Tarzan	17.92	38.58	68.84	59.14	27.34	44.09	62.17	318.08
	Csiky	35.43	55.06	67.38	62.66	41.24	24.33	28.48	314.58
	Privighetorii	16.59	28.73	100	89.98	46.26	81.91	95.02	458.49
	Tineretului	33.37	40.84	65.70	28.69	17.23	17.30	19.00	222.13
	Bătrînilor	26.48	62.02	61.82	57.03	43.42	22.48	33.17	306.42
	Ștrand	100	70.36	55.99	43.79	14.57	22.77	28.02	335.50
	Pepenaru	75.66	100	94.36	65.16	82.68	100	100	617.86
	Sărătura	5.51	27.58	58.55	38.32	19.12	25.61	24.56	199.25

Table 7

Position of lakes as a function of the enzymatic indicator of mud quality

Position	Enzymatic indicator of mud quality	Lake
1	617.86	Pepenaru
2	463.52	Sulfuros
3	458.49	Privighetorii
4	335.50	Ştrand
5	318.08	Tarzan
6	314.58	Csiky
7	306.42	Bătrînilor
8	306.30	Durgău
9	222.13	Tineretului
10	199.25	Sărătura
11	99.74	Rotund
12	88.24	Marinel
13	87.37	Ocnei

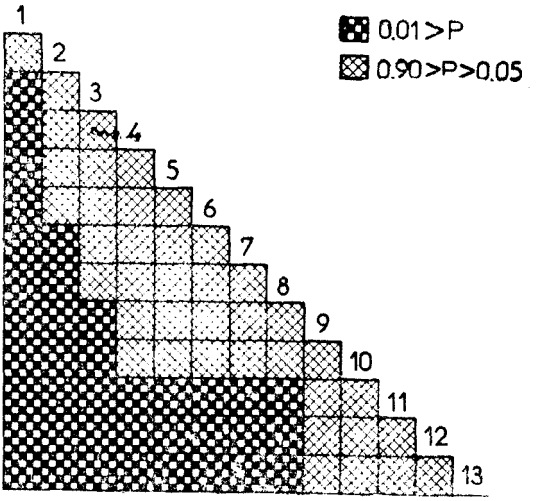

Fig. 1. *Enzymological classification of salt lakes in Turda.* 1 to 13 — The lakes studied and their position according to the enzymatic indicator of mud quality (see Table 7).

muds of which are enzymatically the most active, are the Pepenaru, Privighetorii, Tarzan and Durgău lakes. In respect of the nonenzymatic catalytic activities of muds, the "best" proved to be the Pepenaru, Privighetorii, Tarzan and Durgău lakes.

When the lakes were compared according to the criterion of the minimum variability of activities (Tables 4 and 5), it was found that the "best", the least variable, *i.e.* the most stable, are the Tarzan, Pepenaru, Privighetorii and Csiky lakes, in respect of the enzymatic activities of their muds, and the Privighetorii, Tarzan and Csiky lakes, in respect of the nonenzymatic catalytic activities of their muds.

Comparison of the lakes according to the criterion of the enzymatic indicator of mud quality (Tables 6 and 7) gave results similar to those obtained by using the criterion of the intensity of activities. Again, the muds proved to be the most active in the Pepenaru, Sulfuros and Privighetorii lakes, medium active in the Ştrand, Tarzan, Csiky, Bătrînilor, Durgău and Tineretului lakes and the Sărătura area, and the least active in the Rotund, Marinel and Ocnei lakes.

In other words, comparison of the lakes according to the 3 criteria gave nearly the same results for the Privighetorii, Tineretului, Marinel and Ocnei lakes, but differing ones for the other lakes. We emphasize the special situation of the Pepenaru, Sulfuros and Ştrand lakes, the muds of which manifest a high, but unstable enzymatic and nonenzymatic catalytic potential. The situation of the Tarzan, Csiky and Bătrînilor lakes and that of the Durgău and Rotund lakes should also be mentioned: the muds of the specified 3 lakes exhibit enzymatic and nonenzymatic cata-

lytic activities of medium intensity but of high stability, while in the muds of the Durgău and Rotund lakes the activities are weak but highly stable. Another observation to mention is the high stability of he nonenzymatic catalytic activities in the mud of the Privighetorii lake and their high instability in the muds of the Marinel and Ocnei lakes.

Based on the results described, medical and technological studies are recommended for the extraction of the Pepenaru, Sulfuros, Privighetorii and Csiky muds to be used in balneotherapy.

Conclusions. Comparison of 12 salt lakes and the Sărătura area located in Turda, either in the Valea Sărată—Ocnele Vechi zone (Durgău, Sulfuros, Ocnei, Marinel and Rotund) or in the Băile Romane zone (Tarzan, Csiky, Privighetorii, Tineretului, Bătrînilor, Ștrand, Pepenaru and Sărătura), according to the criteria of intensity and minimum variability of the enzymatic and nonenzymatic catalytic activities of their muds and of the enzymatic indicator of mud quality in the May 1986 — September 1987 period, gave nearly the same results for the Privighetorii, Tineretului, Marinel and Ocnei lakes, but differing ones for the other lakes. The muds of the Pepenaru, Sulfuros and Ștrand lakes manifest a high but unstable enzymatic and nonenzymatic catalytic potential. The muds of the Tarzan, Csiky and Bătrînilor lakes are of medium intensity but of high stability. The enzymatic and nonenzymatic catalytic potential in muds of the Durgău and Rotund lakes is weak but stable. The mud in the Sărătura area has a low enzymatic and nonenzymatic catalytic potential.

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CATALOGUE OF THE COLLECTION OF BIRD SKINS IN THE ZOOLOGICAL MUSEUM OF THE UNIVERSITY OF CLUJ-NAPOCA

(Part I)

PÂNTE GHERGHEL*

SUMMARY. — The paper presents a collection of bird skins, comprising 889 specimens. The birds belong to 187 taxa, from which 183 are from our country, and 4 from other geographic zones. Part 1 of the paper reviews nearly half of the taxa.

The bird collection of the Zoological Museum in Cluj-Napoca consists of the naturalized birds from the faunal exhibition and the reserve, and of the skin collection. From a scientific viewpoint, the last one is more valuable since the labels which accompany each specimen contain, in the majority of cases, information regarding the place, date and author of the collection.

Although it is an old collection, initiated 4 years after the foundation of the museum (1859), there are very few written materials about it [3, 4].

The collection comprises 889 birds classified into 183 taxa (168 species and 15 subspecies), from which 57 are sedentary, 94 migratory, 16 winter guests and 16 passing guests. Four species (with 5 specimens), characteristic for other geographic zones are added to the 183 taxa.

Most skins originate from Cluj district. Only a small number of specimens were collected in the neighbouring districts. The collection also comprises a few birds which were obtained from Hungary, Poland, Norway, California and Tibet.

In time, the collection has acquired an important significance, both historically and scientifically. It indicates profound changes of certain places, especially of the wet and water-covered lands, like that around the locality of Mociu, where, at the beginning of the XXth century, there were still wide-spread pools from which *Egretta alba, Himantopus himantopus* and *Platalea leucorodia* were collected. At present, in our country these species nest only in the Danube Delta. The specimens of species disappeared from Romania *(Gypaëtus barbatus),* of those which appear accidentally *(Gyps fulvus* and *Aegypius monachus)* or of those that have become rare *(Egretta alba, Platalea leucorodia, Himantopus himantopus* and *Recurvirostra avosetta)* are especially important.

Some common species, present in the collection of naturalized birds *(Garulus glandarius, Fringilla coelebs, Passer montanus, Emberiza calandra,* etc.) are missing from the skin collection. However, the great number of species in this collection speaks eloquently about the richness of the ornithofauna of these places. Related to this, it is to be mentioned that in the Danube Delta, the richest region of our country in birds, there were signalled 320 species [5], whereas in the whole country appro-

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ximately 400 species [1], *i.e.*, nearly one third of the Eurasian ornithofauna [2].

In presenting the catalogne we followed the Nomenclature of the Birds of the Socialist Republic of Romania, elaborated on the basis of phylogenetic classification [1].

In the catalogue, the following abbreviations were used for the districts: AB—Alba, BH—Bihor, BN—Bistrița-Năsăud, BV—Brașov, CJ—Cluj, CV—Covasna, HD—Hunedoara, MS—Mureș, NT—Neamț, SB—Sibiu, SJ—Sălaj. "Juv." is the abbreviation for "juvenile".

At the end of the catalogue, an index of localities and one of the species are presented.

Place	Date of collection	Author	Total number of specimens	Sex	Inventory number
		Order **Podicipediformes**			
		Family **Podicipedidae**			
		1. *Podiceps cristatus* L.			
Cluj, Someș, CJ	X. 1902	L. Zwörner	1	♀	2157
Cefa, BH	26.VI.1970	F. Vinczе	4	♂	2157/1
			1		2157
		2. *Podiceps griseigena* Bodd.			
Geaca, CJ	6.III.1970	F. Vinczе	1	♂	2160/1
		3. *Podiceps auritus* L.			
Apahida, CJ	X.1909	L. Führer	1	♀	2157/1
		4. *Podiceps nigricollis* Ch. L. Brehm			
Dej, CJ	VIII.1944	V. Dezső	1	♀	2158
		5. *Podiceps ruficollis* Pall.			
Hăghig, CV	23.VII.1902		1	♀	2159
Mociu, CJ	IX.1909	L. Führer	3		2159
Geaca, CJ	15.X.1970	F. Vinczе	1		2161/1
Geaca, CJ	30.VIII. 1971	F. Vinczе	1		2161/1
		Order **Ciconiiformes**			
		Family **Ardeidae**			
		6. *Ardea cinerea* L.			
Răscruci, CJ	IX.1909	L. Führer	1	♀	2162
Băgara, CJ	IV.1910	L. Führer	1	♀	2162
Mociu, CJ	IV.1910	L. Führer	1	♂	2162
Țaga, CJ	3.VII.1910	I. Ajtai	1	♀	2162
	1911		4		2162
Cefa, BH	23.VII.1970	F. Vinczе	5	2♂, 3♀	2162/1
		7. *Ardea purpurea* L.			
Băgara, CJ	IV. 1910	L. Führer	2	♀	2163
Geaca, CJ	1911		1		2163
Geaca, CJ	15.IX.1972	F. Vinczе	1	♀	2163

		8. Egretta alba L.			
Mociu, CJ	X.1909	L. Führer	2	♂, ♀	2165
		9. Egretta garzetta L.			
Cefa, BH	26.VII.1970	F. Vincze	1	♂	2165/2
Cefa, BH	22.XI.1973	F. Vincze	1	♂	2165/2
		10. Ardeola ralloides Scop.			
Cefa, BH	24.VI.1970	F. Vincze	1	♂	2163/2
		11. Nycticorax nycticorax L.			
Someşul Rece, CJ	VI.1903	L. Führer	2	♂	2156
Gilău, CJ	IX.1909	L. Führer	1	♂	2156
Răscruci, CJ	X.1909	L. Führer	4	juv.	2156
Mociu, CJ	V.1910	L. Führer	1	♂	2156
Cefa, BH	25.VI.1970	F. Vincze	4	2♂, 2♀	2156
Cefa, BH	19.VII.1970	F. Vincze	1	♂	2156
		12. Ixobrychus minutus L.			
Răscruci, CJ	X.1909	L. Führer	1	♂	2162/1
		Family **Ciconiidae**			
		13. Ciconia ciconia L.			
	1911		3		2166
Dezmir, CJ	18.VIII.1958	H. Fülöp	1	♀	2166
Zoo, Turda, CJ	10.XI.1970	F. Vincze	1		2166
Someşeni, CJ	10.X.1972	F. Vincze	1	♂	2166
		14. Ciconia nigra L.			
Răscruci, CJ	X.1909	L. Führer	3	1♂, 2♀	2166
		Family **Threskiornitidae**			
		15. Platalea leucorodia L.			
Mociu, CJ	VI.1910	L. Führer	1	♀	2164
Dobrogea	1911	L. Führer	5	3♂, 2♀	2164
Danube Delta	15.IV.1950	H. Fülöp	1		2164
		Order **Anseriformes**			
		Family **Anatidae**			
		16. Anser fabalis Lath.			
Hortobágy, Hungary	IV.1907	O. Telcky	1	♀	2174
			1		2169
		17. Anser anser L.			
			1		2170
		18. Anser albifrons Scop.			
Cefa, BH	19.XII.1970	F. Vincze	1		2170/1
		19. Anas strepera L.			
Apahida, CJ	IV.1911	L. Führer	1		2173

		20. Anas crecca L.			
Geaca, CJ	10.VIII.1971	F. Vincze	2	juv. ♂, ♀	2173/1
Geaca, CJ	30.IX.1971	F. Vincze	1	♀	2173/1
Someşeni, CJ	26.VII.1973	F. Vincze	1	♀	2173/1
		21. Anas platyrhynchos L.			
Hăghig, CV	I.1903	L. Führer	1	♂	2168
			1	♀	2168
		22. Anas acuta L.			
Ocna Mureş, AB	17.III.1903	L. Führer	1		2171
		23. Anas querquedula L.			
Apahida, CJ	IV.1911	L. Führer	1	♂	2172
Geaca, CJ	29.III.1957	K. Fülöp	2		2172
		24. Aythya ferina L.			
Geaca, CJ	4.VI.1970	F. Vincze	1	♂	2175
Cefa, BH	24.VI.1970	F. Vincze	1	♀	2175/1
		25. Aythya nyroca Güldenst.			
Apahida, CJ	1909	L. Führer	1		2174
Apahida, CJ	I.1911	L. Führer	1	♂	2174
Cefa, BH	24.VI.1907	F. Vincze	1	♀	2175
Geaca, CJ	3.VII.1970	F. Vincze	1	♂	2175
Geaca, CJ	30.IX.1971	F. Vincze	1	♂	2175
		26. Mergus merganser L.			
Cluj-Napoca, CJ	15.X.1903	L. Zwörner	1	♂	2167
		Order **Falconiformes**			
		Family **Accipitridae**			
		27. Gyps fulvus Habl.			
Cibin, SB	VII.1907	L. Führer	1		2202
		28. Aegypius monachus L.			
Buciumi, SJ	24.X.1903	Szilágyi	1	♂	2199
		29. Gypaëtus barbatus Habl.			
Tibet, China			1		2203
		30. Aquila heliaca Savigny			
Cibin, SB	VII.1907	L. Führer	1	♂	2196
Cibin, SB	VII.1907	L. Führer	1	juv. ♂	2196
		31. Aquila clanga Pall.			
	23.III.1904	L. Führer	1	♀	2194
Bonţida, CJ	II.1910	L. Führer	1	♀	2194
	II.1910		1	♀	2194
Apahida, CJ	IV.1911	L. Führer	1	♀	2194
Feleac, CJ	V.1911	L. Führer	1	♀	2194
Cuzăplac, SJ	14.I.1920		1	juv. ♀	2194
			2		2194

32. Hieraëtus pennatus Gmel.

Răscruci, CJ	12.X.1934	L. Führer	2	♂, juv. ♀	2195
Răscruci, CJ	X.1909	L. Führer	1	♂	2195
Răscruci, CJ	X.1909	L. Führer	1	juv. ♂	2198
			1		2198

33. Buteo buteo L.

Miskolc, Hungary	XII.1863		1	♀	2178
Cristian, BV	25.I.1903	Láncz y	1	♀	2178
Făgăraș, BV	I.V.1903	L. Zwörner	1	♂	2178
Dej, CJ	I.VIII.1904	L. Zwörner	1	♀	2178
Cluj-Napoca, CJ	19.VII.1905	L. Führer	1	♂	2178
Borșa, CJ	29.IV.1906		1	♂	2178
Cluj, Mănăștur, CJ	10.XI.1909	I. Ajtai	2	♀	2178
Apahida, CJ	VII.1912	L. Führer	2	♂	2178
Cluj, Hoia, CJ	II.1913		1	♂	2178
Florești, CJ	II.1913		1	♀	2178
Florești, CJ	1913	L. Führer	1	♂	2178
Transilvania			1	♂	2178
			6		2178

33/1. Buteo buteo zimmermannae Ehmcke

Răscruci, CJ	X.1909	L. Führer	2		2176
			1		2176

34. Buteo lagopus Pont.

	1865		1		2179
Cluj-Napoca, CJ	7.II.1905	L. Führer	1	♀	2179
Apahida, CJ	II.1913		1	♀	2179
			6		2179

35. Buteo rufinus Cretzschm.

SE Europe			1	♂	2177

36. Accipiter gentilis L.

	3.X.1903	L. Führer	1	♀	2191
Turea, CJ	26.VIII.1905	L. Führer	1	♀	2191
	2.VII.1906	L. Führer	1	♂	2191
			2	♂	2191
			1	♀	2191

37. Accipiter nisus L.

	3.X.1903		2	♀	2190
	15.VII.1905	L. Führer	1	♂	2190
Turea, CJ	26.VIII.1905	L. Führer	1	♀	2190

38. Milvus milvus L.

		H. Fülöp	1		2185

39. Milvus migrans Bodd.

Apahida, CJ	IX. 1911		1	♂	2181
			1	♂	2181

40. Haliaëtus albicilla L.

Cibin, SB	VII. 1907	L. Führer	1	♀	2201
Zaul de Cîmpie, MS	VIII.1907	L. Führer	3	♀	2201
Răscruci, CJ	XI.1909	L. Führer	1		2201

41. Pernis apivorus L.

			1		2200

42. Circus aeruginosus L.

Hăghig, CV	1.V.1903	L. Führer	1	♀	2192
Floreşti, CJ	4.XI.1911		1	♂	2192

43. Circus cyaneus L.

			1	♀	2193
			1		2193

44. Circaëtus gallicus Gmel.

Cibin, SB	VII.1907		1	♂	2204

Family **Falconidae**

45. Falco subbuteo L.

Cluj-Napoca, CJ	1864		1	♂	2186
Cluj-Napoca, CJ	1864		1	♀	2186
Cluj-Napoca, CJ	1864		1	juv. ♂	2186
Turea, CJ	27.VIII.1905		1	♂	2186
Geaca, CJ	7.IX.1970	F. Vincze	1		2186
			2		2186

46. Falco peregrinus Tunst.

Răscruci, CJ	XI.1904	L. Führer	1	♂	2188/1
Aghireş, CJ	III.1910		1	♂	2182
Răscruci, CJ	III. 1911		1		2188/1
Bonţida, CJ	IV.1911		1		2188/1
			1		2188

47. Falco cherrug danubialis Kleinschm.

Răscruci, CJ	II.1910	L. Führer	1	♂	2183
Hida, SJ	IV.1911	Bonar	1	♀	2188
			6		2183

48. Falco vespertinus L.

	V.1930	H. Fülöp	1	♀	2184

49. Falco naumanni Fleischer

Cluj-Napoca, CJ	1.IX.1905	L. Führer	1	♂	2185

50. Falco tinnunculus L.

Cluj-Napoca, CJ	26.IV.1903	L. Zwörner	1	♂	2187
Cluj-Napoca, CJ	IX.1903	L. Führer	1	♂	2187
Galicia	29.IV.1916		1	♀	2187
Floreşti, CJ	13.VIII.1970	F. Vincze	1		2187

Order **Galliformes**

Family **Phasianidae**

51. Perdix perdix L.

Baciu, CJ	12.V.1970	F. Vincze	1	♀	2340

52. Coturnix coturnix L.

Gilău, CJ	IX.1909	L. Führer	1	♂	2211
Apahida, CJ	IX.1909	L. Führer	1	juv.	2211

Order **Gruiformes**

Family **Rallidae**

53. Porzana parva Scop.

Mociu, CJ	IX.1909	L. Führer	4	3♂, 1♀	2207
Răscruci, CJ	X.1909	L. Führer	1	♂	2207

54. Porzana porzana L.

Apahida, CJ	6.X.1903	L. Zwörner	1	♂	2206
Apahida, CJ	X.1909	L. Führer	2	♂, ♀	2206
Mociu, CJ	XI.1909	L. Führer	2	♂, ♀	2206
Floreşti, CJ	V.1911	L. Führer	1	♂	2206

55. Porzana pusilla intermedia Herm.

Hungary	V.1911	L. Führer	2	♂, ♀	2209

56. Crex crex L.

	IV.1867		1	♂	2205
Cluj-Napoca, CJ	5.IX.1902		1	♂	2205
Apahida, CJ	5.VI.1903	L. Zwörner	1	♀	2205

57. Gallinula chloropus L.

Apahida, CJ	XI.1909	L. Führer	1	♂	2208
Ţaga, CJ	2.V.1910	I. Ajtai	1	♂	2208
Scutard, CJ	20.X.1971	F. Vincze	1	juv.	2208
			1		2208

58. Fulica atra L.

Geaca, CJ	III.1867		2		2210
Geaca, CJ	15.X.1971	F. Vincze	2	♂, ♀	2210
Geaca, CJ	22.XI.1973	F. Vincze	2		2210

Order **Charadriiformes**

Family **Charadriidae**

59. Vanclus vanclus L.

Cătina, CJ	4.X.1903		1	♂	2220
Hortobágy, Hungary	IV.1907	J. Nagy	2	♂, ♀	2220

60. Charadrius dubius curonicus Gmel.

Cluj-Napoca, CJ	18.IV.1904	L. Zwörner	2	♂, ♀	2226
Cluj, Someş, CJ	V.1911	L. Führer	2	♂, ♀	2226
Floreşti, CJ	IV. 1913	L. Führer	1	♂	2226

61. Charadrius alexandrinus L.

Hortobágy, Hungary	IV.1907	I. Teleki	1	♀	2227

Family **Scolopacidae**

62. Gallinago gallinago L.

Aghireş, CJ	X.1919	L. Führer	3	2♂, 1♀	2217
Răscruci, CJ	XI.1909	L. Führer	4	2♂, 2♀	2217
Mociu, CJ	XI.1909	L. Führer	2	♂, ♀	2217
	VIII.1912		1		2217

63. Lymnocryptes minimus Brünn.

			1		2218

64. Scolopax rusticola L.

Feleacu, CJ	1911	L. Führer	1	♂	2216

65. Limosa limosa L.

Hungary	IV.1911		1	♀	2215
Someşeni, CJ	26.VII.1973		1	♂	2215

66. Tringa totanus L.

Mociu, CJ	X.1909	L. Führer	3	2♂, 1♀	2223

67. Tringa nebularia Gunn.

Mociu, CJ	X.1909	L. Führer	4	3♂, 1♀	2223
Mociu, CJ	XI.1909	L. Führer	2	♂, ♀	2223
			1		2223

68. Tringa ochropus L.

Cluj, Mănăştur, CJ	X.1909	L. Führer	1	♂	2224
	4.V.1910	I. Ajtai	1	♀	2224
			1		

69. Tringa glareola L.

Someşeni, CJ	VI.1911	L. Führer	1	♂	2221
Someşeni, CJ	24.VII.1973	F. Vincze	1	♂	2221
			1		2221
			1	juv.	2221

70. Tringa hypoleucos L.

Geaca, CJ	IV.1867		1	♀	2221
Mociu, CJ	X.1909	L. Führer	3	2♂, 1♀	2221
Răscruci, CJ	XI.1909	L. Führer	2	♂, ♀	2221
	23.IV.1910	I. Ajtai	1	♂	2221
Mocia, CJ	VI.1910	L. Führer	1	♂	2221
Gilău, CJ	V.1911	L. Führer	2	♂, ♀	2221
Gilău, CJ	VI.1911	L. Führer	3	♀	2221
Cluj, Mănăştur, CJ	VI.1911	L. Führer	1		2221
			1		2221

71. Calidris minuta Leisl.

Someşeni, CJ	V.1911	L. Führer	1	♂	2222
Apahida, CJ	V.1911	L. Führer	1	♂	2222
			1		2222

72. Philomachus pugnax L.

Cătina, CJ	11.V.1904	L. Zwörner	2	♂, ♀	2219

Family **Recurvirostridae**

73. Recurvirostra avosetta L.

Cluj, Someş, CJ	IX.1911		1		2213

74. Himantopus himantopus L.

Mociu, CJ	IX.1909	L. Führer	1	♀	2214
			1		2214

Family **Laridae**

75. Larus fuscus L.

Someşeni, CJ	X.1902	L. Zwörner	1	juv. ♀	2230
			1		2230

75. Larus argentatus cachinnans Pall.

Apahida, CJ	IX. 1969	L. Führer	2	♀	2229
			2		2232

77. Larus canus L.

Hortobágy, Hungary	IV.1967	J. Nagy	1	♀	2231
Apahida, CJ	II.1910	L. Führer	1	♂	2231
Zaul de Cîmpie, MS	III.1911		2	♂, ♀	2231

78. Larus ridibundus L.

Apahida, CJ	X.1909	L. Führer	2	♀	2228
Apahida, CJ	XI.1909	L. Führer	1	♂	2228
Dezmir, CJ	XI.1909	L. Führer	1	♀	2228
Mociu, CJ	XI.1909	L. Führer	1	♂	2228
Mociu, CJ	VI.1910	L. Führer	3	2♂, 1♀	2228
Zaul de Cîmpie, MS	IV.1911	L. Führer	2		2228
			2		2228

Family **Sternidae**

79. Chlidonias nigra L.

Braşov, BV	8.VII.1903	L. Zwörner	1	♂	2234
Apahida, CJ	IX.1909	L. Führer	1	♂	2234
Geaca, CJ	30.VII.1971	F. Vincze	1	♀	2234

80. Chlidonias leucoptera Temm.

Apahida, CJ	XI.1909		5	3♂, 2♀	2235
			1	juv.	2236

81. Sterna hirundo L.

Apahida, CJ	IX.1909	L. Führer	2	♂, ♀	2237
			1		2237

82. Sterna albifrons Pall.

			1		2238

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RECENZII

Microbiologie industrială şi biotehnologie *(Industrial Microbiology and Biotechnology),* Sub redacţia (Edited by) N. D. Topală, Universitatea „Al. I. Cuza", Iaşi, Institutul Central de Biologie, Consiliul Naţional al Inginerilor şi Tehnicienilor, Întreprinderea de Antibiotice Iaşi and Societatea de Ştiinţe Biologice Filiala Iaşi, 1988, 1067 pages with 363 figures and 269 tables.

The volume comprises 149 papers which were presented at the 6th Symposium on Industrial Microbiology and Biotechnology held in Iaşi on 10—12 September 1987. The Proceedings of the first 5 Symposia were reviewed in Studia Univ. Babeş-Bolyai, Biologia (1981, *26* (2), 73—74; 1985, *30*, 76—77 and 1986, *31* (2), 78—80).

After the Foreword by Professor N. D. Topală, the volume includes an up-to-date and comprehensive review on „Biotechnology and contemporary society", communicated by Professors G. Zarnea and N. D. Topală in the plenary session, and 148 papers presented in the 9 sections of the Symposium.

Biotechnology of immobilized enzymes and microbial cells (15 papers). Different supports (xanthan derivatives, collagen, Ponilex type ion exchangers, calcium and cobalt alginates, gelatine, polyacrylamide) were used for immobilization of many enzymes (asparaginase, histidase, glucoamylase, α-amylase, glucose isomerase, invertase, catalase and penicillin amidase) and some bacteria *(Streptomyces* sp., *Arthrobacter* sp., *Sarcina lutea* and *Escherichia coli).* The technologies applied and the properties of immobilized enzymes and bacteria are described in detail.

Microbial enzymes. Twenty-seven papers deal with isolation and selection of highly active enzime-producing bacterial and fungal strains, optimization of the conditions of enzyme biosynthesis, separation and purification of the following enzymes: urease; alkaline, neutral and acidic proteinases; RNase; enzyme hydrolyzing yeast glucan; amylases; transglucosidase; amyloglucosidase; glucose isomerase; C_1 and C_x components of cellulase; cellobiase; inulinase; catalase; asparaginase; alcohol oxidase. One paper describes chromogenic substrates for the determination of hemicellulase and pectinase activities. A biotechnology for increasing the enzymatic potential of the weakly active mud from a salt lake is the topic of another paper.

Microbial biomass, amino acids, alcohols (11 papers). A technology is described for producing biomass (single cell proteins, SCP) by culturing methylotrophic bacteria in wastewaters resulted from the conversion of methanol into hydrocarbons. Biomass was also obtained by means of the methanol-utilizing yeast *Candida boidinii.* Two papers deal with the bacterial production of L-lysine and L-phenylalanine, respectively. Methods were worked out for producing ethanol or fructose by utilization of wastewaters resulted from the biosynthesis of dextran. The exopolysaccharide-producing bacteria, production of citric acid by a mutant strain of *Aspergillus niger,* influence of Gerovital on the microbial metabolism and the microbiological assay of racemic calcium pantothenate were also dealt with.

Antibiotics. Alkaloids (9 + 8 papers). Morpho-physiology, biochemistry and cultivation of streptomycin- and erythromycin-producing strains *(Streptomyces griseus* and *Str. erythreus,* respectively) were studied. Some papers deal with phage infection of *Str. erythreus* cultures, influence of lipids on the biosynthesis of penicillin and assay of amino nitrogen in culture liquid of the streptomycin-producer. Conidiogenesis, variability of conidia, biochemistry including alkaloid biosynthesis of *Claviceps purpurea,* free amino acids in rye host plants infected with *Cl. purpurea* and inoculum preparation are the topics of 7 papers. One paper is devoted to the saprophytic cultivation of a *Claviceps paspali* strain producing ergotic alkaloids.

Genetics of industrial microorganisms (15 papers). After a review on "The restriction-modification enzymes and their role in recombinant DNA

technology", researches are described on the following themes: *in vivo* cloning of α-amylase genes from *Bacillus licheniformis* to *Bac. subtilis* using the principle of resident plasmid; transfer of an octopinic plasmid into *Agrobacterium tumefaciens* protoplasts; obtaining of recombinants in industrial yeasts by protoplast fusion; L-lysine-producing *Corynebacterium* recombinants obtained by protoplast fusion; protoplast isolation from some *Bacillus* species; dynamics of the reversion of *Bac. subtilis* protoplasts; electron microscopic aspects of the fusion of *Bac. subtilis* protoplasts with *Bac. globigii* and *Bac. licheniformis* protoplasts; protoplasts from a minicell-forming *Bac. subtilis* strain; *Bac. subtilis* mutants with high hydrolase activity; induced mutagenesis in a rifamycin B-producing *Nocardia mediterranei* strain; effects of some mutagens on a cephalosporin C-producing *Cephalosporium acremonium* strain; obtaining of *Micrococcus lysodeikticus* M-13 mutants with increased catalase-producing capacity; preservation of industrial microorganisms.

Yeasts. Food microbiology (11 + 5 papers). Recent advances in methodology of improving industrial yeasts are reviewed, then investigations are described related to chemical composition and cell wall breaking of brewer's and distiller's yeasts, their utilization for obtaining protein concentrates and flavour compounds; stimulation of alcoholic fermentation; technologies for thermo-, auto- and hydrolysis of yeasts; osmo- and alcohol-tolerant yeasts; autochthonous cellulose plates for filtering beer. The papers in the field of food microbiology describe microbiological and biochemical studies of beef and vegetable (soybean) proteins.

Bioenergy and petroleum microbiology (17 papers). One paper deals with the use of porous materials to increase the yield of methanogenesis. Production of molecular hydrogen by facultatively or obligately anaerobic heterotrophic bacteria, anoxygenic phototrophic bacteria and cyanobacteria is the topic of 5 papers. The bacterial polysaccharide xanthan, used in secondary oil recovery, was multilaterally studied (biosynthesis, purification, physico-chemical characterization and biodegradability of xanthan; its protection from biodegradation; preservation of the xanthan-producing *Xanthomonas* strains). Different bacterial populations, able to release oil from porous media when injected into reservoirs, were also the topics of several papers. Some bacteria producing biosurfactants and, consequently, presenting much interest for secondary oil recovery were also studied.

Microbiology of ores, environmental protection and biodegradation (2 + 8 papers). *Thiobacillus ferrooxidans* populations were adapted to As-containing copper ores with the aim to use them for the leaching of copper. A complex microbiological analysis of mine water and ore samples rich in manganese oxides was also carried out. Microbiological and biochemical properties of the activated sludge from the wastewater treatment plant at the Synthetic Fibres Works in Săvinești were studied in detail. Presence of inorganic and organic pollutants in different industrial wastewaters was also studied. Biodegradability of cyclohexanol and cyclohexanone was demonstrated. Biodegradability of organic pollutants in wastewaters resulting from the manufacturing process of diethyl-hexyl-peroxycarbonate was proved. The Hach respirometer was found to be a suitable instrument for testing biodegradability of organic pollutants in wastewaters. A method was worked out for the treatment of wastewaters containing H_2S and other inorganic sulphur pollutants.

Bioengineering (18 papers). Different bioreactor types were designed and manufactured. Automation and computer monitoring and control of the biosynthesis processes in bioreactors were also dealt with. Various sensors, operating elements and amplifiers-converters were achieved. A new type of screen with wavering movement and the differential equations describing the movement of solid particles on this screen are presented. The last 3 papers have the following topics: investigation of the behaviour of cells in electric field with the aim of applications in biotechnology; utilization of some vegetal by-products for culturing the insecticide bacterium *Bacillus thuringiensis;* biosensor with yeast for assaying phenol.

The researches described in this volume were performed under laboratory, pilot plant and industrial produc-

tion conditions. Their results are valuable from both fundamental and practical viewpoints.

The Proceedings of the first 5 Symposia reflected and stimulated the development of industrial microbiology and biotechnology in our country. The present volume proves this development by its more than 1,000 pages and the value of the papers it contains, and will, undoubtedly, contribute to further achievements in this field of science and technology. Last but not least, the excellent work of the Editor, Professor N. D. Topală and of his collaborators in organizing the Symposia and publishing the Proceedings should also be emphasized.

ȘTEFAN KISS

D. G. Zvyagintsev, **Pochva i mikroorganizmy** *(Soil and Microorganisms)*, Izdatel'stvo Moskovskogo Universiteta, Moskva, 1987, 256 pages including 34 figures and 26 tables.

The newest book of Professor D. G. Zvyagintsev, Head of the Soil Biology Department of the Moscow State University, is a monograph reviewing his investigations and those of other authors on the specificity of soil as a habitat of microorganisms and on the structure and functioning, succession, dynamics, regulation and management of soil microbial populations.

Professor D. G. Zvyagintsev emphasizes that the specificity of soil as a habitat of microorganisms is due, first of all, to the fact that soil is a three-phase system consisting of very large solid surfaces adjacent to liquid and gaseous phases. The solid particles and aggregates divide the soil into numerous microzones, partially or completely isolated volumes, in which very different and often contrary (*e.g.* aerobic or anaerobic) conditions are created. The microbial cells, being of microscopic size, live in these microzones. There are hundreds and thousands of such microzones in each gram of soil. The microorganisms are distributed mostly in an adsorbed state on the surface of microzones and to a lesser extent within the microzones and in the liquid phase (soil solution). This is why a great part of the book (pp. 13—109) is devoted to the adsorption (adhesion, immobilization) of microorganisms in soils and to the activity of adsorbed microbial cells. The problems studied include: laws of adhesion of the introduced microorganisms; dependence of adhesion on the properties of microorganisms and solid surface as well as on the composition of media and the conditions determining the possibility of contact between the cells and the surface of adsorbents; desorption of microorganisms; effects of adhesion on the aerobic and anaerobic microbial processes; preservation of microorganisms on adsorbents; effect of antimicrobial substances in the presence of adsorbents; causes of the effects of adsorbents on the microbial activities.

The influence of liquid and gaseous phases of soil on the distribution and activity of microorganisms is described on pages 109—139.

The second part of the book (pp. 140—235) consists of 5 sections. Their titles and the main topics dealt with are specified below: Ways for studying soil microorganisms and the processes brought about by them (reproduction of microzones on macroscales; physical soil models using models of soil particles; modelling by means of native soil samples — simplification of the microzonality in soil; preservation of the natural microzonality in soil); Conceptions of the structure and functioning of the complex of soil microorganisms (concept of the complex of soil microorganisms; concept of the microbial pool; concept of the pool of metabolites; principle of doubling; principle of the reversibility of microbial processes; principle of the multiple limitations; concept of the unsaturatedness of the complex of soil microorganisms; concept of the soil as a multitude of microbial habitats); Microbial succession in soil (criteria used for observing bacterial succession in soil; study of the soil fungi and actinomycetes; succession of the introduced labelled microbial populations); Dynamics of the indices of biological activity in soils (characteristics of the biological activity in soils; dynamics of the microbial number, biomass and productivity of microbial communities in soils; short-term and seasonal variations in the number of microorganisms in soils; mechanisms regulating the number of soil microorganisms; parameters of the dynamics of the number of soil microorganisms; dy-

namics of the number of soil microorganisms from the viewpoint of the stability of biological communities); Management of the microbial populations in soils.

The bibliographical list (pp. 235—256) comprises 506 titles.

Beside a remarkable theoretical value, Professor Zvyagintsev's book presents a major practical importance, too. It is a very useful source of information for evaluating the anthropogenic effects (agrochemical, agrotechnical and silvicultural practices, pollution with xenobiotics, heavy metals and other chemicals, etc.) on soil fertility. We should never forget that the creation and maintenance of soil fertility and, consequently, the agri- and silvicultural production are unconceivable without the contribution of soil microorganisms.

ȘTEFAN KISS

G. Dihoru, C. Pârvu, **Plante endemice în flora României** *(Endemic Plants in the Flora of Romania)*, Editura Ceres, București, 1987, 189 pages with 75 figures.

This book represents an important synthesis work based on an extensive bibliography regarding the flora of our country and of Europe, as well as on numerous personal observations resulted from the examination of certain renowned herbaria.

The book comprises 5 chapters. Since it is addressed not only to specialists but to all categories of nature lovers, in the first part of Chapter I, „Information about endemic plants", the authors specify some of the frequent terms employed, such as endemism, endemit, natural monument, degrees of endangerment (extinct, endangered, vulnerable, rare, indeterminate, out of danger, insufficiently known and not threatened), as well as the notions of sesology, genofond and tracheophyta.

From the factors explaining the existence of the endemits, the stress is placed on the caryologic and geographic ones. Of great importance in this respect are the polyploid elements and the hybrids which appear at the contact of the floras belonging to different climatic zones. The 7 speciogenic centres in our country (Rodnei Mountains, Bistriței and Ceahlău Mountains, Bucegi and Bîrsa Mountains, Retezat and Godeanu Mountains, Carpathians of Banat and Oltenia, Apuseni Montains, Bîrsa Depression) as well as the endemits which appeared in them are described. Related to this aspect, it is worth mentioning that *Lychenis nivalis* is considered as the emblem of the Eastern Carpathians and *Dianthus callizonus* as that of the Southern Carpatians. Due to the large number of microspecies of the *Hieracium* genus, the Retezat and Godeanu Mountains are considered as a hieraciogenic nursery. The number of endemits in our country increases from plain to mountains, so that the montane, subalpine and alpine zones contain 72% from the total. The classification of endemits according to flower colour, height, coenological and ecological characteristics, as well as area' size is also very useful. While certain species such as *Hepatica transsilvanica* and *Trisetum micerotrichum* are spread all over the Romanian Carpathian chain, *Androyalu leritomentosa* from Pietrosul Brostenilor has an area of 150 m² only!

Regarding the history of research on the endemits in the Romanian flora, the first endemit described was *Lychnis nivalis* (P. Kitaibel, 1814) and the last one was *Scabiosa pseudobanatica* (Chirtek, 1985). Twenty-four endemits were described in the XIXth century, whereas 56 were discovered in the XXth century, from which 29 after 1960. Among those who studied the endemits, (F. Pax (1898), A. Borza (1931) and T. Săvulescu (1960) gave them a special importance in the delimitation of the floristic provinces. Another category of studies attempts at making the inventory of endemits in the whole country or in limited zones. Among the authors with such preoccupations we should mention again A. Borza, to which a long list can be added: E. Topa (1960), A. Beldie (1967), B. Pawlowski (1970), A. Beldie and I. Morariu (1976), T. Ștefureac and A. Tăcină (1978), H. Heltman (1958), N. Boșcaiu (1965) should also be remarked for his important work on endemit coenology. In the field of taxonomy, A. Tăcină has to be mentioned also for his caryological researches.

Chapter II, "Presentation of the vascular endemits", is developed over the largest number of pages (199). Eighty taxa (46 species and 34 subspecies) are presented, according to the following plan: scientific name, indication of iconography, bibliographical source and exsiccatae, sesological characterization, botanical, ecological and coenological descriptions and spreading; for 13 species references are also made to their importance. The description order is alphabetical, by botanical families. After the number of taxa contained, the 24 families are disposed as follows: *Asteraceae* (4 species, 7 subsepcies), *Brassicaceace* (7 sp., 3 ssp.), *Caryophyllaceae* (6 sp., 4 ssp.), *Poaceae* (5 sp., 5 ssp.), *Fabaceae* (3 sp., 1 ssp.), *Lamiaceae* and *Rosaceae* (3 sp.), *Ranunculaceae* and *Dipsacaceae* (2 sp., 1 ssp.), *Apiaceae* (1 sp., 2 ssp.), *Liliaceae* and *Primulaceae* (3 ssp.), *Campanulaceae* and *Rubiaceae* (2 sp.), *Fumariaceae*, *Linaceae*, *Papaveraceae*, *Santalaceae*, *Scrophulariaceae* and *Zannichelliaceae* (1 sp.), *Boraginaceae*, *Pinaceae*, *Plumbaginaceae and Saxifragaceae* (1 ssp.).

Taking into account the different degrees of endangerment, the 80 endemic taxa are grouped as follows: 9 endangered, 18 vulnerable, 29 rare, 1 indeterminate *(Fumaria jankae)*, 1 insufficiently known *(Zannichellia prodanii)* and 15 not threatened. A few taxa occupy a somewhat uncertain position. These are: *Peucedanum rochelianum, Aquilegia nigricans subscaposa* (rare or vulnerable), *Anthemis carpatica pyrethriformis* (not threatened, insufficiently known), *Draba dorneri* (vulnerabile or maybe extinct), *Thlaspi pawlowskii* (indeterminate, insufficiently known), *Scabioasa pseudobanatica* and *Asperula carpatica* (rare or insufficiently known).

The endangered taxa are the following: *Centaurea jankae, C. pontica, Aubrieta intermedia falcata, Cochlearia borzeana, Minuartia frutescens cataractarum, M. graminifolia hungarica, Astragalus péterfii, Armeria maritima barcensis* and *Primula wulfeniana baumgarteniana.*

The vulnerable taxa are represented by *Prangos ferulacea carinata, Andryala levitomentosa. Centaurea trichocephala simonkaiana, Barbarea lepuznica, Draba haynaldii, D. simonkaiana, Hesperis matronalis moniliformis, H. oblongifolia, Campanula romanica, Dianthus giganteus banaticus, Lychnis nivalis, Cephalaria uralensis multifida, Astragalus pseudopurpureus, A. roemeri, Ornithogalum orthophyllum psamophilum, Linum uninerve, Stipa crassiculmis heterotricha* and *S. danubialis.*

The rare taxa are: *Athamanta turbith hungarica, Carduus kerneri lobulatiformis, Centaurea phrygia rarauensis, C. phrygia retezatensis, Jurinea mollis transsilvanica, Eritrichium nanum jankae, Thlaspi dacicum banaticum, Edraianthus kitaibelii, Cerastium transsilvanicum, Dianthus callizonus, D. glacialis gelidus, Silene dinarica, Cephalaria radiata, Salvia transsilvanica, Thymus bihorensis, Erythronium denscanis niveum, Ornithogalum orthophyllum acuminatum, Papaver coronasanct-stephani, Pinus nigra banatica, Festuca versicolor dominii, Poalaxa pruinosa, Primula auricula serratifolia, Delphinium simonkaianum, Sorbus borbasii, S. dacica, Galium baillonii, Thesium kernerianum, Saxifraga mutata demissa* and *Pedicularis baumgartenii.*

The group of taxa not threatened comprises *Anthemis tinctoria fusii, Centaurea pinnatifida, Dianthus henteri, D. tenuifolius, Onobrychis montana transsilvanica, Thymus comosus, Festuca bucegiensis, F. nitida flaccida, F. pachyphylla, Helictotrichon decorum, Koeleria macrantha transsilvanica, Trisetum macrotrichum, Primula elatior leucophylla, Hepatica transsilvanica* and *Alchemilla dolichotoma.*

In Chapter III ("Nonendemic" endemits), the authors present 56 taxa which lost their endemic attribute as a result of area broadening or of taxonomic revision determined by the existence of certain synonyms, etc.

Chapter IV, "Endemic microspecies of the genera *Hieracium* and *Rubus*", contains the enumeration of 58 microspecies of *Hieracium* and 37 of *Rubus.*

In Chapter V, "The proportion of endemits in the flora of Romania", we remark the existence of a synthetic table with the figures of different authors about the number of vascular species and separately of the endemits in Romania. The authors themselves do not give any figures, considering that „the taxon number of vascular plants, including the endemits is incomplete". However, they consider that the data of Beldie and Morariu (1976) (3,350 vascular plants, from which 127 are endemits) are the most reliable.

Chapter VI, "Importance and conservation of endemits", insists on the scientific importance of the endemits as historical products of the Romanian territory and as the carriers of a unique genetic information. The endemits are also important in the delimitation of the floristic provinces and districts as well as in the recognition of the vegetal groups (associations, subassociations, variations). Some endemit groups have a role in the stabilization of the talus and in the decoration and vitalization of the rocks. The taxa belonging to *Festuca* genus are important as fodder. Because many endemits have attractive flowers and leaves they are utilized in „alpinaria". The necessity of intensifying the taxonomic and ecological investigations is also evidenced. The ecological researches should consider especially the aspects related to reproduction, in order to assure endemit conservation. One of the ideas repeatedly underlined refers to the important role that the botanical gardens should play in plant conservation.

The book ends with an alphabetical index of Latin names (families, species and subspecies).

The merits of this book, which reactualizes the problem of endemits, consist in the richness of information, concise style of presentation, valuable indications regarding the protection and conservation of endemits as well as numerous suggestions for future investigation. However, the inclusion of the popular names along with the scientific ones, as well as a summary in one of the broad circulation languages would have increased the quality of this book.

PANTE GHERGHEL

Jonathan Silvertown, **Introduction to Plant Population Ecology**, 2nd Ed., Longman, Harlow, Essex and Wiley, New York, 1987, XI + 229 pages including 92 figures and 9 tables, with 25 pages of references.

The issue of a textbook of plant ecology is not a usual event on the book market-place in Europe and the USA. While there are many works on vegetation geography and regional plant communities, on phytocoenology in various languages, there are only a few monographs on plant ecology. What is called plant ecology in the general works of vegetation science is rather an ecological morphology and physiology of flowering plants. Plant ecology is often understood as the study of effects of physical environmental factors on the morphology, and physiology of individual plants. T. A. Rabotnov (1945) in the USSR, and J. L. Harper (1959) in the UK opened new ways in plant ecology, namely, instead to describe and classify plant communities, they analysed the structure and dynamics of single-species populations.

The work reviewed here deals actually with the number of plants in various stages of their life-cycle, with the quantitative effects of genetic and environmental factors on plant populations. Rabotnov, as well as Harper, have always emphasized the specificity of features of plant populations, their differences in comparison to animal populations. Silvertown demonstrates the conceptual unity between plant and animal population ecology. The unifying principle is the mathematical pattern of population structure, the population dynamics of both animal and plant populations being based on differential equations of the Lotka-Volterra type. So, the work of J. Silvertown is a contribution for a better understanding of general mechanisms which govern population dynamics in the whole living world.

The work is written as a guideline, with clear statements and excellent drawings, being a good textbook. It deals with general concepts of plant ecology (Chapter 1), life tables and some of their components (Chapter 2), simple population models (Chapter 3), the regulation of plant populations (Chapter 4), the demography of annual and perennial herbs, of shrubs and trees (Chapter 5), the clonal plants (Chapter 6), with evolutionary ecology (Chapter 7), interactions in mixture of species, *i. e.* a study of plant communities from the viewpoint of population structure and dynamics (Chapter 8), the problem of interspecific coexistence, the competitive exclusion principle and the significance of ecological niche in the plant kingdom (Chapter 9).

The work of J. Silvertown is also a bridge between the Soviet school of

plant ecology and the British school. The author generalizes the results obtained by plant ecologists in the USSR and the UK. Therefore, his references are not only American, as in many other ecological works in the Anglo-Saxon linguistic area.

As a final statement, J. Silvertown shows that the diversity of nature leads to a diversity of ecological theories, which explain various population phenomena, and that there can not be a universal all-explaining ecological theory. These are the philosophical conclusions of the author.

BOGDAN STUGREN

N. Cetăţeanu, A. Braslă, A. Matei, D. Dogaru, S. Şerbănescu, **Sericicultura practică** *(Practical Sericulture)*, Editura Ceres, Bucureşti, 1988, 493 pages with 80 figures and 57 tables.

In Romania, the culture of mulberry tree and the breeding of silkworms is certified by documents since the 15th century. But in spite of this fact, sericulture has constituted itself as a productive branch only after 1974 when the programme of development of the sericulture for the period 1974—1993 has been elaborated.

Besides the silkworm of the mulberry tree *(Bombyx mori)* which is the main source of the most valuable natural fibre, in our country two half-wild species of silkworms have been bred since 1942 and 1966, respectively. These are the silkworm of the oak tree *(Antheraca pernyi)* and that of the ricin *(Philosamia ricini)*.

Due to the favourable conditions for the culture of mulberry tree, ricin and oak tree, from the plains to the hillocks, and also because cultivating land with these plants is one of the best ways to make it profitable, nowadays sericulture is a reality all over the country not only in specialized farms but also in forest areas, schools as well as in private farms.

In order to make a good profit from the approximately 40 kinds of mulberry trees and over 30 races of *Bombyx mori*, it is necessary to possess a good knowledge of the later discoveries regarding the mulberry tree culture and the breeding of the silkworms.

"Practical Sericulture" gives such information to the sericulturists. Through all its content, the book has a strong applicative character. This is evident especially from its division into two major themes: technology of the mulberry tree raising and culture (140 pages) and technology of the raising, breeding and improvement of the silkworms (353 pages).

Regarding the theoretical problems, the book mentions only those that are important for the sericultural practice such as description of the various stages of development, the progress in time of the evolutive cycle, the behaviour of the larvae during the period of "sleep", the physiological basis of the moulting and diapause, etc.

As a response to practical necessities, the book represents an element that contributes to progress of the sericulture, the product of which, the natural silk is unreplaceable in the textile industry, electrotechnics, aeronautics and medicine.

PANTE GHERGHEL

V. N. Pereverzev, **Biokhimiya gumusa i azota poch Kol'skogo poluostrova** *(Biochemistry of Humus and Nitrogen in Soils of the Kola Peninsula)*, Izdatel'stvo Nauka, Leningradskoe otdelenie, Leningrad, 1987, 303 pages with 42 figures and 66 tables in the text and with 22 tables enclosed.

Dr. V. N. Pereverzev, a well-known collaborator of the Polar-Alpine Botanical Garden Institute of the Kola Branch of the USSR Academy of Sciences (Kirovsk, Murmansk Region), has been studying the chemistry and biochemistry of soils in the Kola peninsula for more than 25 years. His new book, reviewed here, is a synthesis of his investigations on humus and nitrogen biochemistry of these soils (podzolic and peat soils, located in the tundra, forest-tundra and northern taiga zones). Besides the analysis of humus and nitrogen, soil-microbiological and enzymological analyses have also been carried out. The same emphasis has been given to both theoretical and practical (agricultural) aspects of the humus and nitrogen biochemistry.

The book consists of Preface, Part 1 — Organic matter and nitrogen in soils of the Kola peninsula (Chapters 1—3), Part 2 — Biological processes and transformation of organic matter and nitrogen in soils (Chapters 4—7), Conclusions, Enclosures and a Bibliographical list with 330 titles.

We specify the chapter headings: Genesis and regional peculiarities of soils; Organic matter and nitrogen in podzolic soils; Organic matter and nitrogen in peat soils; Meteorological conditions and hydrothermal regime of soils; Transformations of plant residues and of organic fertilizers in soils; Seasonal dynamics of soil processes; Efficiency of fertilizers in cultures of crop plants.

All analytical data have indicated that the low intensity of mineralization processes, due to insufficiency of heat during the vegetation period, determines a high efficiency of organic and mineral N fertilizers in both podzolic and peat soils of the Kola peninsula.

V. N. Pereverzev's book is of much interest for soil biochemists and microbiologists as well as for those agronomists whose cultivated fields are located in areas under unfavourable climatic conditions.

ȘTEFAN KISS

Population Genetics and Molecular Evolution, Edited by Tomoko Ohta and Kenichi Aoki, Springer-Verlag, Berlin, Heidelberg, New York, Tokyo, 1985, XVII + 503 pages with 87 figures and 80 tables.

The volume comprises 32 papers presented at the Oji International Seminar held in Mishima in November 1984. The contributors to this volume are leading researchers from the United States, England, Australia and Japan, working in one or more of the following related fields: theoretical and experimental population genetics, molecular biology, molecular evolution, biostatistics, and mathematics.

The opening paper by Crow is a concise historical review of the neutrality-selection controversy indicating the major objections to the theory and how they have been met. The first of the next two papers by Kimura exemplifies the use of diffusion models to obtain the average time until fixation of a mutant gene or genes under continual mutation pressure.

Nei summarizes his original results on human evolution at the molecular level, while Milkman presents a unified theory of population genetics and molecular evolution which reconciles neutrality at the gene level with stabilizing selection at the phenotypic level.

The next two papers also deal with the population genetics of prokaryotes. The following four papers are theoretical papers motivated by the recent discoveries in molecular genetics. The papers by Shimizu, Itatsu and Shiga are rigorous mathematical treatments of population genetics models. Tajima compares the various statistical methods which have been proposed to estimate evolutionary distance at the DNA level, and Tateno reviews past research on the estimation of phylogenetic relationships.

The fascinating phenomenon of codon usage is the subject of the 23rd and 24th papers. The existence of a strong positive correlation between choice of synonymous codons and availability of isoaccepting tRNA molecules has been solidly demonstrated by Ikemura for *E. coli*, yeast, and *Salmonella typhimurium*.

Having a highly scientific level, the book is a remarkable guide to modern population genetics and addresses itself both to specialists and to students in biology.

NICOLAE COMAN

Donald P. Doolittle, **Population Genetics: Basic Principles** (Advanced Series in Agricultural Sciences 16), Springer-Verlag, Berlin, Heidelberg, New York, London, Paris, Tokyo, 1987, X + 264 pages including 20 figures and 42 tables.

The five chapters of the volume represent a valuable comprehensive synthesis of bibliography referring to the Hardy-Weinberg Law, constant allele frequencies, systematic and dispersive forces and quantitative inheritance.

Formulae are incorporated into the flow of the discussion in the text, though usually written on a separate line to enhance clarity. An attempt has been made to introduce formulae as gently as possible and to explain fully what each means. For a biologist, after all, the importance of a formula is not its algebra but the biological meaning of that algebra.

In contrast to earlier books on the subject, this compact text focuses on the potential for genetic manipulation. It provides the foundation in population and quantitative genetics, required to apply genetic principles to animal and plant breeding. Both lecturers and students will appreciate the convenient organization of the material, which makes this an excellent teaching text for a course in applied population genetics. With its concise treatment of basic concepts it should also provide a handy reference to established researchers.

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Lei 35