Evaluation of Estonian Research

- Plant and Animal Physiology -

Report to the Estonian Science Fund Council

by

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The authors of this report were appointed for the purpose of this evaluation by the Swedish Natural Science Research Council.

NFR Naturvetenskapliga forskningsrådet
Swedish Natural Science Research Council

Foreword

Several Swedish organizations have been asked to take part in a general evaluation of all research performed at academic institutions in Estonia. NFR has agreed to organize the evaluation of Estonian research within the field of natural science. This report has been prepared according to an agreement between the Estonian Science Fund Council and the Swedish Natural Science Research Council (NFR).

During the spring of 1991 Estonian scientists completed reports on their research which were sent to NFR. These reports have subsequently been distributed among 14 Swedish evaluation groups. In total about 40 Swedish scientists are engaged in the evaluations. The groups are making site visits to the Estonian laboratories and institutes during 1991/92 to discuss the research performed, the plans for future activities and to get information about the working conditions, experimental facilities, financial resources etc. Each group has been instructed to produce a report assessing its particular research area.

This report concerns the sub-field of Plant and Animal Physiology and will eventually be a part of an extensive report covering all Estonian research in natural science.

The organization of the site visits is done in close cooperation with the Estonian Science Fund Council. Although difficult times prevail in Estonia the site visits performed so far have been successful. The NFR is grateful to the Estonian Science Fund Council for its efforts to handle all practical matters in connection with these visits.

The NFR is also grateful to the Swedish scientists who with enthusiasm and great skill have taken part in the demanding evaluation work.

Finally, the Council wishes to express its sincere hope that this evaluation report will contribute to a further positive development and strengthening of Estonian science.

Carl Nordling
Secretary General

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INTRODUCTION

The Estonian Science Fund Council has instructed Estonian scientists in the field of Plant and Animal Physiology to prepare reports concerning their research activities during the last 5 years. These reports were completed during the spring of 1991 and dealt with the following points:

- project leader(s)
- short description of the objectives
- summary of results
- summary of resources
- scientific staff and their qualifications
- list of publications
- dissertations
- scientific meetings organized
- prognosis of the future development of the project

In most cases the reports were accompanied by reprints of scientific publications written in English and Russian.

In July 1991 the reports were sent to NFR and during the autumn the evaluators received the reports. A site visit by the evaluators to the relevant Estonian research institutions was done in the period January 27-31 1992. The Estonian Science Fund Council had appointed Drs Oleg Tompuu and Raivo Mänd as organizers and contact persons for this evaluation. Dr Oleg Tompuu was the contact person during the entire site-visit of the Evaluation Group.

This report was drafted in February 1992 and was finally approved by the Evaluation Group in a meeting in Stockholm in April.

ACKNOWLEDGEMENTS

We would like to expresse our thanks to the Estonian Science Fund Council for inviting us to do this evaluation, to all the groups for their willingness to discuss openly all aspects of their science with us, and to Dr Oleg Tompuu and Dr Raivo Mänd who so eminently guided us and cared for us during our site visits in Tallinn and Tartu.

GENERAL COMMENTS ON PLANT AND ANIMAL PHYSIOLOGY

The goal of physiology is to understand the mechanisms of life processes. Questions like cellular differentiation and development, as well as metabolism, are studied, often in relation to contrasting environments. In zoophysiology, organ-related physiology such as neurophysiology is an important field of research, whereas in plant physiology photosynthesis and secondary metabolism are key areas of interest. Today the development of physiology is intimately linked to the advances in cell and molecular biology, but physiology also bridges over to understanding the function of the intact organism in relation to ecological questions.

We evaluated 9 projects in the fields of plant and animal physiology. The two subprojects of NS61 (project leaders Drs Laisk and Moldau) were evaluated separately. Evaluated groups worked in institutes of the Estonian Academy of Sciences in Tallinn or Tartu, or in departments of the University of Tartu. Naturally, Estonian physiology only covers a small part of the whole field. On the zoological side, questions related to cellular differentiation and metabolism were studied, and on the plant side studies of photosynthesis and secondary metabolism dominated. Our evaluation is based on the reports and on the information forwarded to us during the site visits. The evaluation is made in an international perspective. The quality of Estonian physiology ranges from excellent to poor. We are aware that differences in the quality of the research may depend on differences in the availability of resources and on other historical circumstances. As we only can evaluate the projects as they are today we have in our judgement not considered differences in available resources. Below we comment on some general observations that specifically apply to Estonian physiological research.

Generally, the project leaders and staff members demonstrated a high academic level of knowledge. However, all projects under evaluation suffered from the financial constraints, which appeared to have been more or less permanent for a long time but which at present are acute. All groups expressed desperate need for chemicals and basic laboratory equipment; these needs were indeed confirmed by what we saw. Spare parts to the mainly Soviet-made laboratory equipment was a growing problem. The computer equipment was of varying quality and the need for modern, western made computers was expressed by everybody we talked to. Experimental work was at present difficult to keep up for all groups that we evaluated.. We have also the impression that available funds have been directed to molecular biology projects, leading in reality to a cessation of investment in modern physiology.

It also appears that this limited amount of resources in many groups has conserved, or developed, a descriptive research and has been a hindrance for the development of a more problem-oriented research as based on critical tests of theories and hypotheses. Very often available equipment appeared to be a primary reason not only for how the work was done but also for the choice of problem to be studied.

However, Estonian research not only suffers from lack of resources. The effects of international isolation were apparent. The international trend to use advanced cellular and molecular methods in studies of physiology were absent. Certainly, besides limited resources, the limited international contact after the second world war has been one of the main reasons why many projects do not meet high international standards. The fact that results mainly have been published in national journals and in the Russian language has efficiently isolated Estonian science. Other hindrances have been an insufficient access to international literature including student text books (which at present is an acute problem), limited resources for travelling and for participation in international conferences and cooperative research projects.

In fact, it appears to us that this international isolation, emphasized by limited laboratory resources, has severely harmed the scientific optimism and self-confidence of many of the Estonian scientists we talked to.

We also made observations related to how education and research was organized in Estonia. We believe that the present organization is negative for the advancement of science. In the biological institutes of the Estonian Academy of Sciences, which we visited in Tallinn and Tartu, we found a research staff of a relatively high average age, and young scientists at various stages of their career were relatively few. This lack of young scientists in general was particularly evident in Tallinn. It is doubtful that those institutes of the Academy, which are distant from the university, can renew themselves. At the same time, scientists at the University of Tartu complained of their heavy load of teaching, and sometimes administration, which made competitive research difficult. This organizational separation of research and education appears to us to be suboptimal for an efficient use of resources for the advancement of both academic education and research.

We are aware that this evaluation covers only a small part of all natural science in Estonia. However, based on what we have observed and after talking to involved scientists we would like to give the following principal recommendations. Fully aware of the economical constraints, which Estonian science now experiences, and for which we have no solution, we find it very important that Estonian physiologists establish more international contacts. We strongly support the present awareness and ambitions to publish internationally in English, and we emphasize the importance of an improved access to international, scientific literature. We suggest that Estonian physiologists tries to establish international cooperation with groups abroad, and try to find ways for young scientists to study and do post-doctoral work in laboratories abroad. For the development of physiology, it is in this context important to introduce methods from modern cell and molecular biology. To facilitate the recruitment of young scientists to replace those who retire in the next 5-10 years, it is important to establish a stronger interaction between the Estonian Academy of Sciences and the University of Tartu. Generally speaking, we are convinced that a close contact between research and education is fundamental for the advancement of science, but academic education is for its quality also dependent on close interactions with the advancement of national and international research.

EVALUATION OF RESEARCH GROUPS

Dr Heino Ainson, Department of Animal Physiology, Institute of Experimental Biology, Estonian Academy of Sciences, Tallinn - Project leader

Eva Ainson, Helgi Kuus, Jüri Vaiga, Olev Poder, Vello Kuusksalu - Scientific staff

Hormonal regulation of lymph formation and haemolymphomicrocirculation

Principal activities

The project aims at investigating factors influencing lymph formation. Especially differences in concentrations of different proteins and other substances between blood and lymph have been studied. The effects of hormonal manipulations on these parameters have been followed; a special interest has been taken in measuring effects of serotonin and catecholamine. Also effects of glucocorticoids and thyroid hormones have been investigated.

A connected project deals with the regulation of the activity of an ecto-ATPase on the plasma membrane of lymphocytes. This activity is e.g increased by free fatty acids.

Evaluation

The question of the control of lymph formation is in itself well worth further study. The group has also developed a very good experimental model for such studies (the permanently catherized sheep). However, the questions asked are not supported or analyzed by adequate theoretical models, and the chemical analyses do not meet international standards. The group has no international publications. Our general judgement is that this is a poor project.

Recommendations

Continuation of the present kind of investigation can hardly be recommended. If the project should be continued, more defined models and analytical tools must be developed. The attempts to establish qualitative changes in protein composition, especially as effected by different experimental manipulations, are of interest. However, these studies require better equipment, especially for 2-dimensional gel electrophoresis.

Dr Olav Keerberg, Laboratory of Biochemistry of Photosynthesis, Department of Plant Physiology and Biochemistry, Institute of Experimental Biology, Estonian Academy of Sciences, Tallinn - Project leader

Juta Viil, Tiit Pärnik, Hiie Ivanova, Hille Keerberg - Scientific staff

Parameters of the reaction system of photosynthetic carbon metabolism in vivo

Principal activities

The project aims at quantifying metabolic steps and regulation of the photosynthetic carbon reduction cycle, and of photorespiration, in leaves exposed to various light, oxygen and CO_2 concentrations. The methodological approach is to use gas exchange and isotope ($^{14}CO_2$) techniques to measure fluxes of CO_2 in combination with biochemical analyses of metabolites. Mathematical modelling based on nonlinear regression analysis is applied and developed to quantitate the integrated function under steady state photosynthesis.

Studies of photosynthetic carbon metabolism are interpreted to show that there are two pools of glycolate, one rapidly turning over and localized in organelles and one turning over more slowly and localized in the cytosol. C_3 and C_4 acids formed in photosynthesis similarly appear to be localized in two pools, one in the cytosol and one in the vacuole. The relative distribution of assimilates differs between C_3 species. Intracellular re-assimilation of photorespiratory CO_2 has been determined by the use of an extrapolation method. The results suggest two types of photorespiration, one dependent on decarboxylation in the glycolate pathway and one independent of the glycolate pathway. This non-glycolate photorespiration is in rate comparable to decarboxylation of C_3 and C_4 acids formed as intermediates in the photosynthetic metabolism. Non-glycolate photorespiration also varies with species and environmental conditions. Attempts have also been made to estimate the rate constants of Rubisco in its functions as both carboxylase and oxygenase in intact leaves.

Evaluation

This group has received international recognition for its studies of photosynthetic metabolism and photorespiration in intact leaves. The gas exchange equipment, which they have constructed, as well as their use of this equipment in combination with radioactive labelling and mathematical modelling of obtained data, is advanced. The importance and quality of their work lie in their aim at quantifying the function and regulation of metabolic processes of photosynthesis in the intact leaf. However, their work would have been even stronger if they had been able to include more biochemical studies as a complement. The group was quite aware of this limitation as set by available equipment. The group has some international cooperation and they have published internationally. The over all judgement is that this is a good project by international standard.

Recommendations

It is scientifically well motivated that this group continues on their experimental approach to quantify the function and regulation of photosynthesis. The proposed development is well motivated. However, the research would benefit if complemented by more biochemical analyses. This competent group should also be complemented by younger members, PhD students and postdoctors. International publication should be improved. Among required equipment, HPLC and modern gas exchange analyzers are very well motivated. With such a development of direction and resources we strongly recommend a continuation of the project.

Dr Aare Kuusik, Department of Zoology, Institute of Zoology and Botany, Estonian Academy of Sciences, Tartu - Project leader

Luule Metspalu, Külli Hiiesaar, Enno Merivee, Urmas Tartes - Scientific staff

Aspects of insect physiology

Principal activities

In this group, different aspects of insect physiology are explored. One subgroup deals with the pheromones of beetles, the other with different measures of physiological activities of insects, especially the effect of juvenile hormone and analogues. The pheromone project is approached both morphologically, electrophysiologically and biochemically. In the juvenile hormone project, effects of treatment on different parameters (respiration, heat production, heart frequency) are followed. One aim of these studies has been to investigate juvenile hormone analogues for potential use in agricultural insect control.

Evaluation

The group has been very inventive in the development of equipment with a very high sensitivity, which is not available commercially. The instrumentation must be considered to be internationally advanced with a competitive sensitivity, despite being based on available components. Both the pheromonal and the respiratory projects work well and have produced promising results. The group seems knowledgeable. However, the instrumental refinement appears to have dominated over formulation of scientific problems. The group has some publications in English but no publications in international journals.

Recommendations

This is a good project, with a clear potential to improve markedly, provided the activities are concentrated on well-defined physiological questions. Increased support is recommended. The younger members of the group would benefit much from a scientific visit (1-2 years) abroad.

Dr Agu Laisk, Institute of Astrophysics and Atmospheric Physics, Estonian Academy of Sciences, Tartu - Project leader

Vello Oja, Hillar Eichelmann, Ulvi Gerst, Heikko Rämma - Scientific staff

Leaf photosynthesis and influence of ozone on plant productivity: Limitation and regulation of leaf photosynthesis

Principal activities

The project is aimed at investigating the limiting factors and regulatory processes which determine and control the properties of photosynthesis in intact leaves. For this purpose non-destructive methods based on gas exchange and absorption and fluorescence spectroscopy are applied in combination with mathematical modelling. The group has designed and constructed a very advanced system for leaf gas exchange measurements.

The group has contributed to the advancement of photosynthesis since 1970 regarding (1) interdependence of photosynthesis and photorespiration, (2) the relationship between light dependence of photosynthesis and regeneration of the substrate for CO_2 fixation, ribulose-1,5-bisphosphate, (3) light acclimatization through a leaf cross section, and (4) studies of stomatal patchiness. Recently the group has studied the well established phenomenon of oxygen inhibition of photosynthesis, as well as the role of stromal pH changes in the dark-light control of photosynthetic enzymes. Determination of photosystem II light response curves measured as O_2 evolution following short multiple turnover flashes have revealed that the rate of photosystem II exceeds the rate of steady state photosynthesis fourfold, indicating that photosystem II is not limiting for steady state photosynthesis. Oscillations in photosynthesis due to dark/light transitions have also been studied in detail as a means to reveal regulatory processes. The complexity of the problem is fully realized and the group applies mathematical modelling as a means to describe the system as based on present knowledge. The goal is to create a mathematical theory of photosynthesis.

Evaluation

This group has established an internationally very good reputation for their work on the limitation and regulation of leaf photosynthesis. The work is theoretically very well based and hypotheses are formulated and tested experimentally in an orginal and competitive way. They have an internationally leading position in the construction of systems for leaf gas exchange analyses and they are at the research front in the application of this technique in studies of photosynthesis in situ. They apply very competently mathematical modelling to improve the understanding of the integrated function of photosynthesis. The group publishes regularly in high class international journals and has established several international contacts and cooperative research projects. The group has also frequently been visited by foreign scientists. Altogether, this is an excellent project by international standards.

Recommendations

This project is most strongly recommended. The future research plans are scientifically very well motivated. The group would make very good use of increased funding. It is important that the group maintains and further develops their international contacts. We also recommend a further development of contacts with plant science at the University of Tartu, enabelling the group to recruit new, young members. Desired equipment is well motivated as is the need of a sensitive spectrophotometer.

Dr Vambola Maavara and Ants-Johannes Martin, Department of Zoology, Institute of Zoology and Botany of the Estonian Academy of Sciences, Tartu - Project leaders

Marika Mänd - Scientific staff

Energetics of ant colonies

Principal activities

In this project, the investigators, mainly helped by bomb calorimetry, try to establish the energetic fluxes in ant colonies. They have access to a natural ant reserve, apparently established mainly on their initiative, and study a socially developed species (*Formica aquilonia*). They find a negative correlation between ant age and energy content.

Evaluation

The measurements are competently performed and are probably unique within the myrmecological field. They form a good basis for elucidating the energy fluxes in the ant colonies. However, the physiological analysis of the data is not very advanced, and the studies are mainly descriptive. The project is more closely related to ecological analyses of social insects. The group has no international publications.

Recommendations

If only considered as a physiological project, this project would not meet international criteria. However, as an ecological project, the studies have a certain interest. Although continued support to this project as such is not recommended, we think that it is essential that the ant reserve is preserved and that continued research on the ants is stimulated.

Dr Udo Margna and Cand Sc Ants Tohver, Laboratory of Plant Secondary Metabolism, Institute of Experimental Biology, Estonian Academy of Sciences - Project leaders

Lembe Laanest, Tiiu Vainjärv, Evi Margna, Elmo Palm, Andreas Paluteder - Scientific staff

Biosynthesis of flavonoids: Control mechanisms and relationships with primary metabolism

Principal activities

The aim of the project is to find the intracellular factors that regulate synthesis of flavonoids in plants. Model materials have mainly been seedlings of buckwheat and barley. Total amounts of flavonoids have been determined after chromatographic separation, and radioactively labelled substrate has been fed to plant material and the distribution of label between different products determined. In combination with inhibitors of specific steps in the biosynthesis and metabolism of phenylalanine, the major precursor for flavonoids, this approach has led to the formulation of two main hypotheses:

1. The availability of phenylalanine as substrate is the rate-limiting factor in the biosynthesis of flavonoids.

2. The primary biological role of flavonoid biosynthesis is **not** the production of specific flavonoids **but** the catabolism of excess phenylanine, that is phenylalanine not used in protein synthesis.

Future investigations will involve studies on processes which control formation, utilization, and distribution of phenylalanine (the shikimic acid pathway, protein biosynthesis, protein catabolism), as well as the relative importance of phenylalanine of primary origin (from the shikimic acid pathway) and secondary origin (from protein catabolism) in the biosyntheses of flavonoids.

Evaluation and recommendations

Using classical techniques this group has come up with some interesting hypotheses, which should be tested and developed further. This would, however, require a more advanced approach and new equipment (HPLC). For the moment, future plans appear somewhat limited. New, young staff members (PhD-students, postdocs) are requested by the group and are needed. The main results have been published in international journals, but international publication should be improved. Overall this is a fair project and continued support is recommended.

Heino Moldau, Institute of Astrophysics and Atmospheric Physics, Estonian Academy of Sciences, Tartu - Project leader

Anu Sober, Jaak Sober, Heikko Rämma - Scientific staff

Leaf photosynthesis and influence of ozone on plant productivity: Response of plants to increasing carbon dioxide and ozone

Principal activities

Enhanced atmospheric levels of CO_2 and O_3 is a result of human activities. The aim of the project is to understand how the carbon balance of plants is affected by these changes. High levels of CO_2 induce an increase of carbon in the plants. This results in a net increase of the C/N ratio despite some kind of feed back control causing stomatal closure, an enhanced allocation of carbon to the roots, and an increased respiration. Also, increasing levels of O_3 in the atmosphere counteract net carbon accumulation under elevated CO_2 levels. The immediate effect of O_3 appears to be stomatal closure. A rapid degradation of O_3 appears to occur already in the mesophyll cell walls.

Evaluation

The group has documented a very qualified use of gas exchange techniques in studies of leaf and plant photosynthesis. The application of their experience to reveal the integrated response of elevated CO_2 and O_3 on photosynthesis and respiration of plants is very well motivated in view of present problems with air pollution. An appropriate cuvette system has for this purpose been designed and built. The work is of both environmental and scientific interest. International contacts have been established and the group publishes internationally. Proposed research plans are highly relevant in view of present problems with air pollution. From a purely scientific viewpoint we rank this project as good.

Recommendations

Mainly based on the need to understand plant responses to environmental pollution we strongly recommend a continuation of this project according to plans. Besides the need for general laboratory equipment, such as Micro-Kjelldal for N-determination, a better computer is also needed. Critical for the project is a well-functioning O_3 analyzer.

Ass prof Evi Padu and Prof Jaan Simisker, Department of plant physiology and biochemistry, Tartu university - Project leaders (the project was earlier lead by Professor Heigo Miidla)

E Hansen and A Tänav - Scientific staff

The physiology and biochemistry of lignification

Principal activities

The project aims at investigating the formation of cell walls and associated lignification. Wheat is used as plant material. The composition of lignin, as well as amounts of different precursors, are analyzed in relation to ontogenesis and nutrient supply. Involved enzymes are also studied.

Two phases of lignin formation have been distinguished. A fast phase associated with vegetative growth and a slow phase associated with the generative phase and a retarded growth in length. The levels of lignin precursors (phenolic acids) were shown to be low during rapid lignification and to increase when lignification was retarded. During growth and maturation the content of the dominating components, vanillin and syringaldehyd, increased. The activities of enzymes involved in lignification, phenylalanine ammonia lyase and peroxidase, correlated well with the rate of lignification. Isoenzymes of peroxidase were also studied and it was found that the catalytic properties of soluble and wall-bound enzymes did not differ significantly. Furthermore, K^+ was found to increase lignification.

Evaluation

Lignin formation is an interesting and important problem in wood formation, and the principal investigator at present, Dr Padu, is well oriented in the field. The investigations have been competently performed using classical plant physiological and biochemical approaches. This is a fair project by international standard, although it lacks international publication.

Recommendations

This project has potential if it is allowed to develop into a project exploring the formation of the vascular system as suggested by Dr Padu. This would demand a drastic decrease in the heavy teaching load of Dr Padu. Furthermore, new analytical equipment (for electrophoresis, gas chromatography etc) as well as PhD students and/or postdocs would be needed to give the project also the molecular biology approach necessary in developmental biology today. Results should be published in international journals. Future support is recommended.

Raivo Raid and J Kärner, Laboratory of Embryological Histogenesis, Tartu University, Tartu - Project leaders

The project has earlier included Dr Toomas Saat

Role of lysosomes in early development and in tissue differentiation in vivo and in vitro

Principal activities

The project has developed from electronmicroscopic studies of chick embryo development. During gastrulation, cells with high lysosomal activities could be observed, as well as necrotic areas in other cell types. Attempts were made to obtain monoclonal antibodies to different cell types in order to identify the cell types involved, but these attempts were not technically successful.

In order to study these phenomena in a more defined system, the investigators shifted to a PC12 cell line system, investigating the effects of nerve growth factor (NGF). When this substance was applied to the cells, their development towards nerve cells was initiated. During this phase, the chromaffine granulae moved to the cell surface, and necrotic areas were visible (no such areas appeared in untreated cells). These events could not be mimicked by cAMP.

Evaluation

The group has managed a series of interesting and competent electronmicroscopic analyses and has entered into the very ambitious monoclonal antibody project. In the PC12/NGF project, the investigators are reasonably internationally oriented within the field. However, plans for the future are not clearly expressed at the present stage; the investigators seem to put much trust in their flourescence activated cell sorter.

No English or international publication has resulted from the studies, although it would seem that some of the results described in Dr Raid's thesis warrant such publication.

Recommendation

This is a fair project, attacking interesting problems. However, it is difficult to evaluate the potential of this project. We feel that its possibility to survive in itself, with only one active researcher, is limited. Dr Raid is suggested to ally himself with other groups working with cellular biology. Only in such an environment could the project have developmental potential. Further support to the project in itself cannot be recommended.

Dr Toomas Saat, Department of Zoology and Zoological Museum, Tartu University, Tartu - Project leader

Jaak Tambets (Ministry of Environment), Väino Vaino - Scientific staff

Oocyte maturation, fertilization and embryonic development of bisexual and unisexual vertebrates (cyclostomes, fishes and amphibians)

Principal activities

The earlier scientific activities of Dr Saat has concentrated on different aspects of descriptive embryology, including oocyte maturation. He has analysed development in terms of a time factor which has enabled comparative studies. He has been working at developing an in-vitro system for the study of oocyte maturation and discusses this in relation to research on transgenic fishes. One of his interests is the problem of oocyte formation in tetraploid fishes.

Evaluation

Dr Saat is now both director of the zoological museum and professor of zoology at the university. The combined administrative and teaching duties leave him little time for active research, although he plans to use the coming spawning season for further investigations.

The results have not been published in English nor in international journals. However, the Russian publications have in general been published in Ontogenez, which is an all-union journal and has a good international reputation. Furthermore, an English summary of many of the investigations is being published in the proceedings of an international congress on fish larvae in Norway.

Recommendations

In general, this has been a fair project, but at the moment, there are no ongoing basic research activities, and Dr Saat seems to be reorienting his interest into aspects of conservation biology. Dr Saat has a postgraduate student and has arranged for this student to go to Finland to learn methods of cryopreservation of sperm (and perhaps with time of oocytes as well). Dr Saat is also actively trying to obtain funds for his projects from both national and international (UNESCO) sources. These initiatives show an active international reorientation and should be encouraged. Although apparently no basic physiological research is being planned we believe Dr Saat's activities in other fields have a good prognosis and should be encouraged.

Background of evaluators

Christer Larsson

Professor of Plant Biochemistry, presently at the Department of Plant Biochemistry, University of Lund. His research interests concern the structure and function of the plant plasma membrane.

Jan Nedergaard

Docent in Zoological Physiology, presently at the Department of Metabolic Research, the Wenner-Gren Institute, the Arrhenius Laboratories, University of Stockholm. His research interests involve studies of thermogenesis in mammals, especially the role of brown adipose tissue, and investigations concerning the effects of adrenergic stimulation on cells, i.e. on cellular metabolism, transmembrane ion fluxes, gene expression and cell proliferation.

Gunnar Öqvist

Professor of Plant Physiology, presently at the Department of Plant Physiology, University of Umeå. His research interests concern photosynthesis, particularly stress and adaptation mechanisms in response to the environment.