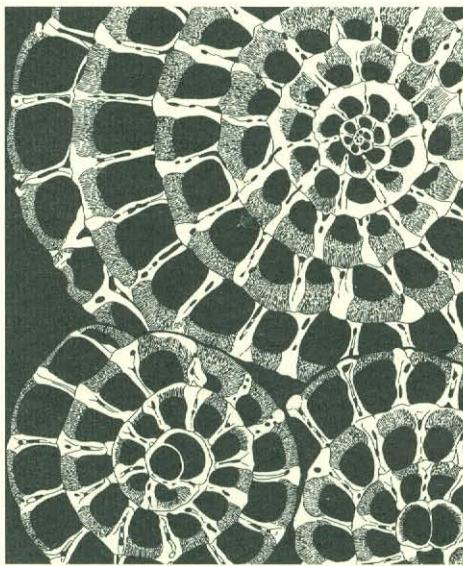


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Doctor Honoris Causa  
LUKAS  
HOTTINGER

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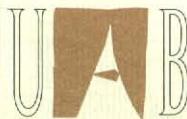


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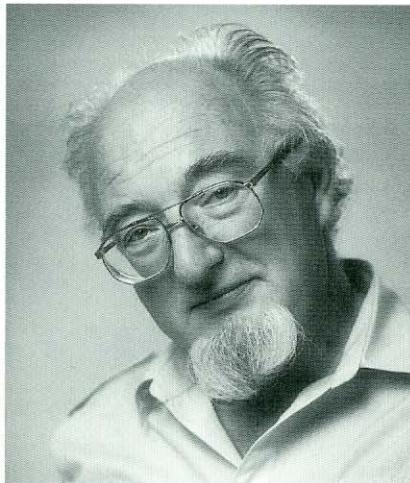
2 FEBRER 1999

Doctor Honoris Causa

# LUKAS HOTTINGER



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de la Facultat de Ciències  
de la Universitat Autònoma  
de Barcelona  
el dia 29 de maig  
de l'any 1997

Bellaterra, 1997



1500-735483

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Editat i imprès pel  
Servei de Publicacions  
de la  
Universitat Autònoma de Barcelona  
08193 Bellaterra (Barcelona)

Impress a Espanya

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PRESENTACIÓ  
DE  
LUKAS HOTTINGER  
PER  
ESMERALDA CAUS



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Excel·lentíssim i Magnífic Senyor Rector,  
Benvolguts Col·legues,  
Estimats Estudiants,  
Senyores i Senyors,

Avui és per a mi un dia de molta satisfacció, i ho és per dos motius. Primer, per rebre el professor Lukas Hottinger com a doctor *honoris causa* de la Universitat Autònoma de Barcelona. Segon, per l'honor que per a mi suposa veure'm directament vinculada a aquest acte de reconeixement públic a la tasca investigadora i docent del professor Hottinger.

Quan, a mitjan anys setanta, vaig arribar a Basilea, ho vaig fer amb la timidesa i por d'anar a un país desconegut. No era una por d'anar a fora, car ja havia fet part dels meus estudis a París, on, a més, havia col·laborat amb la Universitat de París VI, el Museu d'Història Natural o l'Institut del Petroli. Però Suïssa era quelcom de diferent. A la meva ment arribaven aquelles imatges que la premsa ens distribuïa dels suïssos, homes i dones freds i tancats, ufanosos de preservar el seu país envers la immigració, despectius amb els estrangers, on tot es movia a l'hora i amb ordre.

Però, en trobar-me amb el professor Lukas Hottinger, Lukas per a mi des d'aleshores, bé que la seva forta personalitat m'impressionà, el seu tarannà obert em recordà el de la gent dels països mediterranis. Haig de dir que el meu primer pensament fou: «O bé en Lukas Hottinger no és suís o bé les persones que han visitat el país i les informacions dels diaris m'han enganyat». Però és cert que a tots els països hi ha persones que tenen una qualitat humana excepcional. Aquest és el cas del professor Lukas Hottinger.

Aquesta qualitat humana es fa palesa en l'ajut que el professor Hottinger ha prestat sempre als investigadors foranis. Quants estudiants han passat pels seus ensenyaments! Quants estudiants o ensenyants de països en via de desenvolupament han arribat a les portes del seu laboratori, o de casa seva, demanant-li ajuda per fer una tesi, per aprendre unes tècniques, per posar en marxa un laboratori! Han arribat des del món àrab, la Xina, Pakistan, l'Índia, l'est d'Europa, Amèrica Llatina... Potser com a conseqüència de tot això, el seu laboratori ha contrastat amb l'ordenat món suís.

Avui, dia excepcional per a tots els que hem tingut la sort de relacionar-nos amb el professor Hottinger, voldria començar aquesta semblança amb una frase que em digué la primera vegada que vaig anar a Basilea. Quan jo li feia preguntes i més preguntes concretes sobre la identificació d'un fòssil determinat, sobre la seva edat, el medi on vivia, responia: «No ho oblidis mai. Per utilitzar els fòssils cal conèixer-los, i tot el que necessites t'ho diuen les estructures; mira-les bé. No utilitzis els fòssils com a

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segells de correu, ans com a éssers del passat que són». Això és el que ell ha fet al llarg de la seva prolífica carrera, i també el que ha procurat ensenyar, sigui des de la seva càtedra de Basilea, des de cursos internacionals o de col-laboracions institucionals i personals amb molts estudiants i investigadors.

És a la Universitat de Basilea, una de les universitats més antigues d'Europa i amb una llarga tradició paleontològica, on el professor Lukas Hottinger realitzà els seus estudis universitaris de geologia i paleontologia, com a matèries principals, i de zoologia i botànica. En aquesta mateixa universitat preparà, sota la direcció del professor Manfred Reichel, una tesi doctoral sobre les alveolines del Paleocè i l'Eocè. En aquest treball estudia les espècies, els seus límits estratigràfics i els canvis en el temps aplicant el concepte de línies filogenètiques a la construcció d'una biocronologia dels períodes Paleocè i Eocè. Una estreta col-laboració amb el professor Hans Schaub, director del Museu d'Història Natural de Basilea, qui treballava sobre el grup dels nummulits, freqüentment a les mateixes seccions i mostres, donà lloc a un sistema de zonacions dels sediments d'aigües poc fondes que és encara vigent avui dia.

El seu caràcter emprendedor i l'afany de conèixer noves terres el portaren, al final dels anys cinquanta, al Marroc. A Rabat, sota la direcció de Georges Choubert, i en el si del Servei Geològic, creà un laboratori de micropaleontologia amb el qual donar suport als mapes geològics que es realitzaren. Com ell mateix explica, allí les dificultats de treball eren enormes, però les possibilitats d'aprendre coses noves eren immenses. Les ben exposades i poc deformades sèries liàsiques i juràssiques nord-africaines li van permetre d'experimentar, a nivell genèric, l'aplicació de l'anàlisi estructural en la reconstrucció de les complexes estructures internes de les closques dels foraminífers, i estendre els principis de l'anatomia comparada, introduïts en la recerca dels foraminífers per Reichel, als foraminífers aglutinats. L'anàlisi estructural dels foraminífers basada en diagrames tridimensionals fou estesa anys més tard utilitzant el microscopi electrònic de rastreig (*scanning*) en les complexes i irregulars estructures dels foraminífers perforats, com per exemple el sistema de conductes o les estructures rotaloïdes.

La jubilació del professor Manfred Reichel portà de nou Lukas Hottinger a la Universitat de Basilea, però aquesta vegada ja com a professor, situació en la qual ha restat fins a l'actualitat.

La Universitat de Basilea és una universitat tradicionalment petita i eficient, que en certa manera no ha patit la massificació que la major part d'universitats europees ha experimentat després de la Segona Guerra Mundial, massificació que al nostre país no va arribar fins al final dels anys seixanta, i producte de la qual fou precisament la nostra universitat i

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tantes altres. Això fa que al professor Hottinger, com a únic professor de l'Àrea de Paleontologia, li calgui ensenyar, en els estudis de ciències de la terra, micropaleontologia i paleontologia d'invertebrats i vertebrats. Més tard, ha afegit al seu currículum els ensenyaments de paleoecologia i mètodes bioestratigràfics. Aquesta diversificació de l'ensenyament, que podria en certa manera semblar negativa, és altament positiva perquè li dóna una visió interdisciplinària de la paleontologia, visió que els manca a molts altres ensenyants, la qual cosa beneficia no tan sols l'ensenyament sinó també, i de manera molt clara, l'avenç de la recerca.

La invitació per impartir uns cursos de paleontologia a la Hebrew University d'Israel, l'any 1970, li donà l'oportunitat de prendre contacte amb el professor Zeev Reiss i de participar, a l'estació marítima de Steinitz a Elat, en la recerca sobre els foraminífers vivents. Així, el mar Roig es converteix en l'eix de les seves recerques sobre els foraminífers actuals, i va realitzar, entre l'esmentat any 1970 i el 1984, nombroses expedicions. Al golf d'Aqaba, va tenir l'oportunitat de combinar l'observació directa dels models de repartició dels foraminífers, per simple immersió o utilitzant un petit submarí, i d'estudiar la ultraestructura del seu protoplasma mitjançant el microscopi electrònic de transmissió (TEM). Aquestes recerques al mar Roig foren complementades per d'altres a l'arxipèlag de les Maldives, a Nova Caledònia i al mar Mediterrani, en particular a les illes de Creta i Elba, en col·laboració amb el professor David Senn, del Departament de Zoologia de la Universitat de Basilea. Els estudis sobre els foraminífers vivents donaren un important suport a la interpretació del registre fòssil.

Al final dels anys vuitanta, quan s'observà la progressiva destrucció dels esculls coral-lins a l'illa Maurici, amb el conseqüent perjudici econòmic en una illa on una gran part de la població viu del turisme, la Comunitat Econòmica Europea creà un equip interdisciplinari, format per més de vint científics de diferents països europeus, per tal d'estudiar el que començava a ser un desastre ecològic i trobar-hi una solució. La participació en aquesta recerca aplicada del professor Hottinger i el seu equip fou intensa. El resultat de les investigacions provà que l'eutrofitzacíó de les aigües, en aquest cas produïda per l'home –amb la utilització desmesurada de fertilitzants en el cultiu de la canya de sucre– produïa la mort de les comunitats lligades a un medi oligotòfic. Sota condicions extremes, la producció de carbonat s'aturava, i donava lloc als «deserts ecològics».

Aquestes observacions del que succeeix als mars actuals són extraordinàriament importants en el camp de la geologia perquè plantegen un interrogant a les explicacions clàssiques de les grans extincions del passat. I és precisament per això que el professor Hottinger, conjuntament amb molts altres membres de la comunitat científica internacional, entre

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els quals em trobo, engegà ara fa set anys, i dintre del marc dels Programmes Internacionals de Correlació Geològica patrocinats per la UNESCO, l'estudi de la gènesi i els processos que causaren les grans ruptures en l'evolució de la fauna, principalment dels foraminífers de gran mida, amb una estratègia de vida K extrema.

Totes aquestes activitats del professor Lukas Hottinger, que jo he volgut explicar en poques paraules, i que possiblement no he aconseguit realçar el que es mereixia, queden pàlees en la llista de les seves publicacions més importants, la major part monografies que recullen una vida de dedicació a l'estudi dels foraminífers en totes les seves facetes.

Però, tan sols pel que he explicat, possiblement el professor Hottinger no seria aquí. Hi ha quelcom més: la relació de Lukas Hottinger amb el nostre país, la nostra universitat.

La relació del Lukas Hottinger amb el nostre país comença, com a ell li agrada d'esmentar, «abans que la majoria de nosaltres entréssim en contacte amb la bellesa geològica que ens envoltava». Això fou l'any 1954, quan realitzava la seva tesi doctoral, i es traslladà a Catalunya per estudiar les sèries terciàries, aleshores mal conegeudes, de la conca de Tremp, regió que més tard faria «popular» geològicament parlant, fins a arribar a convertir-la en seu d'estudi obligat per a qualsevol geòleg de conques sedimentàries, tant del món universitari com d'empreses i serveis geològics. A ell, juntament amb Hans Schaub, es deu la creació de l'estatge Ilerdià, que designa precisament una sèrie a la conca de Tremp com a estratotip.

En aquells anys difícils al nostre país, quan els camins eren intransitables, els hotels no existien, els estrangers eren sospitosos i fer geologia de camp era gairebé una aventura, ell va quedar enamorat dels pobles pirenencs, de la seva gent i dels seus costums. Com em confessà anys més tard, l'impacte que produí en ell els festeigs dedicats a Sant Martí a la localitat de Bernués, al Pirineu d'Osca, i com fou acceptat a participar-hi, van determinar que al seu primer fill li fos imposat el nom de Martin.

D'aleshores ençà, sempre més ha estat lligat al nostre país i a la seva geologia, tant per la seva col·laboració personal amb les universitats i centres de recerca, com pel fet que aquesta terra es convertí en lloc de pràctiques de camp i treballs de recerca de la major part dels seus alumnes.

La relació amb la Universitat Autònoma de Barcelona podem dir que començà abans del naixement de la mateixa Secció de Geològiques, quan el professor Lukas Hottinger va entrar en contacte, al final dels anys seixanta, amb l'ara professor d'aquesta universitat Joan Rosell. Aquesta estreta col·laboració entre ambdós professors va fer possible l'organització, per part de la Universitat Autònoma de Barcelona (una universitat molt nova a l'època, 1973) conjuntament amb l'Empresa Nacional Adaro de Investiga-

ciones Geològicas, del XIII Congrés Europeu de Micropaleontologia.

A partir d'aquest moment, la relació s'intensificà, i el professor Lukas Hottinger mantingué la promesa, feta al professor Joan Rosell, d'ajudar a la formació d'especialistes en micropaleontologia, per tal de poder organitzar a la nova Secció de Geològiques tant la docència com la recerca en aquest camp. Fou així com el professor Lukas Hottinger es convertí en supervisor d'una part de la meva tesi, primer, i en company de recerca, més tard. Haig de dir que durant els meus primers anys de docència a la Universitat Autònoma de Barcelona, quan no hi havia cap tipus de material, i els meus coneixements eren molt limitats, el professor Hottinger fou una mica el meu «salvador», és a dir, la persona a qui sempre podia demanar-li una informació determinada, un llibre que no era al meu abast o un consell davant d'un problema.

Amb el temps, aquesta relació de treball i col·laboració ha esdevingut una relació d'amistat. És per això que ara em permeto, Excel·lentíssim i Magnífic Rector de la Universitat Autònoma de Barcelona, de sol·licitar per al professor, company i amic Lukas Hottinger el grau de doctor *honoris causa*, que permeti d'expressar en un moment en què la seva jubilació no és gaire llunyana i, com ell mateix diu, per part dels «seus hereus», el reconeixement degut a la seva dedicació al món de la biologia, de la paleontologia i de la geologia, unides en el coneixement dels foraminífers.

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DISCURS  
DEL PROFESSOR  
LUKAS HOTTINGER

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## Paleontology, quo vadis?

Vir Magnifice,  
Vir Mirabilis,  
Dear Colleagues and Friends,

The honour to receive a doctorate of your distinguished academic institution goes of course in the first place to the University of Basel having provided the possibility to do research and academic teaching without too much material preoccupations during most of my active academic life for over three decades. For a single person, to build an architecture of scientific thought of some breadth and significance and integrated into the current knowledge by academic teaching indeed takes time and stable working conditions for many years if not a school over more than one generation. Today, the long-term stability in the status of the academic personnel tends in most larger disciplines to be replaced by the formation of cooperative task forces in order to accelerate scientific production and economic progress with innovative products. This has dangerous side effects which may deepen the gap between the scientific community and the general public by their successively more diverging views of the world expressed in more and more divergent languages. Unfounded fears and emotional rejection of current ideas in science are produced within the general public, if there is no effort and leisure to integrate new scientific knowledge into the world view of the society. To carry out our scientific work, my generation, including myself, has been lucky to live in an extraordinary period of peace, economic growth and social welfare for which we have to be deeply grateful.

The institutions promoting, organizing and codifying the spiritual life of our societies by producing new thoughts, and transmitting these to subsequent generations by teaching, are the churches, universities, academies and museums. I have always been impressed by the long-term stability of these structures of society in spite of their numerous imperfections and shortcomings due to the human nature of the persons involved. Wherever you investigate this phenomenon in the world, these structures have survived over centuries the changes in political regimes, the turnover of state constitutions and the substitution of economic systems. This emphasizes the act you carry out today by supporting and rewarding a successful collaboration between our respective institutions going back to the period of the foundation of Bellaterra Autonomous University in the early years of my academic activity in Basel. Thus, my thanks are directed to both your and my institutions providing the institutional frame and the

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economical basis for a successful common academic activity during several decades.

On the other hand, personally, I am deeply moved to be honoured by a doctorate of a university belonging to a cultural realm which is so much different from ours in Switzerland. During my years of sojourn in Morocco, I have learned to perceive the might and importance of the cultural bonds of language. In the Rif mountains, the limits between the French and the Spanish influence on every-day life was still overwhelming during the early sixties in spite of the efforts of arabisation in this wonderful North-african country. Later, I learned the significance of the cultural bonds produced by the Spanish language accross the world oceans. Strolling one day through the narrow streets of the center of Tremp, the hospitable little Pyrenean town which has been of so much importance to my scientific activity, there was a book shop selling books of communist authors from Cuba at a time when Franco was still very much in power. I pointed out these books to my colleagues from communist Russia but they were unable to understand the phenomenon of *hispanidad*, a language bond to be so much more forceful than state ideologies from left or right. Thus, I am grateful to be admitted, so-for-say, to your cultural realm, inspite of my poor knowledge of the Spanish language, for this opens to me the world accross the atlantic to South America and will extend my life's experience as much as did the access to the marine world under the surface of the sea by scuba diving. Could there be a better reason to be grateful?

Your act honours not only institutions and a single researcher, but also a discipline of natural sciences, paleontology. This discipline has lived during the last three decades in the shadow of plate tectonics in geology and of the rapid expansion of genetics within biology. With the increasing social demand for an ecological understanding of our planet and of the life on its surface including our own existence, the history of life as it is explored by paleontology gains significance and esteem in the general public much more than in our immediate sister disciplines. Each ecological situation in the present day and at a particular site has its own individual history which must be taken into account when trying to understand the processes involved. Paleontology has the answer not only to reconstruct and describe the history of life but also to explore ecological processes running for time periods of geological dimensions and therefore inaccessible to experimental approaches. The current discussion on contradicting models designed to understand the recovery of life after events of mass extinction illustrates the current state of the art in paleontology where the taxonomic inventory of the organisms having lived on earth during Phanerozoic times almost doubles with each generation of sci-

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tists active in the field while the progress in theoretical thinking is slow. The disequilibrium in favour of complementation of the inventory is easy to understand: new taxa are rewarded as scientific result by the rules of nomenclature including the author's name in the designation of the taxon while new theories have a high risk to be wrong or rapidly surpassed by better ones, their authors being forgotten very quickly.

Nevertheless, the first task of a paleontologist is to look at the historical document, i.e. at the fossil itself and at the nature of the encasing rock, analysing in particular the morphology of the hardparts of the organism under investigation. In my view, the precise observation of the fossil's morphology and, beyond taxonomic identification, its interpretation according to the laws and processes of morphogenesis and comparative anatomy are the primary, and presently the most neglected, task of the researcher. In foraminifera, my own field of specialized competence, most smaller benthics are still described only as to their outside morphology and often inadequately documented by SEM pictures registering exclusively the relief on the outside of their shell, with the exclusive goal to justify their identification. However, beyond taxonomic identity, the shells of the foraminifera may have registered millions of years ago functions and modes of metabolism, for instance gaz exchange, biominerallisation, motility, growth, reproduction, endosymbiosis, interaction with other organisms or other types of stress etc. Such traits, visible often in the interior of the shells' architecture (Fig. 1), document much more than the systematic position of the taxon and help to understand the organism's ecological success in particular environments and the canalisation of the evolution of its descendants during earth history within the often narrow limits of internal and/or autecological constraints (Table 1).

Foraminifera produce their test as a biominerallized cell envelope functioning simultaneously as a protective device for the inner part of the protoplast and as endoskeleton with mechanical performances. Calcium carbonate is available in almost limitless quantities in the primary shallow environments of the foraminifera. Its use for biominerallisation represents the most efficient way to produce mechanically resistent hardparts shaped under biological control with minimal expenses of proteins lost to recycling. Thus, calcium carbonate biominerallisation is the response to nutrient scarseness in the environment wherever the nitrates in particular represent the limiting factor, rather than energy, for the carrying capacity of the foraminiferan's habitat. Adding stepwise new parts of cell envelope to previous ones is the primary strategy of cell growth in foraminifera permitting to subdivide the protoplast into compartments of average cell size representing the optimal volume for cellular metabolism. Thus, the foraminiferal cell may produce giant body-sizes reaching about 15 cm

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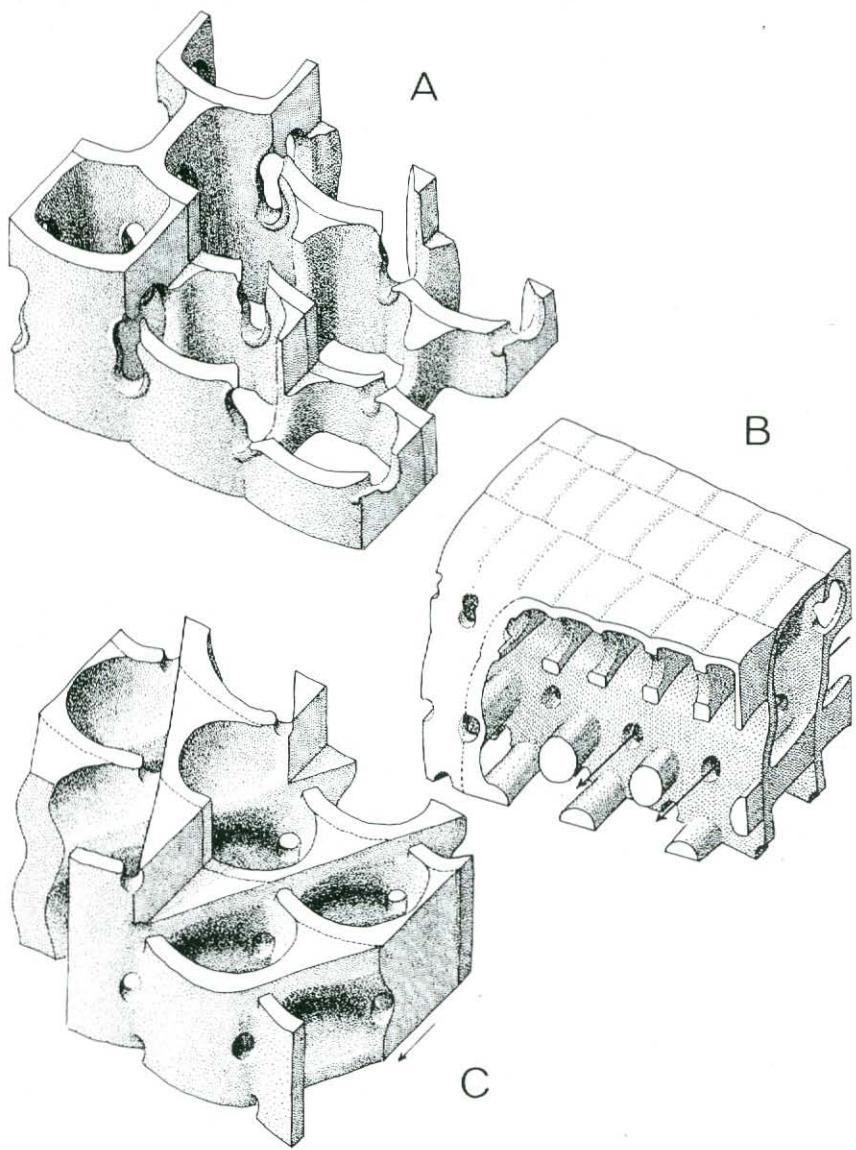
after a comparatively long ontogenesis during several years. This opens for the unicellular organism the potential to adopt strategies of life usually characteristic for multicellulars. Dimorphism of the generations will support and further differentiate this strategy by attributing different lifetimes to each generation and hence two different strategies of life for the same species. The repeated success of this double strategy of life is reflected by the repeated rise of larger foraminifera during earth history since the Late Carboniferous with its diversified fusulinid faunas. Thus, the basic nature of a foraminifer and its cell envelope constitutes a heritage from about Mid-Paleozoic times which may be used in various ways to survive in almost all marine environments. In the same time, this heritage constitutes a general constraint limiting the evolutionary potential to comparatively narrow paths and enforcing stereotyped responses if similar environmental conditions are repeated in earth history.

During periods of more or less simultaneous mass extinction the basic heritage of the foraminifera, as far as expressed in their shell morphology, i.e. their mode of biomineralisation, the chamberwise growth and the alternation of sexual and asexual reproduction survives in populations of smaller benthics while the genetic information governing the more elaborate and specialized strategies of life is lost, most probably by a loss of the corresponding particular environments. Changing patterns in oceanic circulation governing the distribution of nutrients, water temperatures and climatic belts may be the primary cause of some if not all mass extinction events.

When environmental conditions are stabilized for a minimum of about ten million years of time, benthic foraminiferal communities will have

Fig. 1. Different generic structures in stereotype, larger foraminifera.

A: *Sorites* (recent), B: *Archaias* (nov. gen., Miocene, Middle East), C: *Orbitolites* (Eocene). Sectors of two and a half chamberlet cycles out of a porcelaneous disc. Stereographs, schematic, not to scale. Lateral wall of disc indicated in B, cut away in A and C. Arrows: direction of radial growth, in B also radial apertural axes. The structural traits of generic relevance are the disposition of radial (B) or crosswise-oblique (A, C) apertural axes and the mode of subdivision of the chamber lumen by continuous walls (septula) in A and C or by free-standing pillars in B. The common, stereotype traits consist in the discoidal shell shape produced by annular growth of successive chamberlet cycles. The apertures are all grouped exclusively on the marginal face of the disc. Moreover, there is always an open passage between the lateral chamberlet cavities below the lateral surface of the disc, irrespective of all other structural traits. Living representatives reveal the function of this passage: the dinoflagellate symbionts change place in the disc in order to avoid too much irradiation by sunlight in the uppermost photic zone (photoinhibition). Thus, the stereotype structural trait reflects the presence of a device to regulate irradiation in unrelated genera from different geological epochs but present in similar, very shallow environments.



**Table 1. The cascade of constraints in foraminiferal shell morphology**

- 1 Microtubular cell skeleton in rhizopodial ectoplasm —> foramen in cell envelope
- 2 Biomineralisation of calcium carbonate —> access to oligotrophic environments
- 2 —> 3 Cell envelope produced by endocellular processes —> cements for agglutinated walls and porcelaneous walls —> inside-outside polarisation but no layering of walls —> exo- and endoskeletons
- 2 —> 4 Cell envelope produced by exocellular processes —>
  - 4a – non-layered envelope (?)
  - 4b – layered envelope
  - 4c – separate morphogenetic control for outer and inner layer —> exo- and endoskeletons, septal flaps, plates, supplemental skeletons
- 1 + 2 —> 5 Chamber-wise, additive growth —> optimal chamber cavity volume corresponding to average cell size —> growth to shell oversize —> +2 —> access to marine K-strategy —> odd pairs —> dimorphism of generations in adult shell size: double strategy within single species
- 2 + 3/4c —> 6 Chamber subdivision —> batteries of productive units —> high volume accretion rates
- 1 —> 7 Cavity shape of productive units (chambers or chamberlet cavities)
  - 7a – no shape constraints —> expansive chambers —> secondary unchambered shell cavities
  - 7b – elongate-tubular, with terminal openings
  - 7c – more or less isometric, with multiple openings, no constraints as to the latter's position
- 7c —> 8 Umbilical cavity —> umbilical covers —> umbilical architectures
- 4c —> 9 Interlocular spaces —> canal systems —> marginal cords
- 10 Mechanical functions of shell shape in relation with disposition of apertures and/or canal system mouths
  - 10a – protective functions exclusive or largely dominant —> geometry of growth constrained by volume accretion rates only
  - 10b – mechanical functions constant during ontogeny —> shape constance
  - 10c – mechanical functions changing during ontogeny —> shape changes
- 11 Intracellular communication
  - 11a – no constraints —> apertures in peripheral position
  - 11b – shortest ways —> apertures in interiomarginal or polar position —> functional differentiation for growth and movement
- 5 + 10b + 11b —> 12 Geometry of growth constrained by volume accretion rates, constance of shell shape and shortest communication
  - 5 —> 12a – low accretion rates + 7b —> miliolid-spiral chamber arrangement + 7c —> rotaliid or nonionid chamber arrangement
  - 5 + 6/7a —> 12b – high accretion rates —> annular, concentric or dendroid growth
  - 5 + 6 —> 12c – compromise 12a and b —> multiple spirals or alternating chamber arrangement in annular or concentric growth
- x —> y: x is prerequisite to y

*Table 1.* Foraminiferal shell morphology between autecological functions and constraints derived from twelve main performances of the living cell. Cell metabolism as reflected by chamber volume accretion rates, symbiosis and nuclear processes (number of chromosomes, polyploidy in larger forms, mechanisms and periodicity of nuclear division) are not listed as their morphogenetic significance is not yet understood. Acting fibers (known to be present in the rhizopodial ectoplasm) may play some morphogenetic role in the shaping of the shell's ornaments, in particular around the apertures and all over the shell surface of infaunal species.

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diversified again by recreating a differentiated genetic heritage which is new as to its particulars but ecologically as effective as the previously lost one, permitting the foraminifera to play an analogous, complex role in the marine ecological system as before. The recovery of the genetic complexity in the post-event populations is reflected by the rise of new phenotypes with their oversized and complex morphology. The complex internal morphology of the foraminiferal shell permits to differentiate the nature of the progress as reflected by the difference of level in the taxonomic system of the taxa involved: in foraminifera, the genera are defined by qualitative differences in the structural characters of the shell architecture while species are defined by quantitative differences in shell proportion, shape and size. Doubtlessly, distinct genera express larger genetic discrepancies than specific differences which often need only a change in a single factor of allometry to produce a different phenotype.

During times of recovery after mass extinction events we observe in shallow benthic foraminifera an early phase where generic diversity rises (Table 2). Most of these genera are monospecific and many are cosmopolitan. In the subsequent phase, a few successful genera dominate the fauna and start to produce parallel phyla of congeneric sister species. The latter follow closely limited paths of further evolution, often exclusively restricted to size increase with time but many phyla show an increase in dimorphism with adult size increase reflecting a gradual adaptation of their life strategy to the periodicity in their environment (Fig. 2). In later phases of undisturbed evolution, different phyla will become dominant or exclusive in different areas producing a gradual advance of endemism. A cycle of subsequent phases of community maturation may be compared to a sere, i.e. to the succession of communities as observed for instance on a forest clearing or on a ploughed field left uncultivated for several years. In contrast to seres however, the mechanism of replacement of successive communities is not a differentiated immigration of species existing somewhere in the closer or more distant neighbourhood but a coevolutionary process involving the change of the genetic heritage of each individual living within the community. This latter process requires time periods of geological dimensions while even a complex sere may reach its equilibrated final stage after some decades. A striking example is given by the recovery of the tropical forest on the Bikini atoll totally devastated by the experimental atomic explosions four decades ago.

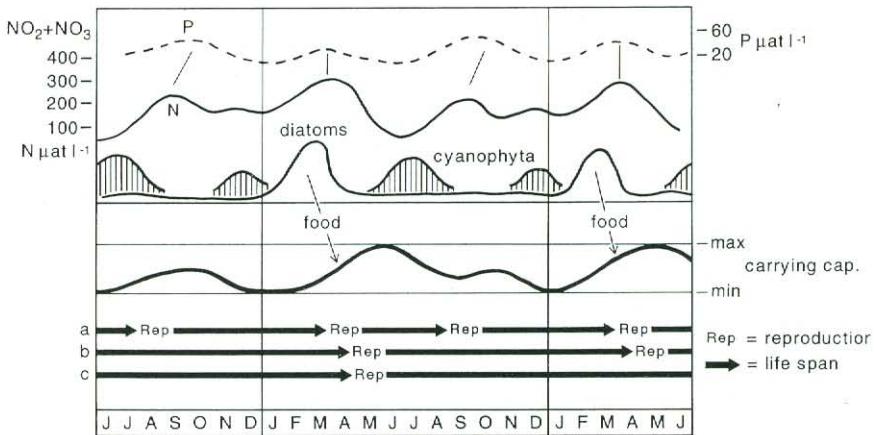
The various phases constituting a cycle of global community maturation as sketched out above may be truncated at very different stages of progress by a new mass extinction event or may lack their initial stages by an incomplete extinction preserving part of the more elaborate genetic inheritance. The latter situation is under closer scrutiny in the frame of the

**Table 2. Global community maturation (GCM)**  
**Phases in a cycle, for K-strategist foraminifera**

Eocene-Oligocene boundary event: plankton and orthophragminiforms out, shallow K-strategists survive				
Priabonian	3?	competition successful	new genera installed besides old ones	new only <i>Spiroclypeus</i>
Late Bartonian	2?	failing to confine competition	new genera emerge <i>O. alpina</i> dominates	new competitors: <i>Pellatispira</i> <i>Biplanispira</i> <i>Heterostegina</i>
Early Bartonian (= Biarritzian)	5	keeping competitors out	species diversity decrease species endemism increase	monospecific endemism of large-sized species frequent
Lutetian Cuisian	4	gaining size	parallel evolution of diversified lineages; odd pairs develop	dm size classes reached
Late Ilerdian				
Early Ilerdian	3	reveling in success	successful genera diversify in different species	success for <i>Alveolina</i> , <i>Orbitolites</i> , <i>Assilina</i> , <i>Nummulites</i> , orthophragminiforms
Late Paleocene	2	experimenting with ways of live	generic diversity increase low-level endemism	about 40 smaller sized forms with complex structures
Early Paleocene	1	preparing for K-strategy phases	no phenotypic response to or no K-strategy (?)	no larger forms no complex structures (?)
K-T boundary event: all K-strategists out, deeper benthos survives. Only <i>Laffitteina</i> survives in shallow water.				

Table 2. The only larger, complex foraminifer surviving the K-T-boundary event, *Laffitteina*, disappears during phase 2 together with many genera of smaller benthics living in deeper-neritic realms. *Laffitteina* presents a stereotypic rotaliid morphology very similar to recent *Pseudorotalia* living in meso- or eutrophic, muddy estuaries of tropical rivers (Mahakam, Kalimantan). The two genera are not related since they belong to different rotaliid families according to their umbilical architecture.

After phase 5, a new GCM cycle starts without apparent ecological forcing. The following phases are tentatively compared to the earlier phases 2 and 3 based on generic K-strategist diversity although several small to medium sized genera survive including the *Nummulites fabianii* lineages representing maybe, by its so-called reticular structure, an advanced grade of nummulitic organisation. Phase 3? is cut off by the Eocene-Oligocene boundary event prior to specific diversity increase in successful genera.



*Fig. 2.* Seasonal change in nutrient concentration in a blue desert during two years and the response of population density of diatoms dependant on the  $\text{NO}_2 + \text{NO}_3$  fertilizer and of cyanophytes having direct access to  $\text{N}_2$  from the atmosphere dissolved in the seawater. Note the delay of P max. in relation to  $\text{NO}_2 + \text{NO}_3$  max. in autumn while they are simultaneous in spring. This indicates a (still poorly understood) difference in quality between the spring and autumn nutrient input and their respective algal blooms. The diatoms are a source of food for the foraminifera and push the carrying capacity to a short maximum. Reproduction takes place when food is most abundant. Strategy *a* uses both yearly algal blooms as reproduction time; strategy *b* the spring blooms only; while strategy *c* is designed to survive the minimum levels of the carrying capacity over more than one year. Within a dimorphic species, each generation may follow its own, distinct strategy, the megalospheric specimens following strategy *a*, the microspheric ones strategy *b* and *c*. This is derived from biometrical analysis of Eocene nummulite shells where E. Machanic (unpublished) measured the periodicity of volume accretion rates in chamberwise growth. Nutrient and bloom data from the gulf of Aqaba, Red Sea (Reiss and Hottinger, 1984, fig. D45, simplified). Life span and reproduction rates according to Zohary *et al.* in Reiss and Hottinger, 1984, fig. G7).

current IGCP 392 project involving your and my own institution very much. At the limit Middle-Upper Eocene, a partial turnover in larger specialized foraminifera takes place, apparently without enforcement of heavy environmental change as it would be reflected by isotopic anomalies in the lithostratigraphic record. Maybe, this change is the result of biological instabilities in communities progressively dominated by endemists.

This is not the place to discuss the different models available in recent literature which try to explain the patterns of biotic recovery after mass extinction events (Kauffman and Harries, 1996) or of the so-called coordinated stasis (Brett and Bird, 1995). However, all these models are based

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on the number and, eventually, on the relative frequency of the taxa in the time gradient from which eventual qualifications such as so-called lazarus, disaster, refugia or progenitor taxa are derived. In foraminifera, the understanding of the biological significance of their morphology has advanced to a level permitting at least to reconstruct their life strategy in a simple K-r gradient on the basis of their morphology and independently from their distribution pattern. Mass extinction and recovery events affect almost exclusively the K strategists among the foraminifera. If the latter are separated from all others, the signal of the fossil record is much improved while the noise is pushed to the background. The noise may be produced by preservation bias, sedimentary gaps and other complications inherent to small-scale facies change, local versus global ecological conditions within a climatic belt, difficulties in high-resolution time correlations and taxonomic inconsistencies. They all may influence the frequency of individuals up to determining their presence-absence pattern in the local paleontological record. The discussion on these models is fully on the move and illustrates the needs of future research in paleontology.

In order to answer the questions raised by current modeling, my intimate requests to paleontological research would be the following: handling the overwhelming quantity of taxonomic data from the fossil record available today needs the help of machines. The prerequisite would be a common language with standardized morphological terms in the diagnoses. The latter represent the first step of abstraction beyond illustration of some specimens representing the taxon. The choice of the terms for composing a significant diagnosis implies also a first interpretation of the meaning of the corresponding morphological traits. This would permit to filter the fossil record with the support of computers according to selected traits of the life history of the organisms investigated, permitting the attribution of qualifications to the taxon beyond its systematic position. Morphometrics, at least in foraminifera, in my view are not a tool to separate taxa but rather to interpret their way of life, for instance by characterizing their growth rates. Taxa should be classified according to their life strategies, beyond the simple K-r gradient, into even more predicative categories of autecological significance. Moreover, we need a new discussion about the significance of higher taxa, in particular the genera, used so often as units in modeling processes of biotic change on earth.

A second bundle of requests is addressed to organismic marine biology. The paleontologists need a comprehensive description of the life histories of selected marine lower invertebrates and unicellular eucaryotes including food requirements, modes of reproduction and ontogenesis, life times, requirements as to their substrate, strategies of larval settlement, ambient temperature and oxygen consumption etc. Many data of this kind

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are scattered in the older literature of marine biology, most are punctual and incomplete. Marine ecology and paleontology should unite their efforts to design a strategy for meeting these demands to the benefit of both disciplines.

The current knowledge on morphogenesis reflects long neglect. Shell shape in many groups of paleontological significance is constrained by modes of shell formation conditioning the geometry of shell growth. The compromise between the constraints of growth with other functions such as motility or protection and parsimony of material consumption has to be investigated in many groups by experimental approaches with living organisms as well as by geometric modelling. The effect of environmental stress on the morphology and its intraspecific variation is another subject on the menu of desiderata.

The currently rising DNA amplification and sequencing techniques seem to open new ways to approach the old problem of the genetic significance of the phenotypes defining the taxa used as basic units of measurement in paleontology. Consider two brothers (standing for a phenotype) inheriting from their father equal parts of the family fortune (standing for the corresponding genotype). Under what conditions would they use their capital in what ways in order to leave to their own sons the same amount of money? Do the laws formulated by genetics really define these conditions or rather the rules of banking determining the stability of capital value in the economic system as a prerequisite, frame and constraint to the transfer of capital from one generation to the next? This parable may be all wrong or inadequate but it might illustrate the complexity and fascination of the many questions raised. In the answers, paleontology will have to participate. In crediting the discipline by your act, you will, hopefully, accelerate their elaboration.

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*CURRICULUM VITAE*  
DE  
LUKAS HOTTINGER

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Born 1933 in Düsseldorf, as son of Prof. Adolf Hottinger, pediatrician, and Dr. Greta Hottinger-Cahn, chemist, of Swiss nationality, resident in Allschwil (Basel).

Primary and secondary schools in Basel (Switzerland). Summer courses in Neuchâtel (Switzerland) and Exeter (England). Maturity 1952 at Humanistisches Gymnasium Basel (classical Greek and Latin). University studies at Basel University in Geology-Paleontology, Mineralogy, Zoology and Botany (1952-1959). Ph.D. Thesis directed by Prof. Manfred Reichel on «Paleogene and Eocene Alveolinids».

1959-64. Setting up a micropaleontological laboratory within the Moroccan geological survey's mapping department, under the direction of Georges Choubert. Introductory courses on micropaleontology at Rabat University within a DEA teaching cycle, under the direction of Prof. Anne Faure-Muret.

1964-66. Assistant curator at Natural History Museum of Basel, directed at this time by Prof. Hans Schaub.

1965. Habilitation at the University of Basel (Privatdozentur) with a habilitation thesis on «Moroccan Jurassic Larger Foraminifer».

1966. Election to succeed Prof. M. Reichel at the University of Basel as Professor for Geology and Paleontology.

1969-71. President Swiss Paleontological Society.

1970. Guest professor at Hebrew University. Jerusalem

1970-72. President Swiss junior scientists.

1974-78. Member of executive council of German Paleontological Society.

1977-79. Production of a TV series in seven parts on the geology of the Alps for Swiss and Babarian TV.

1978-1986. President group of experts for MAB-Switzerland (Man and Biosphere National Research program of Swiss National Science Foundation).

1980-84. Delegate of Swiss group of experts for ASPIS (study of deposition of radioactive waste in the ocean bottom, modeling ocean circulation).

1981. Expedition to Nouméa (New Caledonia) for the study of Nautilus.

1988-94. Vicepresident Swiss Academy of Natural Sciences.

1989-95. European Community Project in Mauritius for the study of the litoral.

1990-95. Leader of IGCP 286 «Early Paleogene Benthos»

1993-96. Leader of International Training Courses on Benthic Foraminifera, within the frame of European COMETT activities.

1994. Member of the Slovenian Academy.

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## MAIN RESEARCH ACTIVITIES

1954-1959: **Paleogene and Eocene Alveolines.** Species, their definition and their change in time, concept of phylogenetic lineages and their use for detailed, zonal biochronology. The results were published as vol. 75-76 of *Mémoires Suisses de Paléontologie* in 1960.

1959-1980: **Structural analysis in Larger Foraminifera.** The Liassic and Jurassic fauna produced the opportunity to experiment, at generic level, with structural analysis and reconstruction of complex internal shell structures. The concept of «exoskeleton» and «endoskeleton» provided a common basis for structural comparison independent of higher systematics and produced a foundation for a general functional morphology of imperforate foraminifera. The details of structural analysis supported by 3D diagrams were committed to a monograph on mainly Moroccan imperforate foraminifera published in Rabat 1967 and subsequently completed by a study of Paleogene conical imperforates (Hottinger and Drobne, 1980). These studies were extended to more irregular structures in perforate foraminifera, such as canaliferous operculiniforms (1977) and rotaliid structures (1980). The synthesis of the studies of comparative anatomy of foraminiferal shells was written as a contribution to *Foraminifera 3* (1978).

1970-1984: **The Gulf of Aqaba studies.** They are summed up in vol. 30 of Springer's Ecological Studies (1984) supplemented by an inventory of the foraminiferal fauna as a whole (1993). The latter provided the opportunity to combine, together with Z. Reiss, the comparative anatomy of smaller benthics with the one of larger foraminifera and to produce a commented and amply illustrated glossary tending to unify morphological description in foraminifera. The main result of the Aqaba studies consists in the recognition of the overriding importance of the oligotrophic nature of a carbonate producing tropical environment housing the larger-sized foraminiferal K-strategists. The researches in the Red Sea were supplemented by several scuba-diving expeditions to the Maldives Islands, to New Caledonia and to various places in the Mediterranean, in particular to Crete and to Elba Island.

**Studies on macroid formation** based mainly on observations in Elba Island (in Coated grains, 1983) relativized the importance of the static ecological factor hierarchy «nutrient concentration-substrate-depth» by the dimension of time (1990): maturation of communities will be an important concept in the understanding of foraminiferal history.

1989-1995: **Studies on Mauritius (1989-1995).** In late eighties, J. Müller from Marsella University approached me for taking over the study of recent foraminifera from Mauritius (Indian Ocean) where he had

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observed heavy damages in the coral reefs and was looking for reasons of such an ecologic desaster. From this approach resulted a research project involving over twenty scientists from half a dozen French and Swiss universities studying water chemistry and the ecology of most major biotic elements in this coastal environment. I participated in three expeditions to Mauritius attracted by the opportunity to observe the consequences of man-made eutrophication in an extremely oligotrophic environment on the foraminiferal assemblages. In opposition to what I expected to hapen, the oligotrophic foraminiferal community is not replaced by meso- to eutrophic ones such as known for instance from large tropical estuaries (Mahakam Delata, Borneo) with *Pseudorotalia*-dominated assemblages, but simply dies away together with most other carbonate producing organisms. Under irreversible conditions of eutrophication, the carbonate production is stopped altogether, a process generatins full deserts constituting a model for some types of fossilized hard-grounds. The results of these activities are committed to a series of reports to the European Community in Brussels and still await monographic treatment to be published in Erlangen as a volume of *Facies*.

1989-1994: **IGCP 286 Early Paleogene Benthos.** For many years, the discussion about genesis and processes causing faunal breakdown during short periods in Earth history are a permanent source of irritation to me, being convinced that there is too much genus of the present period involved. This instigated the set up of the IGCP project focused on the recovery of K-strategist foraminiferal fauna in shallow tropical waters after the K-T boundary event. In collaboration with the Subcommission of Paleogene Stratigraphy, the biostratigraphic zonation of shallow benthics had to be revised, completed and correlated to magneto- and sequence stratigraphy in order to produce a closely spaced time frame for the recovery event. The elaboration of a revised and unified zonation revived all the old contacts established during early work in Paleogene, in particular with the Autonomous University of Barcelona, the Slovenian Academy and the MTA Ankara in Turkey. In addition, close collaboration with the Geological Institute of Lahore University (Pakistan) was set up.

After faunal break-down at the K-T boundary, the recovery of the environment, i.e. de-eutrophication of shallow tropical waters, produces after some 6-8 million years a first set of associations consisting of high numbers of mono- or oligo-specific genera with a considerable degree of provincialism. Few of these genera survive the first K-strategy diversification period. Only the successful ones then start to develop specific diversity in a more cosmopolitan pattern and only later

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reestablished a new, more diversified provinciality on species level. The qualification of these observations will have to be worked out as soon as the systematic description of the numerous, still insufficiently defined or new taxa is completed.

**1993-1996: COMETT training courses.** The extremely useful work of Loeblich and Tappan on foraminiferal genera (1987) and species (from the Sahul shelf, 1994) as well as the practical work carried out in the frame of IGCP 286 clearly demonstrated the insufficient state of the art in the analysis of foraminiferal morphology and its taxonomical consequences as a basis for approach to so many pressing questions about the history of the Earth and its biota. Therefore, with the help of the European Community, and in the frame of EUCOR (three-national cooperation of the Universities on the Upper Rhine), annual, two-week courses on benthic foraminifera, their comparative anatomy and their ecology, were carried through at the University of Basel at a high professional level. These courses united many workers of the ICPG project producing a unified doctrine as to the treatment of structural analysis and interpretation of benthic foraminifera constituting a basis for uniform identification of taxa.

The hand-outs produced and successively completed for this course will provide a basis for a textbook on benthic foraminifera to be published in 1997. There will be in particular a glossary unifying the morphological terms on a basis of comparative anatomy covering all fossil groups from the late Paleozoic to recent. This would constitute an instrument to transform the foraminiferal diagnoses into texts of objective precision permitting to treat them by computers for automatic retrieval and comparison with programs presently in the state of elaboration. This will be the only means to handle in future the overwhelming quantity of taxonomic data with reasonable efforts.

## CURRENT RESEARCH

### **Larger foraminifera: morphology, structure, taxonomy, biostratigraphic distribution, paleoecology and paleogeography.**

Presently, research is running on two parallel tracks: quantification of cloning in benthic foraminifera by measuring the relation of micro- and megalospheric specimens in a population on one hand, and biometry of growth on the other. Growth is measured as accretion rate of chamber cavity surface as seen in equatorial section of planispiral species and by spiral characteristics. Both measuring methods are supported by computer techniques. Progress is slow because our approaches

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to biometry are very cautious. Both tracks of research are supposed to conduct to better morphological definitions of life strategies, a concept which, I am convinced, will be basic to future foraminiferal research combining functional and constructional morphology with ecology, biostratigraphy and paleobiogeography.

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Acte d'investidura  
com a doctor *honoris causa*  
del senyor Lukas Hottinger

29 de maig de 1997



1. El rector obre l'acte i diu:

**Constitueixo aquest claustre, avui dia 29 de maig de 1997, per tal d'investir doctor *honoris causa* el senyor Lukas Hottinger, i demano al doctor Salvador Alegret, secretari general d'aquesta universitat, i a la padrina del doctorand, doctora Esmeralda Caus, que el vagin a cercar.**

La padrina i el secretari general surten a cercar el nou doctor, que entra a la sala, i és rebut a peu dret per tots els assistents.

2. El rector inicia la sessió dient:

**Es declara oberta la sessió. Té la paraula el secretari general, que llegirà l'acord pel qual es concedeix el títol de doctor *honoris causa* al senyor Lukas Hottinger.**

3. El secretari general procedeix a la lectura de l'acord de la Junta de Govern.

4. El rector dóna la paraula a la padrina:

**La doctora Esmeralda Caus, padrina del doctorand, té la paraula.**

5. La padrina llegeix el seu discurs i conclou amb les paraules següents:

**Per tot això, Excel·lentíssim i Magnífic Rector, sol·licito que s'atorgui i confereixi el grau de doctor *honoris causa* al senyor Lukas Hottinger.**

6. A continuació, pren la paraula el rector, fa el lliurament del diploma al nou doctor i li imposa la medalla, tot dient:

Heu estat designat doctor *honoris causa* per la Junta de Govern de la Universitat Autònoma de Barcelona i, com a símbol, us lliuro aquest diploma i us imposo la medalla de doctor *honoris causa*.

Us admeto i us incorporo al claustre de la Universitat Autònoma de Barcelona.

7. A continuació, el rector dóna la paraula al doctorand:

Té la paraula el Sr. Lukas Hottinger, el qual pronunciara la lliçó magistral en aquest claustre.

8. Lliçó magistral del Sr. Lukas Hottinger.

9. Discurs de cloenda del rector.

10. El rector diu:

S'aixeca la sessió.