August 3, 1978

A RECORD OF THE SELF-STUDY EFFORTS OF THE DEPARTMENT OF ENTOMOLOGY

August 3, 1978

A RECORD OF THE SELF-STUDY EFFORTS OF THE DEPARTMENT OF ENTOMOLOGY

compiled by

Kenneth L. Knight

Having undergone rapid growth for more than two decades in an era of accelerating and unpredictable change, members of the Department of Entomology at North Carolina State University are understandably concerned about the future. Will we continue to be swept along inexorably on an uncharted course, or is it possible in some measure to control our destiny? History has commonly been considered to be a key to the future but burgeoning human populations seem to have swept the human race out onto totally unexplored terrain.

Nonetheless, as a prelude to a long range planning endeavor for the Department, it seems wise to place under one cover, a review of past departmental efforts to review progress and develop future plans. Insofar as known, the following pages of text and appendices contain a complete summary of these efforts. They comprise a record which should be invaluable to our current long-range planning efforts.

Since its creation in 1955, the Department has intermittently undergone periods of introspective examination. Probably the first official review was the CSRS Comprehensive Review of October 30-November 3, 1961. Requested by Agricultural Experiment Station Director, Dr. R. L. Lovvorn, the review was accomplished by the following panel: P. J. Chapman, Department of Entomology, N. Y. State Agricultural Experiment Station, Geneva; H. A. Dunn, Entomologist, Cooperative States Research Service (CSRS), USDA, Washington, D. C.; E. R. McGovran, Entomologist, CSRS; and R. L. Metcalf, Department of Entomology, University of California at Riverside (panel chairman).

The general appraisal and recommendations of this panel are reproduced verbatim in APPENDIX A.

In 1965, the Department under Dr. E. H. Smith conducted a self reassessment of its research program. A series of committees was appointed to study and report on the various areas of that program. Committee assignments were made under the following headings: commodity research, medical and veterinary, nutrition and behavior, physiology and toxicology, residue studies, structural pests, taxonomy, and new areas. The charge from the department head, plus the committee reports are reproduced intact in APPENDIX B.

Shortly after arrival here on June 1, 1968, I initiated a series of conferences aimed towards the development of a long-range plan for the Department of Entomology. The consolidated report for this effort was issued on February 16, 1970 at the time of our annual departmental conference with the Dean and Directors (see APPENDIX C).

In 1971-73, Director J. C. Williamson, Agricultural Experiment Station, specified that all departments in the School of Agriculture and Life Sciences having research programs would conduct an intensive research program review. Twenty interdepartmental task forces (created along commodity lines) were established, with each engaging in an elaborate review procedure and report preparation. Subsequently, separate outside expert panels reviewed each of these reports and submitted recommendations based upon their evaluation of the work. These 2 processes resulted in 20 comprehensive reports each (combined

in our office files into 3 large volumes where they are available for examination). On August 17, 1972, the faculty of this department participated in a half-day review of the reports prepared by the SALS task forces. See APPENDIX D.

Following this, by directive of March 23, 1973, the Director of the Agricultural Experiment Station asked each department to project its domestic research program through fiscal year 1978-79 and to append a narrative summary in behalf of the Department of our reactions to the task force and extramural panel reports. A copy of this submission, dated May 17, 1973, is enclosed as APPENDIX E.

Also in 1972, North Carolina State University instituted the self-appraisement study required decennially by the Southern Association of Colleges and Schools. This study resulted in the issue of separate school reports in March 1973. A copy of the School of Agriculture and Life Sciences' report is available in our front office. The official School report does not include the material received from each department. Because of this the report of the Department of Entomology is duplicated and appended as APPENDIX H.

Late in 1972, I appointed a committee to study the position of insect taxonomy in N. C. State University. A copy of their report, dated 1/25/73, is enclosed as APPENDIX F.

In 1974, North Carolina State University began long range planning on a 5-year basis, with the policy that the plan would be updated at two year intervals. The 1975-1980 report was issued in October 1974 and the 1977-1982 report in February 1977. Copies of these reports are available in the front office for examination. These plans are broadly conceived and do not deal with the specifics of development at the departmental level but do treat school and university missions and goals.

On March 20-25, 1977, a comprehensive CSRS review of the department was held on the campus. The review team consisted of Drs. G. R. Defoliart, A. R. Gittins, R. J. Sauer, D. L. Shankland and R. C. Riley (team leader). Their report was received in September. Following this the department through a set of committees, developed a response to the CSRS report. This response was released on April 15, 1978. Copies of both of these reports, as well as of the book of information prepared on the department for the use of the review team, are in the hands of all present faculty.

Numerous other interdepartmental reviews have been held during the past 10 years, as listed in APPENDIX G. Formal reports are not available for several of these but meeting notes are included in departmental files.

APPENDIX A

APPENDIX A

APPRAISAL OF 1961 CSRS REVIEW OF DEPARTMENT OF ENTOMOLOGY

General. The overall impression of the panel was very favorable. The quality of the staff is unusually high and compares favorably with any departments in the U.S. A number of the staff are young men. This situation offers a real opportunity for development and a challenge to these men and the administration to realize the full potential that exists. The panel is of the opinion that the potential could be more fully realized, especially by mature guidance in productive and useful avenues of research.

It appeared to the panel that the department has adequate office and laboratory space for the present, but normal growth will in time place a premium on space. The equipment appears to be reasonably adequate for the work in progress. The panel wishes to compliment the department on the good housekeeping standards that are maintained.

The library is exceptionally good and the department is fortunate in being located so close to it and in enjoying the wholehearted cooperation of the librarian.

The panel was pleased to hear about the good cooperation that exists within the station and with USDA. Two cases in point are the Station statistical department and the Oxford laboratory.

The panel commends the department on the development of the outstanding work in taxonomy. This is traditional in the department and the panel feels strongly that this work should be maintained and strengthened.

There are areas in which the department has not been able to meet all of the needs of the state for controlling pest damage. These include livestock and poultry, ornamental plants, peaches and small fruits, medical entomology, problems in park and recreational areas and in the rapidly expanding suburban areas. Support of these activities would appear to be well within the means of the state, as the percentage of expenditures for research on farm production and related areas is relatively low on the basis of the value of the agricultural industry of the state.

The attitude of the department in encouraging and expecting each staff member to develop research in a basic area of entomology is commendable. The panel feels that for the most sound and useful expenditure of the resources of the department these individual efforts and interests should be carefully balanced with the program of the department, the policy of the experiment station, and the needs of the agricultural industry in the state. For example, one phase of corn earworm research should not be separated from the overall study of its total environment and control. An ecological project should be planned so that the work will contribute

information, whenever possible, on activities and control of this pest on various crops and in various locations. Perhaps each scientist working on this pest could prepare a list of ecological questions that he needs to have answered to do a more effective job of control. These questions could be considered collectively in connection with planning of the research on ecology. This does not imply that the research on ecology of the corn earworm should become service work for control investigations. It does imply that the basic research should be planned so that certain phases of the ecology of the pest (e.g. the behavior of the adults) would not be overlooked or allowed to remain unknown. A complete understanding of an insects ecology would be useful in control. The policy of the station and the needs of the agricultural industry of the state in regards to the corn earworm should be fulfilled by the program of the department.

The department has experienced rapid growth during the past decade to meet the needs for information on insects and their control required to reduce the damage they caused throughout the state. With this larger staff, careful consideration should be given to the philosophies guiding the department and the management techniques that will be the most efficient.

The panel commends the department on maintaining a permanent file of reports of its work.

The panel appreciated hearing Dr. Mitchell's report on bees and wishes to compliment him on his ambitious and worthy activities.

Tobacco Insects. The panel was impressed with the comprehensive nature of the department's research program on tobacco. This should be the case in view of the dominant position tobacco occupies in the State's economy. The department is to be commended for the emphasis that is being placed on insect biology in this program. Intimate knowledge on all aspects of the biology of important pest species is increasingly important in the development of adequate control. It is noted that considerable biological work is being carried out on tobacco insects at the USDA Tobacco Insects Investigations Laboratory at Oxford. Both agencies are to be commended for the very evident effort that has been made to divide the field to avoid unnecessary duplication and to have each program serve to supplement and complement the other. The panel was interested in learning of the nature and scope of the work that is being conducted on the pesticide residues that may occur in finished tobacco and in cigarette smoke. Equally interesting were the physiological studies in progress on tobacco insects, including the metabolism of nicotine by these species. The panel noted what appeared to be an unusual degree of limitation of assignment in the programs of those engaged in research on tobacco problems. This is most evident in Drs. Rabb's and Neunzig's assignments. While the reasons for limiting their efforts almost exclusively to biological studies may have been valid, at least over a short range period, it is the opinion of the

panel that it might be better for both the individual concerned and for the program, to widen their operations to include some control work responsibilities. In one case (Neunzig's) it may be advantageous to add another crop assignment to his program. This would include both biological and control studies of the pest species of that crop. Should this be done, additional help may be needed probably in the form of a competent (BS degree) technician full time.

Corn Earworm and Tobacco Budworm. The project on the biology and ecology of Heliothis larvae has yielded fundamental information of value in identifying immature stages and in defining some of the factors responsible for the economic importance of Heliothis virescens and H. zea. It seems most logical to the panel to extend these investigations to the biology and ecology of the adult insects, investigating such factors as selection of oviposition sites, mating behavior, flight range, etc. Light traps have proved of exceptional value in studies on movement of night flying Noctuidae. However, light traps may be only one of several collecting techniques required to give the whole picture. Also see comments on Tobacco Insects above.

Taxonomy. Research in insect taxonomy is traditional at North Carolina State College. The panel believes the department has an opportunity to consolidate and extend the strong basic position it has in this field. Such action would place the station in a position of leadership in taxonomy in the Southeast comparable, for example, to that occupied by Cornell in the Northeast. Among other advantages, such strengthening would serve to attract increasing numbers of graduate students to the department. To achieve the foregoing end it will be necessary to have some additional space for an expansion of the insect collection, and sufficient new funds to employ a Curator. Such an addition to the staff would free Dr. Young of present part time work as a curator and allow him more time to devote to teaching and research assignments. In addition to assuming the present curatorial duties, the Curator could also carry out the projected plan of developing a collection that is more representative of all Orders than is the case at present. It is noted that work on Taxonomy has been greatly aided by grants from NSF and similar agencies. Such funds are especially desirable in those cases where they enable staff members to pursue taxonomic interests on a hobby or minor activity basis. From a department standpoint this provides needed breadth of coverage in this very large field. The gaining of NSF support for Dr. Mitchell's important studies on bees is especially fortunate. It provides for the full time services of another able taxonomist in "retirement". A fine research program on the taxonomy of aphids is underway. It is well supplied with technical help and should be productive. The panel commends the project leader for undertaking this project which will add materially to the knowledge of this basic area of entomology.

Pesticide Residues. In pesticide residue research an able staff with good equipment is providing urgently needed information on insecticide and other residues on crops and animal products. Good cooperation between entomologist and other department personnel and the pesticide residue laboratory has facilitated the work. In view of the experiences in other state experiment stations, increasing demands for residue investigations can be expected by researchers utilizing fungicides, herbicides, plant growth regulators, nematicides, food additives, etc., as well as insecticides. At some State stations, residue determinations are made in the departments requiring the information as part of the basis for making recommendations for the use of these chemicals. In other stations a central residue laboratory has been developed. In view of the good central laboratory and staff that exists, the panel feels that an expansion of this laboratory to meet all the chemical residue data needs of the station would result in more rapid development and more efficient operation of this work.

The efficient and expeditious management of a laboratory devoted to these problems will require interdepartmental cooperation as well as long range planning between individual project leaders and the laboratory leader. To facilitate this, it is suggested that consideration be given to establishing a technical advisory committee on pesticide residues consisting of representatives from all departments that have need for pesticide residue determinations and the leader of the pesticide residue laboratory. The purpose of this committee would be to develop an equitable arrangement for pesticide residue determinations for the whole station. This would include the development of a program of sample collection and analysis. Care should be exercised to assure that the work of the laboratory contributes directly to the research of the station and that it is not required to do service work.

It is also suggested that consideration be given to the establishment of a second pesticide residue committee consisting of the heads of part or all of the departments concerned and a representative from the directors office to operate at the administrative level. The function of this committee would be to allocate funds from the various projects or departments cooperating with the pesticide residue laboratory to insure its efficient operation.

The panel was not entirely clear as to the scope of the work of this laboratory. It is suggested that consideration be given to officially outlining the objectives of the work of this laboratory and its relation to the research program of the station.

The determination of the products resulting from the metabolism of pesticides by plants and animals and environmental factors acting on pesticides is very important. Residue research deals with determinations of deposits or products formed from pesticide applications and improvement of methods for analyses. The physiological action of pesticides or the products formed from them is generally considered to be in the field of toxicology.

However, there appears to be no reason why both types of research could not be carried on in the same laboratory. On this basis a more informative designation for the present pesticide residue laboratory would be the pesticide residue and toxicology laboratory.

Products formed from pesticides may differ in chemical structure from the original pesticide and give different chemical reactions with reagents used in the chemical determination of the pesticide. They may be as toxic or more toxic than the original pesticide. For this reason, there is a growing demand for bioassay of all products treated with pesticides to determine if they contain any toxic material. The panel suggests that consideration be given to the establishment of bioassay procedures to be run in connection with chemical assays in cases where the toxicity of the products formed from the pesticide are not known.

In modern agriculture where pesticides or other chemicals are recommended for application to crops or animals the responsibility of the experiment station is not fulfilled until a statement of the residue resulting from the chemical treatment is available. Such information is also essential to the development of new agricultural chemicals.

The panel commends the personnel of the pesticide residue laboratory for their accomplishments.

Cotton Insects. The panel was favorably impressed with the good progress that had been made in developing an effective chemical control program for cotton insects and in organizing and publishing this information in a form that can be readily used by growers, the insecticide industry, and others interested in efficient production of cotton. The major pests and their general behavior have been studied, and the information used in the development of the program. It is essential that the project leader keep in close touch with the results being obtained by growers using the recommended chemical control program. However, when a control program has been developed through research and is operating satisfactorily, it is desirable that the research worker devote a minimum of time to the extension aspects of the program.

The panel recognizes the importance of migration and diapause as factors of major importance in boll weevil control. The study of these factors that has been initiated is a step in the right direction and should form the basis for more specific and detailed investigations in the future. As the research develops and promising leads become available, the objectives of this work can undoubtedly be made more specific and the efforts concentrated on the lines that appear the most promising. This study in depth of behavior of boll weevil is well worthwhile.

The development of resistance to pesticides by cotton pests is a constant threat to the efficiency of chemical control. Steps should be taken to develop a reliable means of determining resistance in its early stages to avoid the damage to the crop and the waste of insecticides that occur when an unanticipated high degree of resistance develops. While the laboratory work of determining resistance may be done by personnel not actively engaged in field control studies, the responsibility for evaluation of the degree of resistance that has developed in the field should remain with the worker who is conducting the field studies. In this way a close relationship can be maintained so that changes in control recommendations can be made in time to prevent excessive or unwarranted losses in the field.

Vegetable Insects. Because of the large number of crops and insect pest species involved, and the divergent climatic conditions under which these occur, vegetable crop entomology is exceptionally challenging and difficult. The committee was most impressed with the scope and accomplishments of the research program in this area. Important crops and pests have been investigated and a very satisfactory circular, "Vegetable Insect Control 1961" is available summarizing control practices with insecticides and recommending the growing of insect resistant vegetables as a means of minimizing insect damage. An integrated program of resistant varieties combined with a carefully worked out minimal insecticides program is ideally suited to home garden and small plot vegetable production. It will give economical control together with a minimum amount of objectionable residues.

The work on resistant varieties seems to be developing in a very vigorous fashion with excellent cooperation from the Department of Horticulture. The results with sweet corn and squash have demonstrated rather dramatically that comparative freedom from insect attack can be secured with varieties of proper genetic constitution. The preliminary biochemical studies which have been made on the nature of the factors responsible for resistance are informative and an expansion of this work should be encouraged. In view of the potential importance of such studies and the comparative difficulty usually encountered in conclusively demonstrating the nature of the resistance factor or factors, the panel suggests that the investigators concentrate on one or at most two of these problems until they are brought to a satisfactory conclusion. It is also suggested that in view of Dr. Brett's more than average involvement in teaching (12/30 time) and his unusually heavy schedule of research involving considerable travel, that he be provided with additional full time technical help to permit the most effective utilization of his abilities.

Forage, Peanuts, Soybean and Small Grain Insects. The rapid establishment of a revised heptachlor recommendation for the alfalfa weevil and new treatments to control resistant southern corn rootworms in peanuts is commendable. The solution of both these emergency conditions was met with dispatch and success and involved a considerable amount of testing and evaluation in both situations. The panel is concerned, however, with the

frequency with which these 'emergency' situations appear to arise and leave grower advisors without adequate alternative recommendations and necessitate 'crash' programs to develop new means of control. It is desirable that an objective in all future chemical testing programs be designed to assure the ultimate selection of at least two chemically unrelated materials, one for immediate use in control recommendations and another as a substitute in case the former needs to be discontinued. The panel recognizes that such a program of testing may be more complex and require additional man years of effort. This may be overcome in many cases by increased inter-state coordination and cooperation. For example, a joint peanut insect control program might be initiated by Virginia and North Carolina. Even though considerable informal cooperation already exists between the two states, the panel feels that one program, jointly planned and operated by workers in both states, would definitely reduce the workload on each. The resulting savings in professional man days of effort can be devoted to other areas where research needs exist. Similar arrangements might be worthwhile in the solution of forage insect problems.

The panel recognized the project leaders interest and capabilities in the development of forage and peanut varieties resistant to insect attack. It urges that a limited expansion of his efforts in this area of work be considered and pursued cooperatively with other interested departments, other states and the USDA. It was the impression of the panel that the project leader was spreading his efforts over a rather wide variety of problems and should, perhaps, concentrate his work on fewer investigations and maintain one continuing study in which he is most capable. The development of insect resistant forage and peanut varieties would be a suitable project for the continuing study.

The studies with Barley Yellow Dwarf Virus might well be reconsidered in view of the expansion of effort by both the states of Pennsylvania and New York to elucidate further information on aphid transmission of this disease.

Insect Physiology. The insect physiology program appears to have sufficient space and the promise of adequate equipment and facilities. The project leader is able and well informed. The area of research proposed, i.e. phospholipid metabolism in insects, has already shown in initial explorations a number of unique and distinctive aspects from similar metabolism in higher animals.

In view of the importance of insect physiology to the successful understanding of a large number of applied entomological problems, the panel feels that insect physiology research should be oriented more directly to important economic insects, such as the boll weevil, bollworms, hornworms, etc. By this means, other project leaders confronted with problems, such as factors inducing diapause, flight and migratory behavior, the need for better chemical attractants, the rearing of pest species on synthetic

diets, insecticide resistance, and the basic factors responsible for host plant resistance to insects attack, could be given invaluable background information and guidance.

Apple Insects. In connection with the report on apple pests, it was interesting to learn that this fruit is being produced in increasing volume and quality in western North Carolina. The guidance being provided growers by the department in pest control appears adequate for the present. The spray schedule advised (N.C. Extension Leaflet No. 74) differs in certain basic respects from that offered elsewhere in eastern United States. An especially notable deviation is the general reliance being placed on lead arsenate rather than on DDT in the program. As long as the former "does the job" there are advantages in using it over DDT. It is suspected that apple pest control problems will increase in complexity as the years go by. Ultimately, this may well lead to the necessity of setting up a more extensive and intensive research program than currently prevails.

Blueberry Insects. The initiation of research on an important pest of this new and expanding crop in the state is highly desirable. As the needs of the growers increase for relief from insect damage, the research will need to be expanded. The N.J. station has a good research program on blueberry insects and the development of a cooperative program of research with the N.J. station appears worthy of consideration.

Forest Insects. Forest and Forest Products constitute one of North Carolina's largest industries. It is the understanding of the panel that the U.S. Forest Service Insect Laboratory at Ashville, North Carolina, and the Forestry Department at Duke University are concerned largely with insect problems associated with large state, federal or private forested areas. The panel feels that research on insect problems of farm and small woodlot by the North Carolina station, would supply information useful to this segment of the industry and would serve as a stimulus for greater interest and concern by owners in such problems and their solution.

The project leader's interest and enthusiasm in the study of mite populations in the meso-fauna of forests is commendable and should be encouraged. Mites as economic pests of forest trees have received only minor attention. The panel, however, urges that such a study be reoriented to develop information that would aid in the solution of practical problems. For example, in addition to acquiring knowledge of the species of mites found in the meso-fauna, it would be desirable to learn what species are of economic importance, their biology, what parts of the tree they attack and the type and amount of damage they do. As the project leader becomes better acquainted with the problems of small woodlot owners, he may wish to initiate research on a problem of more immediate concern to them.

Research on Insects at the Mountain Horticultural Crops Research Station. This research is still in the orientation and developmental stage but a good start has been made on becoming acquainted with the main problems. It appears that the major problems are the economical control of insect pests of vegetable and other horticultural crops grown in this area. To accomplish this in the most effective manner, a thorough knowledge of the life history and behavior of the principal pests is needed. The determination of the level of insect infestations that will cause different amounts of damage to crops and the factors contributing to increases and decreases in insect populations should be determined. The mortality, including that caused by biological factors in each stage of the life cycle of the pests, should be determined under the various ecological conditions that occur. After the effect of different levels of fertility on crops grown in the area have been determined, levels of fertility that cause significant differences in crop production could be studied to determine what effect these measurable differences in crop growth would have on insect infestations. This would require the cooperation of a soils scientist and horticulturist with the entomologist to determine that any differences found in the crop were not the response to fertility or horticultural conditions, but were due to the insect infestation. It would also assure the entomologist that the response of the insect population was due to specific soil or horticultural conditions that had been determined by individuals especially trained and experienced in determining these conditions. Serious consideration should be given to the requirements for success in research on the effects of plant nutrition on insect infestations before research of the nature is undertaken.

At a new location like the MHCRS the worker is often confronted by a great many problems requiring his attention. It is desirable to give some attention to all these problems, but it is also desirable that certain problems, often only one or two, should be selected for special attention so that substantial progress can be made on them in a reasonable length of time. The project leader may wish to make a careful study of the situation before selecting these lines of intensive study so that he can use his opportunities and resources to the best advantage. The possibilities should be discussed in detail with entomologists who have had experience in similar undertakings and with co-workers and those having administrative responsibility for the work. The project leader has indicated his intention of doing some of these things and probably planned to do most of them. The panel has written down the above suggestions to emphasize that they feel them to be worthy of careful consideration.

Powder-Post Beetles and Termites. The proposed research on the Anobiid powder-post beetle appears to be a sound approach to obtaining more information on this insect pest and should be encouraged. The cooperative work on chemical control of termites is well worthwhile. It should provide useful information on the effectiveness of these materials under the wide range of soil and climatic conditions in the state.

Extension. It is difficult to draw exact lines between extension work and applied research. This is true especially when results of research are needed for immediate use by farmers or the general public. It is the duty of a research worker to report his results but not to conduct the educational part of the program. It was the general impression of the panel that in some instances research workers were devoting considerable time to extension activities. In the completion of a piece of applied research it is necessary to see that the results obtained from experimental field plots can be applied by growers. This entails cooperative work with growers and contacts between growers and research workers can be very beneficial. However, a definite policy should be adopted to educate growers to seek extension information from extension workers. This practice will leave researchers maximum time for their research.

In an extension program it is essential that the extension personnel work very closely with the research workers. This has been done by and large. The panel wishes to commend the department on the close cooperation that exists generally between the extension workers and the research workers in entomology. It was the impression of the panel that in a state as large as North Carolina it was difficult for the extension entomologists to cover the entire state effectively. To facilitate the dissemination of entomological recommendations, advice, suggestions, etc., it is suggested that specialization in entomology be decentralized to the county level in larger agricultural counties as is the case in other important agricultural areas. To implement this plan it is suggested that consideration be given to giving short courses in entomology to the county extension agents. The extension entomologists should strive to put as much emphasis as is practical in his program on acting as liaison between the research staff and the county agent. This may relieve research workers from some of the demand on their time for extension work.

Pesticide residues are of major importance in connection with crop and animal production and probably will increase in importance. For this reason, it is suggested that means be developed whereby residue information will flow to the county extension workers along with other information on the use of chemicals on crops and animals.

As the Department of Entomology grows larger it is necessary to develop certain procedures which in a small department are often unnecessary. Annual extension programs and reports might be helpful to research workers in planning their experiments.

It is suggested that the extension entomologists have the responsibility of initiating the preparation of control recommendations. The recommendations would be prepared after discussion with the research workers and should, of course, be approved by them.

A number of suggestions on extension work have been made by the panel which may help to reduce the amount of time the research entomologists would need to devote to extension work.

Teaching. The teaching of Entomology at both the undergraduate and graduate levels is an essential function of the Land-Grant College in order to supply well trained personnel for research and other activities. The teaching work at the North Carolina State College in Entomology appeared to cover the major subject matter areas of the field. It appears that in training for scientific work in entomology in the future, greater emphasis will have to be placed on basic work in chemistry, biology, and mathematics, and less on applied courses in Entomology.

In general, there is a very beneficial and stimulating effect of an individual teaching in the same field in which he does research. However, this can be detrimental to the research program if the teaching load becomes too heavy. It was the impression of the panel that the teaching load of the individual in the Entomology Department was not excessive. However, there are continuous shifts in student enrollment and other factors, committee assignments, etc., that add to the workload of the individuals and thus may detract, often without seeming to do so, from the time and energy available for research. With this in mind, the panel suggests that a periodic review be made of all teaching and other activities of each research worker to be sure that a variety of circumstances have not combined to place an undue burden on the individual which will detract from his research accomplishments.

Publications. The panel was very favorably impressed with the number and quality of both the scientific and applied publications issued by the staff.

Insect Survey. The position of Survey Entomologist was vacant at the time of the review. However, the panel feels that this activity is well worthwhile and hopes that the position will be filled in the near future. The insect survey is mainly in the nature of service in which insect conditions are determined and reported as a guide to control operations during the season. However, the panel feels that the work of the survey can make a real contribution to the development of knowledge of insects and their activities in the state if the information gathered in the survey is organized and published at three-to-five year intervals. Such a publication put out in bulletin form would make a permanent record of insect activities within the state. This would be very useful as a reference for entomologists and others in the states who are desirous of having a long term look at insect conditions in the state. It is desirable to plan ahead for such a publication. The panel, therefore, suggests that when the new Survey Entomologist is employed that consideration be given to having him develop a plan of collecting and recording data on insect activities in the state so that it could be published in bulletin or similar form at 3-to-5 year intervals. If this publication of insect survey results were continued over a period of 10, 20, or more years, it is quite obvious that an excellent record of economic insect activities in the state would be built up.

RECOMMENDATIONS

General. It is desirable that future insecticidal evaluation programs be so considered and designed as to assure the selection of at least two suitable chemically unrelated insecticides. Thus, one may be immediately available for recommendation and the others held in reserve in case the use of the former needs to be discontinued.

Because of the importance of a continuous supply of alfalfa weevils, hornworms, bollworms and other important insect pests to a number of areas of research now in progress, additional efforts should be made to develop the continuous rearing of these insects, preferably on synthetic culture media.

The research conducted with insect resistant crop varieties has shown significant promise in insect control in several areas and is a personel research interest of several project leaders. The panel recommends that work be intensified in this area in cooperation with adjoining states and the USDA. Efforts should be made to determine the primary causes of such insect resistance in cooperation with other departments of the college.

Fundamental physiological and biochemical information is needed in understanding such basic problems as diapause, migratory behavior, attraction, and host plant resistance. More emphasis should be placed on major economic pests in planning fundamental research program in these areas.

Joint Planning between States. The panel wishes to encourage joint planning by workers in adjoining states in programing insecticidal evaluation tests where insect problems and cropping practices have considerable similarity and close proximity. Insect problems on peanuts is a case in point. Joint planning with the Holland, Virginia station would undoubtedly result in greater productivity of effort and then provide each project leader with additional time to pursue needed studies in other areas.

Pesticide Residue Laboratory. The duties of the pesticide residue laboratory should be more clearly defined. The panel suggests that a major function of such a group is cooperative service in providing research information on pesticide residues. This would include the chemical nature and magnitude of pesticide residues and their degradation products found in various crops and products that had been treated with pesticides in the research program of the experiment station.

To properly implement this program, interdepartmental coordinating committees would be useful with membership drawn from each of the departments concerned in the development of new agricultural chemicals. The leader of the pesticide residue laboratory could serve as chairman.

The analytical services of this laboratory should be limited to analysis of samples taken from carefully planned experiments coordinated between the leader of the residue laboratory and other investigators, and conducted

with the approval of an advisory committee responsible for scheduling the handling of residue samples.

Technical Assistance. Increase the number of technicians available to professional staff who have heavy teaching loads or other responsibilities and could use additional technicians effectively. A desirable minimum average ratio would be about 2 technicians for each project leader.

The pay differential between the technicians and secretarial and stenographic staff seems very small and the panel feels that an effort should be made to increase the salary levels of the technical positions so that capable, trained and experienced individuals will be encouraged to make careers of these important functions.

Toxicology. In view of the importance of toxicology which is the foundation for chemical field control of insect pests it is recommended that a focal point for the operation and coordination of this work be established. Consideration should be given to the designation of an individual to lead this work. There are several staff members exceptionally well trained and qualified for this work.

Curator. The panel recommends the employment of a curator for the insect collections.

Extension. Research staff members should spend less time in extension activities.

Specialization in entomology should be extended to the county level in the larger agricultural counties. This is in line with practices in other important agricultural states.

The Department of Entomology should provide appropriate short and intensive training courses in practical entomology for county extension agents. Extension entomologists should act as the liaison between the research staff and the county extension agents.

The extension entomologists should have the responsibility for the initiation and final preparation of insect control recommendations. These should be developed in consultation with appropriate members of the research staff of the station. All control recommendations should be approved by the research entomologists.

It is essential to have appropriate pesticidal residue information for important crops upon which to base recommendations and changes in recommendations, as is currently the practice in other important agricultural states.

Insect Survey. The panel recommends that the results of the insect survey be summarized and published in bulletin or similar form at 3-to-5 year intervals.

APPENDIX B

APPENDIX B

June 30, 1965

MEMORANDUM

To: Entomology Faculty

From: E. H. Smith EHS
Head, Department of Entomology

Subject: Reassessment of Departmental Research Program

It is appropriate that we critically review the research program of the department in order to establish goals and objectives consistent with our resources, opportunities, and obligations to our clientele, both scientific and those who make practical use of our findings.

In order to proceed in an orderly manner, I am appointing committees to study and report on various areas of our program. These studies should include the following:

a. Scope of existing research program
b. Adequacy of existing research program
c. Limitations imposed on present progress
d. Trends influencing future course of our program
e. New areas of research for consideration
f. Our most appealing "centers of excellence"
g. Sources of support
h. Recommendations

Particular attention should be given to anticipating the kind of program which will insure strength and leadership over the next decade. Committee members are encouraged to seek the counsel of off-campus authorities in their assigned area as well as members of allied disciplines here and elsewhere. While the number of members on each committee is limited, all members of the faculty are encouraged to contribute to these studies.

It is anticipated that general guidelines will be established by the various committees immediately, that active study begin in the early fall and reports submitted by late fall or winter. It may be appropriate to delay final reports until after the national meetings when conferences with professional leaders can be held.

Committee reports will be circulated to the staff in advance of the faculty meeting at which the committee will discuss its report. After study of reports by the faculty, a consolidated report will be prepared as a general guide to the research program of the department.

The research and teaching needs cannot be considered independently, and a later evaluation of curriculum and teaching is anticipated.

The present areas of research and personnel assignments are shown in Table 1. Committee assignments are shown in Table 2.

The field of entomology, as well as our own department of entomology, is in transition. Your positive participation in this assessment can do much to insure the success of our total program.

EHS:ch

Table I

AREAS OF ENTOMOLOGICAL RESEARCH

TAXONOMY

Young
Leafhoppers

Mitchell
Hymenoptera

Neunzig
Immatures

Rabb
Immatures

Smith
Aphids

Farrier
Mites

BEHAVIOR

Yamamoto
Host specificity

Axtell
Mite behavior

Rabb
Photoperiodic response

NUTRITION

Yamamoto
Mass rearing
Nutritional requirements

PHYSIOLOGY

Hodgson
Biochemical pathways
Phospholipids

RESIDUE STUDIES

Sheets
Jackson
Analyses
Methodology

STRUCTURAL PEST CONTROL

Household Pests

Wright
Biology and control

Wood Products Pests

Moore
Biology and control

TOXICOLOGY

Dauterman
Molecular toxicology

Guthrie
Resistance to insecticides

Main
Enzymology

MEDICAL AND VETERINARY

Axtell
Biology and control
Eye gnats
House flies

Bruce
Livestock pests

COMMODITIES

Peanuts

Campbell
Biology & control
Plant resistance

Forage Crops

Campbell
Biology & control
Plant resistance

Forests

Farrier
Biology & control

Fruits

Smith - Peaches & apples
Biology & control

Turnipseed - Apples
Biology & control

Neunzig - Blueberries
Biology and control

Tobacco

Mistric
Biology & control

Neunzig
Biology & control

Rabb
Biology & control

Yamamoto
Mass rearing

Vegetables

Brett
Plant resistance
Biology & control

Chalfant
Plant resistance
Biology and control

Table 2

Committee assignments for reassessment of research program of Entomology Department

Taxonomy	Toxicology and Physiology	Medical and Veterinary	Nutrition and Behavior	Commodity Research	Residue Studies	Structural Pests	New Areas
Smith	Dauterman	Bruce	Neunzig	Campbell	Dauterman	Moore	Yamamoto
Farrier	Main	Moore	Main	Chalfant	Campbell	Smith	Young
Mount	Guthrie	Neunzig	Hodgson	Brett	Jackson	Mount	Rabb
Rabb	Sheets	Wright	Axtell	Turnipseed	Brett	Farrier	Mistric
Young*	Hodgson*	Axtell*	Yamamoto*	Mistric*	Sheets*	Wright*	Guthrie*

*Chairman

November 10, 1965

REPORT ON REASSESSMENT OF DEPARTMENTAL RESEARCH PROGRAM

DEPARTMENT OF ENTOMOLOGY

Subcommittee on Commodity Research

C. H. Brett	R. L. Rabb
R. B. Chalfant	C. F. Smith
W. V. Campbell	G. F. Turnipseed
M. H. Farrier	R. T. Yamamoto
H. H. Neunzig	W. J. Mistric, Chairman

Introduction

This report brings together the results obtained from 25 questions developed by the committee chairman and submitted to each of the 10 commodity research leaders listed in Dr. E. H. Smith's table of organization (Memorandum of June 30, 1965). The questions were directed to obtain information on the 8 key points suggested in the above memorandum. With the exception of a single question pertaining to the adequacy of each person's own program, no answers were suggested for any of the questions. The response of the group to most questions was very good, and no significant write-in questions or suggestions were received. Thus, this report encompasses the current, independent thoughts of the 5 individuals on the Commodity Research Committee as well as the 5 other staff members actively engaged in this area. The committee chairman organized all expressions of fact and opinion and summarized significant agreements or differences on each of the key points included in the reassessment. A summary of this reassessment is followed by a series of tables containing detailed information regarding the present status and predicted future of commodity research.

Scope of Existing Research Program

Ten faculty members are currently engaged in 12 projects approved by the Station in the areas of (1) forage crops, (2) forest, (3) fruits, (4) peanuts, (5) tobacco, and (6) vegetables. The oldest continuing projects are those on forage crops and tobacco which were approved in 1954. The most recent projects are those on "Biology and Control of Peach Insects" and "Mass Rearing of the Tobacco Hornworm" which were initiated in 1964.

The number of persistently injurious insects on which research is conducted during most years include 2 on forage crops, 17 on fruits, 3 on peanuts, 8 on tobacco, and 19 on vegetables for a total of 49. Only 43 species are involved, however, for 6 species occur on 2 crops. Field research in these areas is conducted on 24 private farms and 14 experiment stations reaching into every section of the state. Eighty acres of crops are used annually for research. Stations provide 45 acres and growers provide the other 35 acres, mostly rent free.

Of the 10 faculty members engaged in commodity research, only 2 are devoting 100% of their time to this area. The others are involved in basic research not commodity oriented or in teaching or in both of these areas. Theoretically, the 10 project leaders devote about 6.5 man-years to commodity research. However, most project leaders report 10% to 20% additional loss of their time due to the handling of university affairs which are not specifically related to the research and teaching processes. Thus, the actual number of man-years devoted to commodity research is probably closer to 5.5.

Commodity research is supported by 9 full-time assistants (7 man-years), 14 part-time assistants (3 1/3 man-years), and 3 graduate students (1 man-year). The secretarial force needed to handle commodity research is estimated at 1 3/4 man-years. Twelve automotive vehicles are used for a total of 2,145 vehicle-days annually, which is equivalent to about 8 vehicles used full time. Office space provided to 10 faculty members amounts to about 1,800 square feet for personal use and 800 square feet for the use of their assistants and graduate students. The approximate number of square feet of other space devoted to commodity research is as follows: greenhouse, 3,500; insectary, 1,300; laboratory, 1,000; and storage, 800.

Although the scope of this program may seem sizable, the present effort appears to be only slightly greater than 50% of that expended 5 years ago. The decline in faculty has been due to death, resignations, shifts to fundamental areas of research, increased teaching obligations, and increased activity in academic affairs. The decline in good graduate students has been even more drastic, although the total number of graduate students in entomology has not changed appreciably. As new faculty positions have been added, commodity research has lost a considerable amount of space and is in greater competition for the time of secretaries. The one area in which a decided increase in support has been provided is that of full-time assistants. This increase has kept the program from being completely disrupted while faculty members attempt to reorganize their resources and reorient their objectives.

Adequacy of Existing Research Program

Before considering the entire program, it seemed appropriate to ask each project leader to evaluate his own program in terms of it being more than adequate, adequate, or less than adequate from the standpoints of the (a) public and (b) university. No projects were described as more than adequate, while 2 projects were less than adequate from the public standpoint, 2 less than adequate from the university standpoint, and 1 less than adequate from both standpoints. In general, it appeared that individuals more closely oriented toward ultra-applied research tended to list such research as being inadequate from the university standpoint, and vice versa.

Hence, the problem arises as to what is adequate from the researcher's own vantage point. It may appear that the simplest way to continue to merit substantial support is for the researcher to move in the directions most likely to be awarded by administrators. However, by training, conviction, or inclination he may be hesistant to do this. Nevertheless, excessively frustrated researchers and aborted research efforts to serve both the public and university can no longer be afforded by any corner of this triangular relationship. On the surface of things, a few individuals may appear to have mastered the art of handling these 3 areas simultaneously and effectively; however, close scrutiny usually reveals that what has been mastered is the art of covering up deficiencies in one or more of these areas from time to time as the emphasis shifts back and forth.

Out of this period of adjustment emerges the belief that applied entomology is worthwhile and that it should be strong in its own right. The overall commodity research program should have multiplicity and flexibility, but each individual should be encouraged to concentrate his efforts to insure continuous high quality research in depth eventually leading to new concepts of insect control. Routine testing of established methods of control and services connected with plant protection should rapidly be assumed by extension, industry, and a more educated public. If we fully utilize our imagination, the sophisticated research methods available, and what the other sciences have to offer, we shall become first class scientists in the intellectual eyes of a changing university and in the long run contribute more to a changing society. Although some of us may not wish to admit it, certain major crops have been produced successfully during the past several years without our research services, while others have not done well with our research services. Perhaps this is some indication that certain research has indeed been short range.

Limitations Imposed on Present Progress

Diversity of responsibilities is the main factor limiting individual effectiveness and rate of progress in commodity research. Coupled with this diversity of obligations is a shortage of (1) assistants and (2) facilities. Of somewhat lesser importance to the group but of considerable significance to certain individuals are (1) long travel requirements, (2) lack of departmental library, and (3) insufficient coordination between research and extension. Of particular concern to only one individual in each case were (1) insufficient number of vehicles, (2) lack of academic atmosphere, and (3) excessive organization which lowers efficiency.

All of these factors are essentially related to the organizational scheme employed, and some of the factors are in turn related to one another. Certain factors would appear to be inherent in any system, such as long travel distances may be required when the academic atmosphere is provided, and vice versa. Unavoidable circumstances such as this should be recognized, and individuals affected should be given special consideration.

On the other hand, the increasing diversity of obligations appears to be affecting most everyone. The characteristic trend accompanying increased diversity leads to an increased need in the number and/or quality of assistants which in turn leads to an increased need of space and/or changes in the type of facility. Faculty members are acutely aware of this chronic and serious problem. Many of them have already reached a point of diminishing returns. If given more freedom to chart their own paths in line with their competence, experience, and creative and productive capabilities, most individuals would choose to concentrate in one or a few areas at a time. This would insure greater efficiency in the production of a considerable amount of research of the highest quality. In short, some investigators have simply diversified beyond their capacity to do a significant amount of excellent work in any area, irrespective of the assistance and facilities available.

Trends Influencing Future Course of Our Program

Trends Which May Influence Existing Projects

The most significant trend which may influence existing programs is the public concern about residues and pollution. It thus follows that more noninsecticidal methods of control may have to be developed. However, some difficulty may be expected in this area because mechanized harvesting will likely increase on units of increasing size, while marketing and consumer demands for high quality products are not likely to diminish.

There will be a growing interest in preventive controls, and industry will assume a greater share of the responsibility for devising the chemical aspects of control. At the same time, more researchers will forsake commodity research at the university level.

The urban population will seek more information about insect problems which are of concern to them, but which may be only of minor significance to the average farmer. Forestry will begin selecting, breeding, planting, and producing timber in much the same manner as field crops, and this should present insect problems and considerations not heretofore encountered.

Existing Problems Which Affect Most Areas of Commodity Research

The insecticide residue and insect resistance problems continue to mount. To cope with these problems, there are needs for (1) a better understanding of the pest problems and (2) a better understanding of the ecosystems. When these two aspects are better known, more integrated controls can be established. This may lead to more preventive types of control and make possible effective control over larger areas. Increased efforts in mass rearing of insects is needed to speed up this research and open the doors to new aspects of control.

The lack of sufficient coordination between research and extension should at least be partially overcome. However, the premature release of research information for publicity and political gain will probably continue to aggravate and confuse the scientific issues and education of the public.

Potential Problems Which May Affect Most Areas of Commodity Research

Long range problems which may affect most areas of commodity research include (1) more food and fiber needed for an exploding population, (2) unrealistic support of popular but unproven solutions and unrealistic opposition to existing methods of control, (3) stronger pressures in orienting and directing research from outside through lucrative grants, and (4) a shortage of entomologist trained and interested in commodity research.

New Areas of Research for Consideration

As might be expected from the preceding discussions, top priority of future considerations should be directed toward concentrating and strengthening existing programs. The only truly new commodity position having a majority endorsement of present workers would be on "Ornamental, Lawn, and Recreation Pests." Other commodity positions listed included (1) livestock pests, (2) small fruits, and (3) stored product pests. The following additions were favored presumably as adjuncts to existing programs: (1) insect diseases and biological control, (2) attractants and repellents, and (3) statistical design and sampling.

Our Most Appealing "Centers of Excellence"

Each project leader was asked to list the specific area within his commodity research project in which he thought he might make the most significant contribution. Six members listed some phase of ecology (biology and control sometimes added) and three members listed some phase of plant resistance.

In addition, each project leader was asked if there existed a "core" or "philosophy" around which all existing commodity research might create a "center of excellence." As might be expected, ecology was listed 6 times and plant resistance 3 times. The only "philosophy" expressed (3 times) was to permit certain faculty members to restrict themselves to applied entomology only.

Sources of Support

In the matter of support it is quite clear that state funds are favored most. Federal funds are quite appropriate wherever they fit into our program. Industrial support must be viewed with some caution,

but these funds are usually acceptable. The support offered by public grants and farm organizations should be scrutinized prior to acceptance. Support offered by private grants and individuals are rarely acceptable.

Recommendations

1. Permit, encourage, and provide more time for present faculty members to concentrate on one or a few phases of a project for as long as it may take to arrive at meaningful and durable knowledge derived from modern experimental methods and the finest creative skills. Since many members have not been given the opportunity to concentrate and specialize since their graduate days, it is difficult for them to immediately predict what their requirements may be in terms of assistants and facilities. However, it would appear that overall facility requirements should be more than doubled in the near future. The number of assistants needed will probably increase more slowly, as the members themselves must first become familiar with this changing style of commodity research.

   The above suggestion will be far more difficult to implement than it was to conceive. Besides being encumbered by broad commodity research projects, members are currently involved with a wide range of departmental and university activities. The more significant of these activities include (1) teaching of entomological service courses, (2) senior and graduate teaching of nonapplied entomology courses, (3) basic research not oriented toward a commodity, (4) taxonomic research, (5) routine identification of insects, (6) extension work, (7) pesticide residue work, (8) museum assistance, (9) insect resistance studies, (10) public relations, (11) advising graduate students not actively engaged in station-sponsored projects, and (12) an ever-increasing multitude of departmental and university activities not specifically related to the research or teaching process. Other obvious problems affect the personal advancement and departmental relationship of two members located in the mountain area. However, they, too, should move toward refinement, concentration, and specialization or else they may someday be relegated to what is to become the modern extension service.

   In short, most efforts in applied work are presently strangled by an excessive diversity of responsibilities in a period that challenges the best in us to better understand the total environment and develop superior concepts of control. If applied workers are not freed from some of their individual burdens, even if of their own making, we may witness the continued rapid and perhaps eventual erosion of applied entomology from the university scene.

2. The degree to which we consolidate, the unity of effort obtained, and the degree of excellence achieved should make evident the possibilities for future growth. Because of the ecological and host plant relationships involved in existing projects, it may be appropriate at a future date to widen this work; or if these areas should become sufficiently strong, it would be wise to expand into biological control or enter the promising new area of "Ornamental Pests."

Table 1. Existing projects under which commodity research is conducted.

Project Leader	Year Project Initiated	Project Number	Title of Project (Support)
		FORAGE CROPS	
W. V. Campbell	1954	H-3012	Investigation of Insects Attacking Forage Crops (State, Federal, Industry, Nickels)
		FOREST	
M. H. Farrier	1962	S-5107	Role of Arthropods in Forest Litter Reduction (State)
		FRUITS	
H. H. Neunzig	1962	S-5095	Biology and Control of the Blueberry Bud Mite and Blueberry Insects (State)
C. F. Smith	1964	-	Biology and Control of Peach Insects (State, ARS, U.S. Forest Service)
G. F. Turnipseed	1959	H-3081	The Effect of Insects and Pesticides on the Quality of Apples (State, Federal, Industry)
		PEANUTS	
W. V. Campbell	1954	H-3012	Investigation of Insects Attacking Forage Crops (State, Federal, Industry, Nickels, ARS)
		TOBACCO	
W. J. Mistric, Jr.	1954	H-3013	Insecticidal Control of Insects Attacking Flue Cured and Burley Tobacco (State, Federal, Industry)
H. H. Neunzig	1958	S-5036	Studies on the Biology and Ecology of the Corn Earworm and Tobacco Budworm (State)
R. L. Rabb	1954	S-5019	Biology, Ecology, and Control of Insects Affecting Tobacco (State, TRF)

Table 1. Continued.

Project Leader	Year Project Initiated	Project Number	Title of Project (Support)
R. T. Yamamoto	1964	ARS	Mass Rearing of the Tobacco Hornworm (State, ARS)
		VEGETABLES	
C. H. Brett	1960	H-3096	Vegetable Insect Control with Insecticides and Resistant Varieties (State, Federal)
R. B. Chalfant	1961	S-5080	The Bionomics and Control of Insects Affecting Horticultural Crops (State)

October 29, 1965

REPORT ON REASSESSMENT OF DEPARTMENTAL RESEARCH PROGRAM

DEPARTMENT OF ENTOMOLOGY

Subcommittee on Medical and Veterinary Entomology

Mr. W. G. Bruce	Dr. C. G. Wright
Dr. H. B. Moore	Dr. R. C. Axtell, Chairman
Dr. H. H. Neunzig	

A. Scope of existing program.

The present research program in medical and veterinary entomology involves investigations on (1) the biology and control of Hippelates gnats and (2) integrated control of the house fly. The former is state-supported and the latter is supported by a Public Health Service grant. The research emphasis is thus on the biology and behavior of Diptera associated with man and animals. This includes research on the natural enemies of such Diptera. The concept of integrated control is the rationale for the present research on the biology and behavior of Diptera and their natural enemies. This orientation to biological problems underlying the eventual application of integrated control measures is being used as the guideline for the future development of the medical and veterinary entomology program.

B. Adequacy of existing research program.

The existing research program is an adequate base from which to build a stronger program. The project on integrated control of the house fly has been supported adequately by the Public Health Service and a proposal is pending for expanded support. The project on Hippelates gnats receives support for the salaries of one faculty member and one technician, and a few hundred dollars for supplies and equipment. This is on a state appropriation of $15,000 per year. This is not adequate state support for research in medical and veterinary entomology.

C. Limitations imposed on present progress.

Progress is hindered by the restriction to a narrow project on Hippelates which receives an inadequate level of support. This makes long-range planning very tenuous. The project is not of such importance in the field of medical and veterinary entomology as to attract grant support. In its present form it drains manpower and financial resources from the house fly project which, although of more significance, is not state-supported. The Hippelates project should be regarded as part of a broad project on the biology of Diptera and the state support increased to $30,000 per year.

Certain avenues of research are hindered by the lack of appropriate collaborators. A field of research generally progresses at a faster pace when there are 2 or 3 investigators with complimentary interests producing a cross-pollination of ideas and an exchange of "know-how" and equipment. This collaboration prevails in the pesticide research program in this department and in a less formal arrangement in the commodity-oriented activities. The present program in medical and veterinary entomology needs a second investigator and could be stimulated by new complimentary programs in insect ecology, insect behavior, and taxonomy.

Progress is limited by inadequate physical facilities. Present laboratories have inadequate bench facilities. An additional 1,000 sq. ft. of properly furnished laboratory space is needed for the development of a full-scale research program in medical and veterinary entomology.

D. Trends influencing future course of program.

The program in medical and veterinary entomology has been in existence only 2 years but is being developed at a very opportune time. The problem of pesticides in the environment is increasing and will continue to increase at a spectacular rate. The simple solution to insect control by chemical means is increasingly causing problems and as a result there is a greater emphasis now being placed on biological investigations geared toward the development of more refined control measures. Arthropod control programs are seriously hampered by inadequate background information on the ecology and behavior of the target species. Concerned agencies, such as the World Health Organization and the U. S. Department of Agriculture, are therefore striving to stimulate more research efforts in these areas and on biological control agents.

The time is also opportune in the more restrictive viewpoint of the economic development of North Carolina. Travel and tourism have increased in this state to the point of being the third largest income producer behind manufacturing and agriculture. It was a 1.1 billion dollar income producer in 1964. Much of this travel involves use of the splendid recreational facilities in the State. These facilities would be more attractive to more people if the nuisance of biting flies and gnats were not so great. Concurrently the State is becoming more urban with the residents becoming more aware of the need for proper development of the recreational resources. A second factor is the growth of the livestock industry with the resultant high concentrations of animals in one place which magnifies the problems of disease and pest control. Insects and mites which are usually of minor importance on animals raised for home consumption became major profit reducers in commercial-type operations. As North Carolina diversifies its agriculture and becomes more urbanized, it will be increasingly

drawing on the body of man's knowledge in medical and veterinary entomology and therefore ought to be encouraging fundamental investigations in that field.

The development of new research programs in the triangle region also favors the development of the medical and veterinary entomology program. The establishment of the Public Health Service Environmental Research Center may offer tremendous opportunities for cooperative work and perhaps the appointment of adjunct professors. The Water Resources Institute should be a coordinating body that could help our program.

The time is also opportune in regards to the development of the biological sciences at North Carolina State University. The rapid expansion of the School of Liberal Arts, the newly expanded Zoology and Microbiology Departments and the establishment of a School of Agriculture and Life Sciences point to the need for greater emphasis on the nonagricultural aspects of entomology. There is increasing improvement in the atmosphere for research and training programs geared to long-range goals rather than to the solution of short-term commodity production problems. The concurrent growth of the Graduate School from negligible numbers to its present 1,600 students is beginning to bring recognition to this institution. The Department of Entomology has contributed to this growth but must strike boldly to broaden its approach if it is to win its rightful place in the biological sciences in the emerging university. The alternate will be relegation to a service department in the agricultural aspects of a School of Agriculture and Life Sciences where the latter are outgrowing the former.

E. New areas of research for consideration.

The areas of research to be conducted will depend on the specialization of the project leader(s). It should be emphasized that there is no substitute for placing ambitious, trained men in the proper position, leaving them time to think, protecting them from petty involvements, and providing adequate technical, moral, and financial support. Strong universities are characterized by the freedom of the faculty to develop their individual specializations.

The present research on the biology of the house fly and its natural enemies ought to be expanded to other Diptera. The approach of investigating the effect of pesticides on the natural enemies of the target species is proving profitable in the house fly research and ought to be applied to other cases. There is a need for intensive investigations of the effects of pesticides on the aquatic ecosystem which is of great importance to the field of medical and veterinary entomology.

Present research efforts on the behavior of mites and gnats ought to be expanded into intensive research on the sensory behavior and host selection by arthropods affecting man and animals.

The existing program does not provide for research on actual disease transmission by arthropods. This work is obviously of great importance in the field of medical and veterinary entomology. At the present the environment is not conducive to such research due to the lack of collaborators in virology and a veterinary school. This situation may change with the expansion of the Microbiology Department and possible expansion of the Veterinary Research Center. In that event, the addition of a person trained primarily in virology should be seriously considered.

F. Most appealing area of work.

The existing research program has increasingly emphasized the comparative behavior of arthropods, including investigations of the sensory receptors. This has included investigations on the interactions between olfactory perception and environmental stimuli in regulating behavior. These investigations should be pursued in greater depth and emphasized in the future development of the program.

The present limited investigations on the effects of pesticides on the predators of the house fly suggest potentially profitable work on the impact of pesticides on ecological systems.

G. Sources of support.

There has been no difficulty obtaining support from the Public Health Service for the house fly research. Additional support for worthwhile projects could be obtained from PHS. Other sources of support are: Department of Defense, National Science Foundation, Department of the Interior and Department of Agriculture. These sources should be regarded as supplemental to state support which should be drastically increased.

H. Discussion.

The field of medical and veterinary entomology is not a fundamental area of entomological research. However, it can be an important area in the total development of an entomology department, because it is an eclectic field. It draws upon taxonomy, physiology, behavior, nutrition, ecology and toxicology. These areas can find a common meeting place in a training program in medical and veterinary entomology. Graduate training should therefore be the primary goal of the research program in medical and veterinary entomology at this institution.

It is felt by the committee that the present research program on the biology and behavior of Diptera provides a suitable basis for expansion. This means that the area of disease transmission would not be emphasized. This seems advisable in the absence of collaborators in virology at this institution. This also means that the research would be oriented to biological problems rather than to commodity problems. The biological investigations should emphasize the behavior of the whole organism in relation to its environment. The orientation to biological problems underlying the eventual application of integrated control measures is a good guideline to use in the future development of the medical and veterinary entomology program.

The research program ought to develop in an orientation to other departmental programs. Both the newly initiated program in insect behavior and the program in medical and veterinary entomology would profit by attacking problems of insect behavior cooperatively at the whole-organism and systems levels.

An important group of Diptera affecting man and animals is not included in the present program. Namely, the many species that develop in an aquatic environment. In order to achieve a balanced research program as well as provide a well-rounded training program in medical and veterinary entomology, it would be highly desirable to study the aquatic Diptera. Also, the necessity of obtaining information on aquatic insects has been intensified by the concern regarding the effects of pesticides in the aquatic environment. Therefore it is recommended that an entomologist specializing in aquatic entomology be added to the program. Investigations should be coordinated with the Water Resources Institute which should also be able to assist in obtaining funds.

The concept of the field of medical and veterinary entomology needs to be updated to include not only the study of the effects of arthropods on man and animals but also the effects of man's arthropod-control measures on himself and his environment. The entomologist should be concerned with the total effects of pesticides used for arthropod control. This means a greater emphasis on ecological research. Therefore, it is recommended that an ecologist be added to the medical and veterinary entomology program. Investigations would be oriented to the fate of pesticides in the environment.

The medical and veterinary entomology program would profit greatly from a coordinated program on the taxonomy of medically important arthropods.

Although new positions would bolster the program in medical and veterinary entomology, these should be considered only when facilities and financial support have been made adequate for existing departmental programs. There should be no new positions created with inadequate support that will result in a further drain on existing programs.

With the addition of new positions in medical and veterinary entomology, consideration should be given to a bold new interdepartmental program to capitalize on our strength in pesticide research and the establishment of the Public Health Service Environmental Research Center in this locality. This program would be concerned with "environmental biology" and perhaps would need to be established as an institute. The participants would be concerned with research and training on the interaction between man and his biological environment. The effects of pesticides on the biosphere would be an important part of the program. Medical and veterinary entomology, being concerned with the effects of arthropods on man and animals, and the effects of arthropod-control measures, could play an important role in such a coordinated program.

The pending program of graduate training in medical entomology will hopefully be approved. It points in the right direction in that it integrates the medical and veterinary entomology program with other facets of the Department and initiates closer liason with the School of Public Health at Chapel Hill. This approach should be further strengthened in the future.

The present program in medical and veterinary entomology has developed rapidly in a period of 2 years. It has been given as much freedom of development as one could reasonably expect. It has not been tied to chemical control recommendations or to a commodity. This situation should continue. The gnat project should be regarded as the beginning of a research program on the biology of Diptera and allowed to evolve into a broader project on dipterous behavior. In this way the program will have the best opportunity to attack long-term biological problems and make significant contributions to the field.

I. Summary of recommendations.

1. The *Hippelates* gnat project should be considered as a part of a broad research program on the biology and behavior of Diptera. The facilities should be improved and expanded and the financial support doubled. It is essential that adequate support for the present medical and veterinary entomology program be provided before new positions are created.

2. Research on aquatic insects should be initiated and coordinated with the program of the Water Resources Institute. To do this, an aquatic entomologist should be added to the program.

3. Research on the environmental effects of pesticides should be initiated. To do this, an ecologist should be added to the program.

4. A coordinated program in taxonomy should be initiated by the addition of a specialist in the systematics of Diptera to the taxonomy program of the department.

5. An interdepartmental program in environmental biology should be developed.

November 29, 1965

REPORT ON REASSESSMENT OF DEPARTMENTAL RESEARCH PROGRAM

DEPARTMENT OF ENTOMOLOGY

Subcommittee on Nutrition and Behavior

H. H. Neunzig
A. R. Main
E. Hodgson
R. C. Axtell
R. T. Yamamoto
Chairman

A. Scope of Existing Research Program

Nutrition may be defined as the process of dietary intake and assimilation of inorganic and organic substances for growth, development, maintenance, and reproduction.

Behavior may be defined as any motion, movement, or activity.

In the context of the brief definitions above, there is within the department no systemic research or programs in either areas. A number of individuals who are involved in other projects or programs have touched or conducted work in these areas; these activities may be listed briefly as the effect of photoperiodism on diapause in the tobacco hornworm, host plant resistance in alfalfa and cucurbits, behavior (general) of Hippelates, house fly and mites, and dietary requirements of two insects slated for mass rearing. Interest in the behavior of insects is more pervasive among individuals than is nutrition.

B. Adequacy of Existing Research Program

Research on insect behavior incidental to other projects and programs as it exists presently does not meet the criterion of an adequate and sustaining program. There is little coordination of research among the individuals and funds are not allocated specifically for research on insect behavior.

Contracts provide, at least on paper, a means of obtaining funds for support of, or initiation of, research, the ends of which are not explicitly cited in the contracts. In practice, this manner of obtaining funds is disadvantageous in that the obligations of the contract, as well as the fundings, do not provide adequate equipment or facilities for research demanding wider latitude and applications. Contracts, on the other hand, are sometimes suitable devices if they fit congruously into existing programs where facilities, equipments, and technical assistance are already on hand.

C. Trends Influencing Future Course of our Program

1. Nutrition

Research on nutrition has been concerned mainly with the elucidation of qualitative and quantitative dietary requirements of a variety of insect species over the past two decades. A generalization which can be drawn from endeavors in this area is that most insects require qualitatively the same basic organic and inorganic constituents for growth and development. The interest in this area, therefore, has waned, and it is not presently an area of research which generates or stimulates extensive energies and thoughts. Assimilation of nutrients transcends into biochemistry and would fit more properly in a biochemistry program. Similarly, components of diets which are not nutrients but stimulate the uptake of nutrients provide the rationale for host selection and research in this line would fit more securely under a program in behavior.

"Mass-rearing" of insects appears to be a trend in entomology; however, on analysis of its contents, the emphasis seems to be placed more on the mechanics and automatization of handling large numbers of insects rather than on the nutrition of the insects concerned. Sufficient knowledge and experience now exist so that formulation of diets for insects should present no formidable obstacle in any "mass-rearing" projects.

2. Behavior

The study of insect behavior can be approached in a number of ways such as:

a. Through ethology of the study of organisms under natural situations and environments

b. Through causality or the elucidation of the mechanisms (physical, physiological, neurological, biochemical) underlying behavioral phenomena

c. Through genetics or the study of the variability and the stability of a response (to a stimulus) in populations

d. Through "control" systems and the derivation of mathematical analogies and models a posteriori.

All approaches are being utilized presently, but not with equal fervor.

Two areas in insect behavior which can be considered trend-forming are:

(1) Insect communication

(2) Hormonal control of overt or long-term responses

The former has involved search for and identification of intraspecific stimuli (pheromones) which are utilized as signals in courtship, alarm, orientation, reproduction, caste determination, etc., in social and non-social insects. Corollary to these endeavors, there have been intensive investigations in interspecific chemical defense mechanisms (repellents, toxins, venoms) and host selection mechanisms (attractants, light, feeding stimulants, etc.). The appreciation of hormones in insects has also been intensified by recent findings of researchers that not only vital metabolic processes but behavioral responses as well are controlled by hormones. None of the hormones have been fully characterized as yet. The orientation of many entomologists towards chemistry or chemists towards entomology will no doubt nurture and continue research in chemical stimuli for some time.

Another area, which cannot be truly construed as forming a trend but which underpins all behavioral investigations, is sensory and neurophysiology. Electron microscopy combined with electrophysiological and biophysical techniques has elucidated and delineated many fundamental structures and functions of receptor and neural integrative systems. These findings, in turn, have contributed much to our understanding of vision, sound reception, gustation, olfaction, and other behavioral and physiological phenomena.

D. New Areas of Research for Consideration

Insect behavior has sufficient adherents in the department so that a program in his area would be highly desirable. An embryonic program now being initiated, in which a number of hypotheses are being tested, include:

1. Host selection and resistance in plants and animals.

2. Hormonal control of reproductive behavior. Two specific problems are being considered under this heading, and they involve the role of mating in triggering oviposition and the role of nutrients and hormones in conferring autogenicity to certain strains of dipterous insects.

3. Comparative utilization and function of specific feeding stimulants in insects.

E. Our Appealing Centers of Interest

The terminology has been changed from "excellence" to "interest." There seems to be a widespread interest in behavior of insects, but there appears to be no "rationale" in which to guide and interpret experimental results or to describe phenomenological events in behavioral terminology.

A program in behavior once started may have sufficient gelling quality so that loose interests in behavior may have a stronger and compelling structure under the categories listed in "Trends Influencing Future Course of our Program." There is likely to be a future tie-in with behaviorists in other departments in the Biological Institute, but it is too early to envision a cooperative program at this time.

F. Sources of Support

The embryonic program in progress is presently supported through funds allocated for the project on the mass-rearing of the tobacco hornworm. Conceivably, aspects of the program concerned with mechanisms of host selection and resistance in plants could be supported through state funds. Funds for the areas concerned with hormones and feeding stimulants could be obtained through grants from NSF, NIH, and Department of Agriculture.

G. Recommendations

1. A strong program in behavior of insects is highly desirable and should be given prime consideration for support in terms of facilities and administrative encouragement. Initially, a program would incorporate the research ideas listed under "new areas for research." With time, the program may undertake other areas and may involve individuals whose research interest resides in insect behavior, but whose primary assignments may be in other programs; for example, in Commodity Research. How well the divergent interests and capabilities can be amalgamated into a coherent program will depend upon factors not foreseeable at this time.

2. A program in nutrition is not recommended at this time. There are sufficient personnel with the knowledge and experience to assist projects which require the formulation or development of diets for various purposes.

3. The advancements and trends in entomology cannot be neglected if the department is to grow in stature. Over the long haul, sound principles and generalizations emanating from research efforts contribute to the lasting quality and assets of a department. In line with the expectations of this reassessment, a program in insect behavior, if it is to mature and progress in time, must probe into causal mechanisms, into identities and distributions of stimuli (pheromones, attractants, stimulants, etc.) into patterns of responses from comparative mensuration, and into the sensory and neurological systems of insects. It would be logical, therefore, to recommend that any future expansion in the Department include positions which would contribute to the program on insect behavior. Such positions may, for example, be filled by a sensory physiologist or a natural products chemist.

November 19, 1965

REPORT ON REASSESSMENT OF DEPARTMENTAL RESEARCH PROGRAM

DEPARTMENT OF ENTOMOLOGY

Subcommittee on Physiology and Toxicology

W. C. Dauterman	T. J. Sheets
F. E. Guthrie	E. Hodgson, Chairman
A. R. Main	

In its preliminary considerations the Committee expressed the view that this particular phase of the department's activities has been reviewed more extensively and more recently than any other. They referred to the Program Grant site visits, the Program Grant Advisory Committee's visit, various training grant site visits, etc. The suggestion was made that a copy of the original program grant application and a copy of the Advisory Committee's report (when available) be attached as part of the Committee report.

The Committee does feel, however, that some consideration of the relationships between different research programs in the area and the relationships between this area and the rest of the department should be critically examined. Much of the report, therefore, will be general in nature and wide in scope, the gathering of facts and figures being kept to a minimum.

A. Scope of Existing Research Programs

This area of research is represented by the research programs of Drs. Dauterman, Guthrie, Hodgson, and Main.

Although these programs do not fit into exact categories, the following disciplinary assignments may be made:

1. Molecular toxicology ----------Dauterman and Main
2. Toxicology ----------Guthrie
3. Toxicological genetics ----------Guthrie
4. Comparative biochemistry---------Hodgson
5. Insect physiology ----------Not currently represented in this department.

The following points should be borne in mind:

1. Dr. Dauterman is involved in more than one program, being also interested in the synthesis of compounds involved in lipid metabolism.

2. Dr. Guthrie's work on alkaloids could also be considered under the heading of comparative biochemistry since these compounds are part of the normal diet of many insects and other organisms.

3. Dr. Hodgson's program consists of more than the lipid investigations, the work on microsomal oxidations being particularly close to toxicology.

4. Although the work of a number of people at this institution borders on insect physiology, there is no single research program devoted to this field. Those in this category are Grosch, Guthrie, Hodgson, Stewart and Yamamoto.

5. Comparative biochemistry is devoted primarily to insects at the present time. This area need not be considered as related to toxicology; it can be an entirely separate discipline. This has been done at a number of institutions. However, there are at least two good reasons for joint consideration. First, this is a means of getting basic biochemical information on animals of great practical importance. Such groups as the nematodes, platyhelminths, molluscs, protozoa and insects are ignored completely by biochemistry departments and from a biochemical viewpoint by zoology departments. Since toxicology as it exists outside medical schools is concerned ultimately with the safe control of these organisms, it appears reasonable to carry out these activities in the same place. Second, the community of methodology makes cooperation a practical advantage.

   The relationship between entomology and the general area of toxicology and comparative biochemistry is one primarily of origin and administration. Toxicology can best be defined in terms of the chemistry of toxic materials, many of which are devoted to control of organisms other than insects. An important branch of this subject is concerned with man and other mammals. Similarly, comparative biochemistry, by its nature, cannot be confined to a single taxonomic group.

   It is neither the Committee's function nor its desire to question the present administrative divisions and assignments; its purpose is to make clear that administrative organization and disciplinary divisions do not necessarily coincide and that we would be less than realistic if we do not recognize this where it occurs and take it into account in our deliberations.

B. Adequacy of Existing Research Program

If adequate coverage of an area of scientific research means having an active research program on each aspect, clearly adequacy is almost impossible. If adequacy is having enough good research programs that expert knowledge is available in the general area covered, then this department comes close. If adequacy is having a solid base of research programs on which to build, one which provides the basis for growth from within, then we believe that an adequate program exists in the area of toxicology and comparative biochemistry. Certain limitations, both material and philosophical, must be overcome if this growth is to occur.

C. Limitations Imposed on Present Progress

The less-easy-to-define philosophical limitations are probably the most important and often the most difficult to solve. This is, itself, a strange paradox since when the solution is seen, it is more likely to need action than money. The limitations are summarized below:

1. The concept of a "balanced" entomology is, itself, a major limitation. With four full-time faculty members, the department is already "unbalanced" in the direction of toxicology and comparative biochemistry. As money is readily available in this area, and since its most meaningful growth must come from research workers who are not entomologists, any proposed growth results in more "imbalance" and results in a department which is less of an entomology department.

2. The concept that a very basic approach can be justified only in terms of an unspecified amount of extension or applied work is not realistic. The importance of such work can be justified, the work can stand on its own merit, and its merit or lack of merit should not be judged in terms of some other activity, no matter how useful such activity might be.

3. Lack of suitable facilities. All of this group should be located in adjacent facilities. The present facilities in Gardner Hall are unsuitable for this type of work being done, and the facilities in the Gardner Hall Addition will soon be overcrowded.

4. Lack of non-federal support. This is particularly needed for new faculty positions and for providing flexibility in new equipment purchases.

5. Non-academic involvements of the faculty are increasing at an unrelenting pace.

6. Unnecessary difficulties with M and O. Maintenance and Operations appears to exist not to help the progress of teaching and research, but as a policy-making body devoted to some end which is never made clear. This has frequently resulted in delays and added costs.

7. Unnecessary difficulties in hiring staff. There appears to be an almost total lack of appreciation at the campus and the state level of the highly technical nature of this work. It would be impossible, for example, to explain that it might be necessary to hire a skilled electronics technician at a salary equivalent to that of an associate or full professor.

8. Difficulties exist in the purchasing procedures which cost valuable time and funds. In addition to slow on-campus procedures, having to deal with the inept companies presently under contract to the University is enormously costly.

9. The Business Office also appears to be dedicated to its own peculiar ends. The present policy of not being allowed to collect early payment discounts because they cannot handle the payments in time is an example of the high cost of this attitude.

D. Trends Influencing Future Course of our Program

1. The most significant trend is the increasing need for this kind of research. Although many institutions have considered themselves especially qualified in the general area of pesticides, this is the only one that has established a program oriented along molecular lines.

2. As a direct consequence of (1), the support on the national level and, if properly developed, on the state level will increase dramatically in the next few years.

3. As a result of the recent decision to move the Environmental Health Center to the Research Triangle, there will be a very marked local emphasis on programs of this type.

E. New Areas of Research for Consideration

The needs for future expansion most readily apparent at the present time are as follows:

1. An enzyme chemist interested in the purification of enzymes.

2. A geneticist interested in mammalian resistance to pesticides.

3. A biochemist interested in energy metabolism. This would form a well developed link between the lipid program and other areas of interest such as microsomal oxidations.

F. Sources of Support

1. Public Health Service

2. State

3. In the past TIRC and various companies have given a small measure of support and probably would again.

4. NSF is a future source worth considering.

G. Recommendations

1. Three new faculty positions be created. Although support can be obtained from PHS for this, the state should assume some obligations in terms of both salary and research funds.

2. Effort be made to obtain better facilities either by renovations, or if this is not adequate, by building. Particular attention should be paid to locating different members of the group together, and to future expansion.

3. Efforts be made in conjunction with other departments to correct the situation with regard to purchasing, M and O, the Business Office, non-academic activities, etc.

4. Effort be made to get the state to assume a bigger share of the responsibility for the program.

5. The necessary administrative machinery be set up within the department to ensure that the Toxicology and Biochemistry group and the rest of the Entomology Department can each grow at their own rates. This should be flexible enough that entomologists in the group participate in Entomological activities while non-entomologists need not. Such an arrangement has obvious practical advantages in terms of recruitment of manpower and funds and in addition allows extensive growth without becoming a millstone around the Department's neck.

REPORT ON REASSESSMENT OF DEPARTMENTAL RESEARCH PROGRAM

DEPARTMENT OF ENTOMOLOGY

Subcommittee on Residue Studies

C. H. Brett M. D. Jackson
W. V. Campbell T. J. Sheets,
W. C. Dauterman Chairman

A. INTRODUCTION

Organic pesticides have been used to control insects for about 20 years. For several years after their introduction, studies of their residues were limited largely to data gathering to satisfy requirements for registration. However, during the last 5 to 10 years, needs for more thorough studies have been clearly recognized. It is now considered a necessity to investigate, not only the residue status on raw food products, but many other residue problems such as persistence and degradation in soils, movement in soils and from treated to untreated sites, and effects on many kinds of organisms other than insects. Progress has been made in some areas, but in North Carolina the research has not been undertaken at levels generally considered necessary.

The Pesticide Residue Laboratory has been in operation for about 10 years. During his tenure, T. G. Bowery was actively engaged in both residue and toxicological studies. After Dr. Bowery departed, the program of the laboratory shifted more to toxicological research; and residue studies *per se* were deemphasized. A recent realignment separated toxicology and residue studies for the explicit purpose of strengthening both programs.

The Pesticide Residue Laboratory is administered through the Department of Entomology. The Laboratory serves the School of Agriculture and Life Sciences by providing pesticide residue analytical services for research in several departments. A Pesticide Residue Laboratory committee made up of a representative from each interested department, two administrators, and two individuals from the laboratory has two major functions: (1) the committee evaluates research proposals submitted to the laboratory and establishes a priority list to be used as a guide for conducting analyses and (2) each committee member serves as a liason between faculty in his department and the Pesticide Residue Laboratory personnel.

This reassessment committee considered its responsibility to be that of evaluating the status of residue studies in the Department of Entomology, outlining areas where emphasis is needed and proposing new and broader pesticide residue investigations. Residue studies not the responsibility of the Department of Entomology, except for analytical service of the Pesticide Residue Laboratory, were disregarded in this

reassessment. Research conducted by Pesticide Residue Laboratory personnel as a part of their personal research and as cooperative efforts with other programs in Entomology were, of course, considered as integral parts of the Departmental program.

During the development of this report, the committee solicited and evaluated ideas from many individuals. We received direct help from W. J. Mistric in preparing one section. We have discussed pesticide residue studies with several individuals from other organizations: A. W. Avens, Food Science, Agricultural Experiment Station, Geneva, New York; J. E. Fahey, Pesticide Chemicals, Entomology, Res. Div., USDA, Beltsville, Maryland; P. C. Kearney, Pesticide Investigations-Behavior in Soils, Crops Res. Div., USDA, Beltsville, Maryland; D. J. Lisk, Pesticide Residue Laboratory, Cornell University, Ithaca, New York; and C. H. Van Middelem, Pesticide Research Laboratory, University of Florida, Gainesville, Florida.

In the Department of Entomology, we have talked with:

R. C. Axtell	H. H. Nuenzig
J. M. Falter	R. L. Rabb
M. H. Farrier	H. E. Scott
F. E. Guthrie	C. F. Smith
W. J. Mistric	E. H. Smith
H. B. Moore	C. G. Wright

Specific questions directed to those in the Department included:

(1) What is the status of residue studies in your area of responsibility?

(2) How important are pesticide residue studies to continued progress in your area?

(3) What specific pesticide residue studies need investigation?

(4) Do you have time to devote to needed residue studies?

(5) How should the Pesticide Residue Laboratory contribute? What are its roles?

(6) To what extent should we depend on industry for residue analyses in support of registration of pesticides? What should the Pesticide Residue Laboratory contribute to such analyses?

B. SCOPE OF EXISTING PROGRAM

Pesticide residue studies are a part, at least intermittently or sporadically, of several individual research programs in the Department.

A wide spectrum of interests and objectives are encomposed. Major direct interests reside with faculty involved in commodity research, but there is indirect and limited direct interest of some others.

As promising new insecticides are developed, residues that remain on economically important plant parts must be determined before the chemicals can be registered for use by the U. S. Department of Agriculture. The major responsibility for residue determinations of this type is normally assumed - and rightly so - by industry. Several faculty members (W. V. Campbell, C. H. Brett, W. J. Mistric, R. B. Chalfant, H. H. Nuenzig, and C. F. Smith) in the Department do, from time to time, collect samples from field experiments and ship them to industrial laboratories for analysis. The committee members and others in the department favored continuation of close cooperation with industry for these analyses. The Pesticide Residue Laboratory has, in some cases in the past, determined residues of highly promising experimental insecticides on crops. There is not complete agreement on the extent the Pesticide Residue Laboratory should be involved in such analyses, but the majority seem to favor continuation on a limited scale only.

Methods of reducing or minimizing insecticide residues in plants are the objectives of studies being conducted by W. J. Mistric in cooperation with H. D. Bowen, and W. E. Splinter of the Department of Agricultural Engineering, The major approaches and variables involve rates and methods of application, spray additives, and types of pesticides. There is a continuing need for such work as an integral part of insect control methods.

Occasional studies of a routine or survey nature have been conducted cooperatively with the Extension Service. The heptachlor-heptachlor epoxide determinations in alfalfa hay and milk during 1965 is illustrative of this type of study. The personnel involved from Entomology were J. M. Falter, W. V. Campbell, and M. D. Jackson. Several faculty from Animal Science cooperated. Problems such as this, although not specifically research, are intimately and importantly related to North Carolina agriculture. The Department of Entomology, including the Pesticide Residue Laboratory, must sometimes assist on projects of this kind.

The Pesticide Residue Laboratory personnel should, as in the past, cooperate with other laboratories in checking one another for accuracy and dependability of methods. The Regional Laboratory (S-58) at Gainesville, Florida will be one of the main cooperators.

A study of the effects of simultaneous intake of two chlorinated hydrocarbons (DDT and aldrin) by dairy cows on residues appearing in milk was recently terminated. This interaction was investigated by W. C. Dauterman and M. D. Jackson in cooperation with the Department of Animal

Science under a Public Health Service grant. Other studies of residues in milk have been conducted by A. R. Main and M. D. Jackson within the last few years, but none are active now.

The effects on plant growth of combinations of insecticides, fungicides, herbicides, and nematocides are being investigated by T. J. Sheets in cooperation with F. T. Corbin of Crop Science under a U. S. Department of Agriculture grant. The studies are supported for a three-year period.

To support residue studies, the Pesticide Residue Laboratory has the following positions:

Project Leader	T. J. Sheets
Instructor (chemist)	M. D. Jackson
Instructor (Effective July 1, 1966)	Vacant
Research Technician III	Carole Morris
Technician III	Vacant
Technician I	Vacant
Secretary (1/2 time)	Merlene Byrd

The time of the project leader is divided between three research activities:

Service and cooperation on pesticide residue in the School of Agriculture and Life Sciences	50%
Methods of analyses	25%
Personal research	25%

Such an allotment of time must be flexible, and the amount of time that the project leader will be able to devote to personal research will depend on the analytical load of the laboratory and his ability to complete those responsibilities.

C. ADEQUACY OF EXISTING PROGRAM

Residue studies presently conducted in cooperation with industry for registration of new insecticides is adequate in most cases. The limited contributions the Pesticide Residue Laboratory can make on highly promising insecticides lags due to present space and personnel limitations.

Studies on methods of reducing residues in plants and soils now characterize most commodity research. Part of the objectives of such work is attained by development and use of effective, non-persistent pesticides; but other factors have been evaluated especially in the cotton and tobacco programs of W. J. Mistric.

In order to clearly evaluate the adequacy of residue studies associated with commodity research, we have listed and discussed each major commodity area separately.

Cotton and tobacco. More insecticide is probably applied to cotton and tobacco in North Carolina than to all other plants, animals, and structures combined. Even with this vast usage of insecticides on approximately one million acres of cotton and tobacco, certain insects remain exceedingly difficult to control. This is particularly true of the boll weevil on cotton and the tobacco budworm on tobacco. Growers faced with outbreaks of these insects tend to increase dosages over recommended amounts, shorten application intervals, and apply a mixture of various chemicals, all of which tends to greatly increase the residue problems on these crops and also in the soils and streams. In addition, the predator and parasite populations are often depleted through such excessive use of insecticides; this effect in turn induces an outbreak of other economic pests not controlled by the insecticides being used for weevils or budworms. This result leads to use of other insecticides and, hence, increases the total usage of insecticides even more.

Research has shown that this problem can be partially overcome by proper selection and timing of insecticidal applications in an integrated control program which fully utilizes natural and cultural controls. However, present mechanized application techniques essentially disperse a pesticide over entire fields, covering all portions of the plants and the soil surface. Available data show that the insects in question feed and move about chiefly on only a relatively small portion of the plants. Research is underway to determine the specific behavior patterns of these insects in relation to factors which may influence their choice of feeding sites and paths of movement over the plants. As the behavior patterns of these insects become better known, it should be possible to concentrate the application of insecticides on specific parts of the plants where they are likely to result in the most effective control. At the same time, natural control agents would receive greater protection; and the total residue problem would significantly decrease.

Results of research with cotton begun in 1962 indicate that when electrostatic applications are perfected, it may be possible for growers to achieve the desired degree of insect control with one-half the amount of insecticides presently used.

Research efforts on tobacco were renewed in 1964, and results with soil systemics, cornmeal bait, and various spray additives directed to the top six leaves of the plant have shown promise toward improved effectiveness. Rates of application have not been reduced; but research continues with various pressures, delivery rates, particle sizes, types of nozzles, formulations, and methods of application.

Extensive research with insecticide residues on tobacco was conducted several years ago by R. L. Rabb, F. E. Guthrie, and T. G. Bowery. However, the residue status is not static; as new insecticides are introduced, new unknowns are created. Practically, the critical aspect is the level of residues in tobacco smoke. A cigarette-smoking machine is available in the Pesticide Residue Laboratory, but a more recent model may be desirable for extensive investigations.

Alfalfa. Heptachlor and heptachlor epoxide residues have been of primary concern on alfalfa since development and use of the zero tolerance concept. Development of sensitive equipment that detected residues well below the 0.1 ppm level brought the problem to the forefront.

The acreage of alfalfa grown in North Carolina has declined from a peak of about 80,000 acres several years ago to about 20,000 acres in 1965. A survey conducted during the summer of 1965 showed all but a few samples had residues well below the actionable level. While some individual problems may still occur from feeding 1965 hay, the low levels of heptachlor now present should pose no serious residue problems to dairy industry in the State.

Uptake of pesticide residues from soils and transport into economically important plant parts, an occurrence once thought to be negligible and unimportant, is now recognized as a major source of contamination of untreated crops. Corn or small grain usually follow alfalfa in a rotation. Systemic uptake from soils of low levels of heptachlor epoxide by corn and small grain should be determined and storage of the pesticide in grains measured.

Corn. Aldrin is still effective against the wireworm, *Melanotus communis*, and is recommended and used in Coastal Plain of North Carolina. Aldrin and its epoxidation product, dieldrin, may create residue problems on crops grown in rotation with corn, especially crops such as peanuts on which the major economic plant part develops underground. Too, systemic uptake, if any, is not well known. Research should be initiated to determine potential residue problems in corn from soil application of aldrin and heptachlor.

Peanuts. Peanut hulls, once used in animal feeds, are now prohibited for feeds since the detection of significant levels of DDT, dieldrin, and lindane. It is not known whether residues were the result of direct application or soil contamination.

The restricted use of the hulls represents an important loss to the peanut industry; however, even more important is the possible contamination of the kernels from contaminated soil.

A survey of soils in the peanut belt should be made to determine present levels of pesticides. The potential residues on peanuts grown in

these soils may be ascertained by controlled application and analyses of plant parts including the hay, nuts, and the hulls.

Soybeans. Toxaphene-DDT is frequently applied to soybeans to control a variety of late-season insects, and there has been a growing concern about possible residues (especially DDT) in the beans and oil. Some states in the South have removed this combination from recommendations, but the combination still has label approval. Sufficient evidence of insecticide contamination of the beans and oil is apparently lacking. Residues of toxaphene and DDT should be determined for threshed beans and oil under North Carolina growing conditions.

Stored Grain. The use of DDT on feed grains or an overdose of malathion may occasionally cause a residue problem. However, isolated cases of misuse do not justify a program of residue analyses for stored grain. On the otherhand, a residue study involving the complete analysis of animal feeds (including stored grain as it appears in feeds) and transfer of residues to meat and milk is needed.

Vegetables. Most insecticides now used on vegetables do not appear to cause significant soil residue problems. One exception is the use of DDT on sweet potatoes. Although it is no longer recommended in North Carolina, an estimated 90 percent of the sweet potatoes acreage (22,000 acres) was sprayed in 1965 with 20 lb/A of DDT for control of wireworm. On a limited scale, soil residues are significant and may pose problems from uptake by crops grown in rotation with sweet potatoes. The level of soil contamination and acreage involved should be determined, and research needs evaluated.

In the Hendersonville area Gerbers Baby Food Company has been concerned about residues of lindane in crops such as carrots and potatoes. Insecticides that do not persist in soils appear to be the answer to this problem.

Fruits. Control methods for peaches are available, and the residue status of these are generally known.

There may be some question of residues resulting from the use of endrin for mice control in apple orchards in Western North Carolina. The U. S. Department of Agriculture presently is surveying, in its nationwide monitoring program, the extent of soil contamination from endrin used for that purpose. One location is in Henderson County, North Carolina.

The major blueberry pest is the budmite. Residue studies of pesticides for control of this pest have been conducted and label approval is pending. There doesn't appear to be an immediate need for additional residue studies associated with blueberries other than the more general investigations involving side effects in the environment.

Minor Crops. Departmental faculty and the Pesticide Residue Laboratory also have responsibilities for insecticide residue studies on minor crops in North Carolina. All residue needs involving minor crop uses should be coordinated with the IR-4 project which is headquartered in the Department of Entomology, Rutgers University, but IR-4 personnel cannot necessarily supply data necessary for label approval.

Structural Pests. Although total uses of insecticides for control of structural pests is not comparable to use for insect control on crop lands the number of clientele involved far exceeds that of most other types of pest control. There are presently no residue studies being conducted in this area by Entomology faculty. Important problems are (1) residues associated with pesticides used to control various types of indoor pests, (2) depth of penetration of insecticides into wood surfaces and factors influencing penetration, and (3) movement and persistence of insecticides in soils at high rates of application.

Forests. Growers of seed-tree orchards are using increasing amounts of insecticides. Rates per acre are comparable to those used in apple production. As with other intensive use areas, potential problems from persistence in soils and other side effects exist.

Large scale use to control forest insects pose a greater hazard to wildlife than agricultural use on arable lands. Applications are made directly to shelter areas, and run-off into streams and lakes may occur. This problem parallels similar problems associated with the use of pesticides on crop lands.

In the discussion of residue studies associated with several commodities, uptake of residues from soils was suggested as a major area of interest. Residues in crops sprayed for insect control are conducted during the development of new insecticides, and such data are necessary for approval of official labels for marketing. However, little attention has been given to uptake of residues by non-treated crops grown in rotation with treated crops. Toxaphene-DDT mixtures are used extensively in cotton and soybeans. Other chlorinated hydrocarbons are still used for a variety of insect problems, and residues from past treatments are prevalent in most soils. Low levels of pesticides that are normally thought to disappear rapidly may persist for extended periods under some conditions. It is, therefore, imperative that thorough study of uptake, translocation, storage, and metabolism of pesticides in crop plants be initiated. Equally important, closely-related research on accumulation and disappearance of residues from soils should be conducted concurrently.

To insure success of these residue studies associated with commodity research projects, it is essential that faculty in Entomology, Agricultural Engineering, Animal Science, certain other departments, and the Pesticide Residue Laboratory work together. Each has its appropriate responsibility and contribution toward a common goal.

By far the greatest use of pesticides in North Carolina is on crop lands. In the intensely farmed areas, for example the Upper Coastal Plain, there are many streams and farm ponds in close proximity to fields of tobacco and cotton that receive frequent applications of pesticides. The potential for movement off of fields and into streams and ponds, with possible effects on aquatic biota, is apparent. Rates and pathways of movement, persistence and degradation in water, uptake and accumulation in aquatic organisms, effects on organisms, shifts in population numbers, and transfer of pesticides among aquatic species are all essentially unknown. This field of research is an enormous one with diverse ramifications requiring a combined effort of ecologists, soil scientists, chemists, and physiologists for thorough study. If a project could be developed, the Pesticide Residue Laboratory could take a vital part in it.

There is a clear inadequacy of long-term studies on the fate and effects of pesticide residues in the environment. Two faculty members listed these as the most important residue studies for the Department. Such studies are not totally the responsibility of the Department of Entomology but should be developed, cooperatively, when appropriate, with persons in other departments. Some in Entomology have a direct interest in them. R. C. Axtell has special interest in pesticide retention in water and in uptake by and effects on aquatic arthropods.

It would appear that, in general, there is general consistency among the faculty that a strong program in residue studies is important to Entomology and to Agriculture, that the Pesticide Residue Laboratory should be a focal point for cooperation and development of a sound residue program. There is not complete agreement on the types of residue studies that should be undertaken nor the breath and depth of such studies. One general consensus is that, to be effective, especially in extensive studies with commodity research, the Pesticide Residue Laboratory must obtain and maintain support for personnel, up-to-date equipment, and supplies. Otherwise, it remains ineffective.

D. LIMITATIONS IMPOSED ON PRESENT PROGRESS

Many of the research projects listed under Adequacy of Existing Program are not being conducted because responsibilities of the faculty prevent further research undertakings. In other cases faculty would not be particularly interested in developing the suggested research although they recognize the need. Lack of professional manpower with adequate support, therefore, could be listed as a limitation hindering progress. However, as we realistically appraise the situation, we conclude that considerable progress can be made with moderate support when the Pesticide Residue Laboratory provides analytical services.

An immediate limitation, inadequate space, in the Pesticide Residue Laboratory, will be eliminated when the laboratory facility in the old Universal Equipment Building is completed. However, there are striking limitations in the basic equipment of the laboratory. In addition, as new pesticides are introduced, equipment needs shift; and some instruments become obsolete within three to five years. Present funds allocated for supplies and personnel do not adequately support the program. We estimate that within two to four years the Pesticide Residue Laboratory will be requested to perform analyses numbering 6,000 to 8,000 annually in support of research in the School of Agriculture and Life Sciences and the Agricultural Experiment Station, a share of which belongs to Entomology. These estimates will materialize if the laboratory effectively cooperates on research programs. A modern up-to-date laboratory with adequate, well-trained staff will be needed to carry on this program. Financial support is essential.

Unforeseen "fires" often interrupt research. Although time on such problems is usually well-spent from the viewpoint of agriculture, research progress is often impeded.

E. TRENDS INFLUENCING FUTURE COURSE OF PROGRAM

As the use of organic phosphates, carbamates, and other non-persistent insecticides increases, use of persistent chlorinated hydrocarbons decreases. This trend will probably continue. The major effect on the residue program will be one of diminishing need, over the years, for certain types of residue studies, for example, disappearance rates of chlorinated hydrocarbons from soils and their residues in treated plants. The main effect, in this case, would be one of change of the types of pesticides investigated. To some extent, however, the type of pesticide determines the kind of residue studies undertaken.

On the other hand, we must keep in mind that there is presently more of an increase in non-persistent chemicals than there is a decrease in use of certain chlorinated hydrocarbons. The reduction in use of chlorinated hydrocarbons is restricted largely to specific members of the group (for example, heptachlor, endrin, dieldrin); use of others (DDT and Toxaphene) continues at a relatively high volume.

A shift toward sophistication of instrumentation seems to parallel the trend toward new insecticides. Costs for equipment increases as sophistication increases. Specialization or reorientation of supporting personnel may, over a period of several years, be a necessary corollary also.

Legislative actions which tend toward more stringent controls promotes more thorough study of pesticide residues in the environment. This

trend is exemplified by requirements for data on disappearance rates from soils. As recent as about three years ago, no appreciable data on loss rates from soils were required for non-phytotoxic pesticides. Extensive data are now required.

Trends in industry toward testing experimental compounds more thoroughly than in the past should lead to less testing by Experiment Station personnel. Since fewer compounds may reach the Experiment Station, fewer residue studies for the purpose of obtaining residue data for registration will be conducted. Such trends appear to coincide with the philosophy in the University on research. A gradual shift from residue studies of a more practical or applied nature to those that are more original or more basic may result.

F. NEW AREAS OF RESEARCH FOR CONSIDERATION

New areas of research suggested are an outgrowth of discussions with many scientists and represent a summary by the committee of the large number of problems described under Adequacy of Existing Program.

Extensive investigations on absorption, translocation, degradation, and storage of pesticide residues in crop plants and on persistence and degradation in soils are critically needed. Certain aspects of this research would have direct practical implications; they are essential to continued safe and efficient use of pesticides. Studies on mechanisms of absorption of pesticides by plant roots and leaves and on mechanisms of transport and storage in plants would assist in interpretation of field problems and observations and add to our general knowledge of pesticide behavior.

In mono-crop systems and especially where persistent insecticides are employed, possible accumulation of residues in soils should be investigated and the relation of accumulation to plant uptake evaluated.

Transfer of residues from plants into animals and animal products should be studied in cooperation with Animal Science personnel. Grains, hays, plant fiber or bulky plant materials such as corn cob and peanut hulls are often used in mixed feeds for dairy animals. Studies of transfer from these plant products into animals and animal products should be undertaken.

Finally, then, we need long-term studies of the fate and effects of pesticide residues in the environment. Although such investigations may not be the complete responsibility of Entomology, consideration should be given to strengthening our program in ecology. Studies of this type are in progress in Zoology and Experimental Statistics under the direction of Dr. D. W. Hayne.

G. SOURCES OF SUPPORT

1. Funds to equip and staff the Pesticide Residue Laboratory for its service to the School of Agriculture and Life Sciences should be actively sought from State and Hatch Act sources.

2. Limited support for research projects involving uptake of residues by specific crops might be obtained from appropriate commodity groups (for example, The Peanut Growers Association for studies involving peanuts; The National Cotton Council for studies on cotton).

3. Funds are distributed periodically (annual in most cases) by the Agricultural Research Service, U. S. Department of Agriculture. However, that agency usually solicits proposals in specific areas; and their interests and ours usually do not coincide exactly. It is, nevertheless, a possible source of support for studies especially aimed at minimizing pesticide residues - and they interpret this terminology very broadly. The study on interaction effects on plants presently underway is supported by this source.

4. Support for studies on mechanisms of uptake, transport, storage, and disappearance from plants and ecological studies on the fate and effects of pesticide residues in the environment should be sought from the Public Health Service (PHS) and National Institutes of Health (NIH), U. S. Department of Health, Education and Welfare.

5. PHS and NIH are also possible sources of support for studies on transfer of pesticides from animal feeds into meat and milk. However, the State should also support this research.

H. RECOMMENDATIONS

It is recommended:

1. That increased State support for the Pesticide Residue Laboratory be actively pursued. A reasonable approach would include support for the general function of the Pesticide Residue Laboratory. Initially, $25,000.00 is needed to complete installation of laboratory benches and hoods and to purchase an oven, two vacuum pumps, two laboratory carts, a pH meter, Soxhlet equipment, several other pieces of equipment, and miscellaneous glassware. For annual operation of the laboratory, fund needs are as follows:

Personnel	$ 70,000.00
Equipment	15,000.00
Supplies	52,000.00
Maintenance	3,500.00
Travel	1,500.00
Total	$142,000.00

2. That cooperative research between interested faculty in commodity research and the Pesticide Residue Laboratory be undertaken to study soil persistence and breakdown of pesticides and their uptake and storage in crops grown on contaminated soils.

3. That financial support be sought from NIH and PHS for research on mechanisms of absorption, translocation, storage, and fate of pesticides in plants to be conducted by present faculty.

4. That a faculty position be established for research on the fate and effects of pesticide residues in the environment and that support for it be pursued from NIH and PHS. This recommendation is similar to one given in the Subcommittee report on Medical and Veterinary Entomology. (recommendation No. 3).

5. That long-term plans be developed to locate the Pesticide Residue Laboratory on the campus in a permanent facility.

November 24, 1965

REPORT ON REASSESSMENT OF DEPARTMENTAL RESEARCH PROGRAM

DEPARTMENT OF ENTOMOLOGY

Subcommittee on Structural Pests

C. F. Smith
M. H. Farrier
H. B. Moore
D. A. Mount
C. G. Wright
Chairman

A. Other Individuals Contacted for Their Views on Structural Pest Research

Professional Entomologists:

1. W. Ebeling, Professor of Entomology, University of California, Los Angeles, California

2. J. McD. Grayson, Head of Entomology, Virginia Polytechnic Institute, Blacksburg, Virginia

3. H. R. Johnston, Principal Entomologist, Wood Products Insect Laboratory, United States Department of Agriculture Forest Service, Gulfport, Mississippi

4. R. J. Kowal, Assistant Director, Forest Insects Research, United States Department of Agriculture Forest Service, Washington, D. C.

5. C. D. Mampe, Jr., Assistant Technical Director, National Pest Control Association, Elizabeth, New Jersey

6. J. V. Osmun, Head of Entomology, Purdue University, Lafayette, Indiana

7. P. J. Spear, Technical Director, National Pest Control Association, Elizabeth, New Jersey

8. Several other professional men were contacted by letter, but did not respond.

Pest Control Operators:

1. J. R. Hutchcraft, Terminix, Inc., Charlotte, North Carolina

2. W. C. McClellan, Fumigators, Inc., Raleigh, North Carolina

3. W. H. Wilson III, Wilson Pest Control Company, Winston-Salem, North Carolina

B. Scope of Existing Research Program

H. B. Moore is investigating the biology and control of *Xyletinus peltatus* (Harris) (Anobiidae: Coleoptera), a common wood-borer in structures in North Carolina, and C. G. Wright is investigating the species of cockroaches and their occurrence in buildings in North Carolina.

C. Adequacy of Existing Research Program

The existing research is far from adequate; however, due to factors listed under limitations, this program cannot be developed in greater detail.

D. Limitations Imposed on Present Progress

Limitations are imposed on active research by Drs. Moore and Wright in this area due to: (1) teaching responsibilities during nine months of the year which involve more student contact hours than recommended for full-time teaching, (2) the advising of a total of 29 students, (3) extension responsibilities, such as organizing and conducting the annual pest control operators' three-day school and answering many structural insect inquiries from pest control operators, and (4) other necessary college duties.

E. Trends Influencing Future Course of Our Program

The population of the United States is presently 34% urban and 36% suburban, according to recent data. The 70% of our people living in metropolitan areas will soon have greater and more nearly equal representation in government because of reapportionment of representation and the establishment of the Federal Department of Urban Affairs. Therefore, because of political pressures, if for no other reason, it can be expected that the problems of metropolites will be the subject of scientific research and extension services similar to that provided for the farmer in the past. Entomologists will be required to work with this large, representative segment of the population.

Structural pest control is a growing industry and it will continue to grow. The 1965 National Pest Control Association annual report states that there are more than 5,000 firms in the United States actively engaged in the pest control industry. They estimate the present annual gross volume of business to be $350,000,000 a year and the $400,000,000 mark should be reached by 1970, if not before. Therefore, structural pest control is an industry that is of major importance to entomologists, governmental agencies, and suppliers alike, especially as agricultural lands decrease.

As our society continues to evolve and living standards increase, the public will demand additional information on pests with which they come in contact. Providing this information will necessitate the investigation of many questions on safety of pesticides in buildings, interrelationships of insects and their habitats (buildings), etc. Answers will be secured through active, directed research programs.

There is increasing stress on controlling wood-boring beetles and stored tobacco pests by fumigation. Questions relating to such fumitations need to be answered. At this time they are not being investigated.

Landowners are spending large sums of money to control shrubbery and turf pests. Even though this control may involve only one or two shrubs, they often spend as much as $10 to $20 on it. While expending money and labor, the landowner often becomes interested in this group of pests and requests further information on them and their control. In the southeast, there is little investigative research being conducted on shrubbery and turf insects, although it is obviously needed.

Regional laboratories are being formed to study certain insect groupings. We are in a favorable geographical location for the development of an active program in structural insect research. There are few institutions in the United States where such research is being conducted.

F. New Areas of Research for Consideration

Many worthwhile research projects were suggested by the people contacted, however, until such time as this area of entomological endeavour is strengthened in the department, or either of the two members involved in this area changes projects, the suggestions need not be considered.

If it becomes possible for the two faculty members now involved in this area to devote additional time to research, or an additional member is added to the team, the following research projects should be given serious consideration:

1. Important aspects of insect pests attacking shrubbery and ornamental crops

2. Fumigants - general knowledge on their actions under simulated and actual field conditions.

3. Termite control soil tests in cooperation with the U. S. Forest Service

4. Comparison of cockroach behaviour: resistant versus non-resistant, population rhythms, etc. under laboratory and simulated field conditions.

5. Effectiveness and limitations of different insecticidal formulations on various surfaces

6. Biology and new control methods for subterranean termites and powder post beetles

7. Relationships of insects and their habitat (the building)

8. Research on pests of stored tobacco and their control

9. Biology and control of certain important ant species

10. The development of a bioassay test for the detection of termite control chemicals in the soil

11. Biology and control of fleas

12. Dusts versus liquids for the control of various structural pests

13. A test to determine the effects of a cellulase inhibitor (extracted from Sericea sp.) on subterranean termites.

14. Safety of pesticides in buildings.

15. Attractiveness of new materials used in building construction to structural pests.

16. Method of effectively controlling millipedes.

G. Our Most Appealing Centers of Interest

Drs. Moore and Wright have conducted research on the following insects of urban or industrial importance:

1. Wood destroying insects (several species of powder post beetles and termites)

2. Household and nuisance insects (cockroaches, brown dog ticks, and boxwood psyllids)

Their teaching program has familiarized them with many species included under structural insects and with research on many of them. This provides a general, overall knowledge of the area.

H. Sources of Support

Support for a project may be secured from one of the following agencies when the project is of interest or value to the particular agency.

1. National Pest Control Association - funds have been secured for departmental research in past years. Presently this association has a very small research fund budget, but limited sums of money are available periodically.

2. Flue Cured Tobacco Stabilization Board - possible source of funds for research projects on stored tobacco pests, fogging, and fumigation.

3. National Institutes of Health - frequently provides funds for research projects which involve insects and their possible relation to public health.

4. National Science Foundation - possible source of money for research projects on household pests.

5. Faculty Research Fund - will provide limited monetary support for the initiation of approved research projects.

6. Pest Control Firms - may provide limited support, through their state organization, to projects of direct value to them. Of concrete value is their cooperation in securing sites to conduct field research.

7. Pesticide Industry - will provide money if research is related to their pesticide products. Caution needs to be exercised here to avoid any unfavorable conditions which can possibly develop if a satisfactory agreement is not initially reached.

I. Discussion

The field of structural insect research will require increased attention as our nation continues to become rapidly urbanized and the public demands increased information on, and control of, those insects which annoy them. Many questions raised by the public's interest in these insects will need to be scientifically investigated before reliable answers can be given. Reapportionment to give equal representation to the mass of people and the establishment of the Federal Department of Urban Affairs should give impetus to research in this area of entomology.

Research by individuals in this area should be of a practical nature so that the data secured are of value immediately, or in the near future, to homeowners, pest control operators, and other people needing this type of information.

It is recommended that an active research program on structural pests research be developed in this department because of: (1) the growing need for research on this group of insects, (2) the lack of research with these insects in the United States, and (3) the geographic location of this state in the Southeast where structural insects are common pests.

To initiate this program, it is recommended that an additional entomologist, interested in shrubbery and turf insects, or fumigation, be hired. He should assume a portion of the teaching duties of Drs. Moore and Wright, permitting all three individuals to expend a portion of their efforts in their particular research specialities. These three men, devoting time to teaching and research, can develop an active research program in this important, but neglected, field of entomological endeavour.

It is further recommended that a graduate program in this area of entomology be initiated, with each faculty member advising interested, qualified graduate students. Training of these graduate students should follow the general procedures set up for all other graduate students in the department.

J. Summary of Recommendations

1. No expansion of research beyond the present program should be considered until the existing teaching loads of Drs. Moore and Wright are lightened in some manner.

2. Research on structural insects should be supported and increased by the addition of an entomologist to conduct research on shrubbery and turf pests or fumigation.

3. Teaching duties of Drs. Moore and Wright should be shared with this third member of the team, enabling them to develop an active structural insect research program.

4. Graduate students should be encouraged to study in this area of entomology.

REPORT ON REASSESSMENT OF DEPARTMENTAL RESEARCH PROGRAM

DEPARTMENT OF ENTOMOLOGY

Subcommittee on Taxonomy

C. F. Smith
M. H. Farrier
D. A. Mount
R. L. Rabb
H. H. Neunzig
D. A. Young, Chairman

(Dr. R. C. Axtell's cooperation is also gratefully acknowledged.)

A. Scope of Existing Program

1. Research

a. Homoptera

(1) Dr. Young is engaged in a study of the Cicadellinae, one of the major subfamilies of leafhoppers, including some 1,500 species. About one-third of this is ready to go to press. An estimated three years will be required to complete this program.

(2) Mr. Frank Mead is progressing well with a revision of the Western Hemisphere fulgoroid genus Oliarus. This is a Ph.D. dissertation.

(3) Mr. John Flynn is nearly finished with a revision of the fulgoroid genus Cedusa, also a Ph.D. dissertation.

(4) Dr. H. D. Blocker has completed a revision of the leafhopper genus Balclutha for the Western Hemisphere. The work is nearly ready to go to press.

(5) Mr. W. J. Knight has a revision of the leafhopper genus Dikraneura well in hand as a doctoral dissertation.

(6) Mr. James F. Greene is preparing his Master's dissertation, a revision of the Western Hemisphere species of the leafhopper genus Psammotettix.

(7) Mr. Bob Hill and Mr. Robert H. Davis are in the initial stages of a study of the higher categories of leafhoppers, with special emphasis on the characters of the ovipositors.

(8) Dr. C. F. Smith has been working for some time on aphids, with major emphasis on Eriosomatinae (woolly aphids) of North Carolina and on the genus Drepanaphis. He has recently begun a study of root aphids on conifers.

b. Other Insect Orders

(1) Mr. James Cornell has completed a revision of the scaphidiid genus Eubaeocera which is almost ready to go to press.

(2) Dr. T. B. Mitchell continues his estimable progress in bee taxonomy and is presently engaged in a study of megachilids.

(3) Dr. H. H. Neunzig and Dr. R. L. Rabb are engaged in studies of immature insects as their time permits.

(4) Dr. C. J. DeLoach has nearly ready for press his doctoral dissertation on two species of flies, one of which is new. This can be reviewed as a taxonomic undertaking from a biological approach.

(5) Dr. M. H. Farrier is cooperating with Forest Service personnel of the Federal government at the Research Triangle in a pioneer project entitled "Arthropods of the Forest Floor."

(6) Dr. R. C. Axtell is doing work with major taxonomic implications in the important dipterous genus Hippelates.

2. Museum

The research program in systematics at N. C. State University is supported materially by the Museum. The Museum began in 1952 and has grown rapidly until very recent years. The major contributions to the Museum were those of Dr. B. B. Fulton, who contributed a splendid collection of Orthoptera, chiefly from Eastern United States, and Dr. Z. P. Metcalf who contributed a very strong collection of Auchenorrhynchus Homoptera from throughout the world. The Museum collections are also strong in aphids and bees as a result of the contributions of Dr. C. F. Smith and Dr. T. B. Mitchell, respectively. In most of the major groups of insects the Museum collection is strong from Eastern United States, with a heavy emphasis on North Carolina.

From the standpoint of the world fauna, our collections are strong only in the Homoptera Auchenorrhynca and in certain groups of bees. In the Homoptera Auchenorrhynca our collections rank certainly in the first ten in the world, and perhaps in the first five.

The Museum is presently housed in approximately 90 cabinets in a thousand drawers. In addition to the specimens which are in drawers, there are approximately 300 Schmitt boxes remaining from the Metcalf collections to be placed in drawers and several hundred additional Schmitt boxes which have accumulated more recently, among them a considerable number of specimens from Peru. The alcoholic collection, consisting primarily of immatures, includes approximately 1,000 trays of vials (approximately 15,000 individual vials). The aphid collections total approximately 65,000 slides, including an estimated 500-600 species. The mite collections curated by Dr. Farrier include about 30,000 slides and additional alcoholic material.

The Museum functions in a major way in contributing materials for taxonomic research problems at this and other universities. In providing specimens to others, our Museum is simply reciprocating for the specimens which have been loaned to us from a number of other institutions, including Museums throughout the world.

Of the collections of insects east of the Mississippi River, the collections at N. C. State University, along with those of the Florida Plant Board, Cornell University, the Illinois Natural History Survey, Ohio State University, and the U. S. National Museum in Washington, are outstanding. In addition to contributing to taxonomic research, the Museum provides a reference collection for problems which arise in the course of field research. In this connection, Mr. Mount reports that in the last few years he has been averaging about 300 determinations per year of insects sent in through extension service from field workers. This figure should be increased materially to account for the identifications which are made by the various specialists as a result of personal contacts.

B. Adequacy of Existing Research Program

In the opinion of the Committee, the adequacy of the research program can be measured only against the objectives of the program. Our research program at State has been determined largely by the interest of the personnel engaged in the program, and to a lesser extent by needs of the agricultural community of North Carolina. It is believed that an interest-oriented program will continue to produce the maximum possible results from the personnel engaged in the program. It is quite obvious from what has been said in the preceding section that there are areas of systematics which are not being covered at this time, and these present opportunities for future expansion. Some of these are discussed below in the section entitled "New Areas of Research for Consideration."

C. Limitations Imposed on Present Programs

This problem will be approached from two standpoints; first, the standpoint of personnel limitations, and second, that of Museum limitations.

1. Personnel Limitations

It is again not possible to recognize limitations without having set objectives. It was pointed out that our systematic efforts have been concentrated in the areas of specialty of the people engaged in the program. The discussion of limitations resulted in a consideration of what our objectives should be in our systematic program. The results were that first of all there should be a minimum general covering of major orders of insects and a much greater development in those areas in which we have specialists on our staff. Concerning the minimum development, the Committee feels that there are weaknesses in the Diptera and in the Lepidoptera.

In addition to our personnel shortcomings in professional entomologists, our Museum stands in great need of a curator and a technician. The need for a curator has been recognized for a long time by the administration, but this remains the most critical problem we have. The word "curator" can be interpreted in a variety of senses from a relatively high administrative position in some museums to a caretaker without administrative duties at others. It is in the latter sense that our needs are interpreted at this time. It is suggested that a well-trained man with a Master's Degree would be adequate for this job. It is suggested that the job classification for the curator be set up as a Research Assistantship at a salary of approximately $7,000. In addition to the curator, the Museum needs a technician. In the past two years we have lost the technician we had.

2. Museum Limitations

The Museum is weak in Lepidoptera and Diptera of the major orders of insects. This shortcoming is related to the lack of personnel interested in these two orders. The Museum has grown as much as it will grow with its present space allottment. Approximately 50 percent more space is needed based on the current input of specimens plus the backlog of specimens on hand. It is estimated that 44 cabinets and 500 drawers at a cost of $12,000 are needed merely to curate properly our present collections. It is estimated that the nearly immediate needs for the alcoholic collections will be an increase of approximately 50 percent of our present collections.

D. Trends Influencing Future Course of Our Program

Recent trends contributing importantly to our plans are:

1. An increase in support for systematics of the conventional type

2. An increase in emphasis on approaches to systematics which are non-morphological in essence.

E. New Areas of Research for Consideration

Based on the ideas set forth above, that the Museum should be brought up to a minimum standard, and that unilateral disproportionate growth should be sought in those areas wherein lie the interest of our personnel, and based to a lesser but nevertheless important degree on the needs of the agricultural community of North Carolina, the following are set forth as new areas of research for consideration:

1. Additional research in Diptera

2. Additional research in Lepidoptera

3. Additional research involving an experimental approach to systematics (this area could well overlap the two preceding areas listed)

4. Research in trans-disciplinary areas.

In this connection, research of the nature being carried out by Dr. Farrier in Acarina, the possible research of a Dipterist to tie in with the program in Medical and Veterinary Entomology being carried on by Dr. Axtell, the possible employment of a Lepidopterist whose interests might tie in with the work of Dr. Neunzig and Dr. Rabb, were suggested.

5. Research in Aquatic Entomology

This is a response to an existing need in North Carolina. It is felt that as water problems increase there will be an increasing need to measure effects of such things as industrial development in North Carolina on aquatic life, measurable only in terms of pre-existing populations of aquatic insects, factors which are presently unknown.

F. Our Most Appealing "Centers of Excellence"

These have been brought out largely in the section on the "Scope of Existing Research Program" above. In resume, these are:

1. Homoptera

It is felt that North Carolina State University is in a position almost unique in the world in the opportunities it offers to a specialist in the Homoptera Auchenorrhyncha. This results not only from the good collections, but also from one of the most complete libraries in the world, much of it in the form of separates which were accumulated by Dr. Metcalf and used to prepare his catalogs of the Homoptera Auchenorrhyncha. The collections accumulated by Dr. C. F. Smith in the Aphididae are also very strong.

2. Taxonomic Studies of Bees have been very productive.

3. Taxonomy of Immatures

The taxonomy of immatures, although it has had less development of the two preceding areas, must be listed as an area of strength because of the size of the collection, because a good course in immature insects is offered here, and because of the interest of Drs. Rabb and Neunzig at N. C. State University.

4. Acarology

Relatively few universities in the United States--Oregon State, Ohio State, Kansas University, LSU--have collections of mites as good as or better than ours. We have a course in acarology in the curriculum.

5. Library

The Library at N. C. State University is particularly strong in entomological works, and must be included in any consideration of our most appealing centers of excellence.

G. Sources of Support

There has been no problem in obtaining support for the systematic studies at N. C. State University.

The Committee feels that support has been adequate for research, but inadequate for new positions. Our major support of our systematic activities in recent years has been Federal except in Acarina.

H. Recommendations

1. Personnel

It is recommended that a curator and a technician be provided for the Museum.

It is felt that the creation of a new position for a Dipterist and a Lepidopterist is advisable. This could very well tie in with the need for an experimental approach to taxonomy and with the modern trend toward trans-disciplinary research.

It is recommended that a position be established for an entomologist who is interested in aquatic entomology to take care of the present need mentioned above.

2. Museum

There is no prospect that the Museum's need for space will lessen. It will continue to grow. In view of the space problems in the biological sciences on the campus at present, it is felt that ultimately the logical solution for the problem of the Museum is a separate building. All of the Committee approached this solution with the reservation that the building should be close to Gardner Hall. It was pointed out that this had been previously suggested by Dr. Guthrie, and that Dr. Young had approached the Botany Department to find their reaction to housing herbarium collections with the entomological collections in a separate building and that after an initial negative reaction, there was a change of opinion and that the botanists now support this. It was mentioned that the Zoology Department might have similar space needs for their zoological collections. It was suggested that a small portion of the space provided in a separate building might be used to house a few exhibits which would attract attention to the entomological activities at the University. In this regard, it was pointed out that separate museum facilities are now provided at the University of Kansas (for zoology only) and at the University of Illinois (The Illinois Natural History Survey), and at the University of Florida to some extent (The Florida State Plant Board).

3. Emphasis

The opinion was expressed by most of the people present at the meeting that the taxonomic activities of N. C. State University be encouraged by the administration. Dr. Rabb pointed out that of all the branches of our biological sciences today it is only in systematics that real efforts toward synthesis are undertaken. It was the consensus that taxonomic research of a conventional nature be continued, but that there was a great need for an increase in the amount of activity in taxonomy from the new experimental approaches and from the standpoint of life history studies, and that this should be kept constantly in mind in assessing the chief interests of prospective new members of the staff.

March 1, 1966

REPORT ON REASSESSMENT OF DEPARTMENTAL RESEARCH PROGRAM

DEPARTMENT OF ENTOMOLOGY

Subcommittee on New Areas of Research

Dr. W. J. Mistric
Dr. R. L. Rabb
Dr. R. T. Yamamoto
Dr. D. A. Young
Dr. F. E. Guthrie, Chairman

Research at a university is so intimately related to the academic program that it was not possible to make recommendations concerning new areas of research without providing some semblance of balance with the graduate training program. Departmental goals in research and teaching must be compatible and each appropriately funded. These goals must not be upset by overextending our capabilities into areas which aggravate, rather than complement, the departmental program.

The challenge for the entomological profession during the next several decades has been clearly stated by leading entomologists, Presidential Advisory Committees, and several scientific disciplines related to entomology. The immediate challenge not only concerns research but also, and perhaps to a greater degree, concerns training. The demand for persons trained in ecology, biochemistry, behavior, toxicology (to list a few key examples) cannot possibly be met at present, and each new study group increases the demand on already unobtainable personnel. Universities and governmental organizations will merely compete for the same individuals, and we would be less than realistic if we did not accept this fact. Therefore, the next ten years must see a maximum training effort in these critical areas if the proposed basic research programs are to be realized. That is, persons must receive training in modern biology if new concepts for the study of insects are to be incorporated into programs proposed for the nation and the region. This may decrease our initial effort in research to an appreciable degree.

Departmental Programs

The major areas which should be strongly represented in our research and teaching programs are:

1. Ecology including behavior.
2. Economic entomology including pesticide residues.
3. Physiology, biochemistry, and toxicology.
4. Taxonomy.

At the present time, the major effort and resources of our department should be expended in strengthening the programs of existing personnel. Some of these personnel may find it to the benefit of all concerned to shift emphases in varying degrees so that everyone's effort contributes as significantly as possible to strengthening the four major areas listed above. It is the responsibility of the individual faculty member to identify himself with one of these areas and work more actively with others so identified in developing stronger programs in research and teaching. This does not necessarily mean cooperative research projects. It does mean cooperation in improving course offerings, obtaining facilities, sponsoring key visiting lecturers, and in general demonstrating an active and constructive interest in sponsoring a broader, more comprehensive, and perhaps more modern academic program in each identified area than might be represented by the individual's own research interest. One possible mechanism to foster such interest groups might be through seminars in the four designated areas, utilizing departmental seminars only for special occasions.

If individuals do not wish to identify with specific programs, this is their right and prerogative.

Present Weaknesses

1. Lack of support for graduate students. At the present time the State supports graduate assistants only through Agricultural Foundations funds, a not always consistent source of support. Further, the project leaders are not assured of continuing support for students not on sponsored federal funds even when progress has been excellent. This creates an atmosphere of uncertainty which is not conducive to stability or excellence in either the research or training programs.

2. Restrictions imposed by commodity pressures. Programs are likely to be restricted in depth and scope when tied closely to a crop.

3. Lack of proper facilities for some programs. As a specific example, the program concerned with mass-rearing of hornworms, ultimately the insect behavior program, has been operating with antiquated laboratory facilities. We cannot expect to recruit successfully for promising young faculty if we cannot provide a better atmosphere for their research programs.

4. Restrictions on faculty time. The faculty cannot be expected to serve all segments of the university efficiently. Some reasonable allocation of time best fitted to particular talents of the faculty should be considered when assignments are made for committee and administrative chores. Far too much faculty time is now being devoted to committee work, to meetings and conferences of a nature not commensurate with the demand on the faculty time, to extraneous paper work, and to discussions by groups of persons,

only part of whom can contribute significantly to the subject being discussed. The members of this specific subcommittee (probably representatives of the university faculty) estimated that they allocate 17 per cent of their daily effort to "administrative" (committees, meetings, nonacademic conferences, reports, and other paper chores) problems of the university, school, biological sciences institute, and department. No member questions the necessity of some participation in these activities. It is the degree of, administrative importance attached to, dubious importance of, and lack of efficiency in, these extra assignments that create the conflict. If we are going to establish a university, the proper atmosphere for creative thinking must be gained. Countless interruptions and attention to petty problems cannot be tolerated if that goal is to be realized. [Obviously the estimates made above cannot be validated, but it seems clear that a thorough study of "faculty time" should be made.]

5. Lack of adequate subprofessional help, particularly in quality, is a weakness of the departmental program, no less so now than when recognized and recommended by the McGovran Review Committee in 1960. As but one specific example, the museum simply cannot provide the necessary service to all segments of the program without a curator.

Departmental Growth

The subcommittee takes the position that growth in numbers *per se* is not a good criterion of quality in an academic department. Our department numbers over 25 faculty members at present (positions filled and open), and there are a number of outstanding departments in North America with much smaller faculties. In these outstanding departments a few strong programs are continuously undergirded with personnel who strongly complement the existing strengths. On the other hand, many very large, but generally ineffectual, departments have continually weakened their departmental structure by adding new programs completely out of context with existing ones. Growth by dilution has particularly been an earmark of the southern universities, and this may well be a major reason the region has not kept pace in quality research and training.

As an example of a program which is being built on strengths, let us briefly discuss the program in comparative biochemistry and toxicology. This group has work devoted to explaining the response of animals to toxicants in their environment on both the molecular and organismal approach. Although specific interests may not always be closely akin, the group has a commoness which becomes increasingly evident as the research programs are developed. For example, Dauterman's synthetic program has produced compounds of great interest to both Main and to Hodgson. The adaptation of organisms to toxicants is being viewed with interest by the entire group, at least to some degree, and this is an example of how extrapolation might be made to existing problems in the environment. Programs in research represent a very major portion of the program here, and nearly one-half of

the graduate students receive training in the broadly defined area. A major conference at N. C. State was recently built around this area of endeavor which could well be the stimulus for similar conferences in other parts of our department. As evidence of recognition at the national level, three of the faculty in this discipline were invited speakers at major scientific conferences in 1965. To summarize, this program is well on the way to becoming nationally recognized and should continue to be strengthened.

To illustrate an area which could be built into great strength, let us briefly examine ecology and behavior. At the present time we have two faculty members devoting the major portion of their research to ecology, another who recently published a paper concerning population dynamics, strong programs in insect behavior oriented toward host selection of both plants (Yamamoto) and animals (Axtell and Yamamoto), several economic entomology programs making contributions to ecology, and a number of supporting programs in other departments, some of which have definite entomological overtones. Although this latter phase will not receive further mention, it is obvious that a coordinated effort in ecology in the Institute of Biological Sciences is needed.

To make order out of chaos, we need to orient the effort of the people working in the general area to a cooperative effort in ecology. One person needs to be assigned overall responsibility to the background graduate courses without the pressure of commodity orientation and be encouraged to devote his major effort to inter- and intradepartmental coordination. It is probable that at least two years will be required to outline a respectable program, and a lesser deadline might result in a superficial program. The buildup of strength in ecology is interpreted to mean both a buildup in the conceptual area and also in the subareas contributing to the basic discipline. That is, we should not preclude growth of a smaller subunit as long as it adds strength to the general theme of ecology. Certainly the recent additions in behavioral research are an excellent illustration of this point.

A decided effort in ecology would support the programs in economic entomology, in medical entomology, in taxonomy, in pesticide research and overall graduate student training. In addition to the current programs, the programs necessary for the future will need a much greater emphasis in ecology. This is particularly true for student training where nearly every conceivable avenue for future research will require a greater understanding of our increasingly complex ecosystem. Already we have work underway with predacious mites, Hippelates, brood discrimination by diapause studies, and host selection which promise to contribute a degree of sophistication not previously engendered in our programs.

The ecosystemic effects of pesticides, a problem demanding regional and national leadership but getting neither, might serve as a focal point for the overall program. New and existing programs which utilize the integrated control concept, biological control agents, host selection, population dynamics, and pesticide residue research aimed at the environmental problems could all be interwoven into one central theme without

destroying the individuality of any program. It takes little foresight to recognize that this will be the major problem for the future as food surpluses disappear and population expansion and urbanization make increasing demands on land utilization. The state and the national need is evident, support is essentially limitless for a strong program, and a thread of continuity is needed at this critical stage in the evolution of this program.

Cases for building on existing strengths can be easily made for taxonomy or for economic entomology. These are also areas which have great potential and need consolidation and identification of direction. As we build them, we should consider new positions in terms of how we can develop new concepts, not how we can add information to a taxon or to control of a specific insect or group of insects. We should attempt to build taxonomy by adding persons interested in, for example, allochronic speciation or zoogeography, etc. and in economic entomology not by simply adding a tobacco or a cotton entomologist but by adding personnel who will contribute to fundamental research and concepts of control.

One danger is inherent if we limit the buildup only where strong programs presently exist. That is the danger of imbalances until the areas requiring identification and direction have reached a higher stage of evolution. Yet, we can hardly hold back progress, particularly when we are just gaining momentum. With the great interest and relatively large number of faculty involved in some of the programs we have outlined, it is obvious that an imbalance will exist only if the proper attention is not given by either the faculty or the administration. The area of insect biochemistry and toxicology is an example of a program which does not follow the classical tradition of entomology. Should it become evident that this program stifles planned growth of conventional entomology, or is itself being stifled, appropriate alterations will have to be made as outlined by the administration.

Recommendations

1. This particular time in the evolution of the Department should be devoted to consolidation. We need to examine critically our programs, identifying both our direction and the strength to build the program(s) we envision.

2. New programs or new positions should only be added as an adjunct to existing strong programs; we should not grow by accretion. However, this should not be imposed in such a manner that it stifles buildup in the areas the faculty identifies as a necessary baseline for development of the Departmental program. When the foundation programs have been coordinated and the direction identified, it may well be that a critical position must be added to bring a key area up to a minimal standard.

3. The following new faculty positions should be added to build up the entomology program in the tradition of classical entomology. They should have no commodity orientation.

a. Ecologist

b. Aquatic entomologist

These positions are broadly defined and candidates should be sought from the standpoint of professional qualifications rather than strict orientation to a project.

A third position in physiology will eventually be required in the departmental program. However, the subcommittee feels that this position should be deferred for one to two years so that positive direction can be established in this part of the program.

4. Support for additional graduate students should be forthcoming from permanent state sources. Further, a mechanism should be provided to ensure that assistantship funds are allocated in a manner that assures stability to both the student and the research project.

5. Support for additional subprofessional help must be obtained for some key programs, and the educational background of technicians should be at a higher level (increased funds to obtain higher ratings).

APPENDIX C

APPENDIX C. Feb. 16, 1970

PLANNING FOR THE DEPARTMENT OF ENTOMOLOGY

A long-range plan for this Department has been developed over the past year and a half which is believed to allow for our orderly growth and to give us as fully rounded and adequate capabilities as exist anywhere in the United States.

On September 11, 1968, a daylong conference was held on our capabilities and future needs in the field of teaching. October 1-2, 1968, a 2-day review and planning conference was held on extension in entomology. Then, on July 17-18, 1969, a conference was held to consider our longterm research requirements. From these 3 workshops, an appropriate long-range program has been developed. The details of this plan are presented in the following set of tables.

AREAS OF DEPARTMENTAL RESPONSIBILITIES

A. APPLIED RESPONSIBILITIES (Research and Extension)

I. Southern Field Crops, Insects of (cotton, tobacco, peanuts)

II. Man and Animals, Insects of

III. Grains, Soybeans, Forages; Insects of

IV. Forests, Ornamentals, Turf; Insects of

V. Vegetable Crops; Insects of

VI Wood-destroying Insects (structural pests)

VII House and Industrial Insects

VIII Fruit Crops; Insects of

IX Beekeeping

X Identification and Survey

XI Science Education (4-H, other)

XII Pesticides

B. FUNDAMENTAL RESPONSIBILITIES (Research and Teaching)

XIII Pest Management (Including biological control and host resistance).

XIV Biology, Behavior, Ecology

XV Morphology

XVI Pathology

XVII Physiology

XVIII Taxonomy

XIX Toxicology

XX Genetics

FACULTY VACANCIES AND REQUESTED POSITIONS

February 16, 1970

1. Vacancy "A". This is an extension position approved by the SALS administration who would devote one-half of his time to commercial vegetables and the other half to fruit. Employment of such an individual is planned for June or July of 1970.

2. New Position "A". A research position is in the SALS 1971-73 budget for a man to work on the insect problems of grains, soybeans, and forages. This would free Dr. Campbell so that he could devote himself nearly full time on the development of host plant resistance techniques for the control of the insect pests of grains, soybeans, forages, and of some of the southern field crops.

3. New Position "B". An extension position is in the SALS 1971-73 budget for a man to work on extension on the insect problems of flowers, ornamentals, and nursery stock.

4. New Position "C". A research position is in the SALS 1971-73 budget for a man to work one-half time on the insect problems of commercial vegetables and one-half time on those of flowers, ornamentals, and nursery stock.

5. New Position "D". A research position is in the SALS 1971-73 budget for a man to work in the area of "environmental toxicology" and who would be an integral part of the school's Environmental Quality Program.

Miscellaneous. An extension vacancy exists for a man to do survey and identification work. He will be a research assistant and as such is not considered as a faculty member.

FACULTY CAPABILITIES DESIRED FOR 1973 AND BEYOND

February 16, 1970

1. Entomological research in forestry. The development of wood lots and forests for production of timber, paper pulp, and recreational areas is a large and important industry in North Carolina. Moreover, in terms of acreages of timberland, North Carolina ranks high among the states of the east. In view of this and of the severity of some forest insect problems within the state, it is considered imperative that a research program for the control of forest insects be initiated within this department. Although forest entomology is taught at Duke and research work is underway at the Research Triangle there is no applied research being conducted on North Carolina's forest insect problems. A faculty member for this area would, of course, also be expected to teach one or two advanced courses in this area.

2. Morphology. Morphology or insect anatomy is a science discipline basic to the entire field of entomology. A well-rounded entomology department should have a member with strong capabilities in this area. We would not necessarily have to hire a separate morphologist because when we fill some of our budgeted commodity positions we might be able to get a man who could do fundamental research in morphology. However he is procured, there should be such an individual on the faculty.

3. Genetics. A capability in genetics has also become fundamental to a good entomology department, since genetic tools capable of incorporation into pest management programs are now becoming available. Here again, it is doubtful that one would go for a full time position but rather one would attempt to fill the need through getting a man with this capability to care for a commodity need.

4. Curator for Insect Collection. This remains as a very important need. Employment of a faculty member for this is not contemplated. Rather, employment of a research assistant at the $10,000 - 12,000 level will be a desirable alternative.

ENTOMOLOGY DEPARTMENT FACULTY DEPLOYMENT IN 1969-71

February 16, 1970

A. Applied Responsibilities

Area	Person	Research	Extension
I. Southern Field Crops	Robertson	0.10*	0.85
	Bradley	0.50	
	Mistric	0.75	
	Campbell	0.30	
II. Man and Animals	Falter	0.30	0.70
	Axtell	0.25	
III. Grains, Soybeans, Forages	Campbell	0.30	
IV. Forestry, Ornamentals, Flowers, Turf	Robertson		0.05
	Whitfield		0.10
V. Vegetables			
Garden	Scott		0.25
	Brett	0.15	
Commercial			
	Vacancy A	0.15	0.35
	Brett	0.05	
VI. Wood-destroying Insects	Moore		0.10
VII. House & Industrial Insects	Moore		0.20
	Wright	0.30	
VIII. Fruit			
Garden	Scott		0.10
Commercial	Vacancy A	0.15	0.35
	Neunzig	0.20	
	Rock	0.60	
	Smith	0.25	
IX. Beekeeping, Pollination	Meacham		0.05
	Scott		0.15
X. Identification & Survey	(Research Assistant)		1.00
XI. Science Education (4-H)	Scott		0.50
XII. Pesticides	Weekman		0.50
	Sheets	1.0	
Totals		5.35	5.25
	Administration		1.50

B. Fundamental Responsibilities

Area	Person	Research	Teaching
XIII. Pest Management, incl. Biological Control & Host Plant Resistance	Axtell	0.30	0.25
	Bradley	0.30	0.15
	Brett	0.10	0.70
	Brooks	0.10	
	Campbell	0.20	
	Farrier	0.15	0.40
	Guthrie		0.15
	Moore		0.70
	Neunzig	0.10	
	Rabb	0.35	
	Rock		0.20
	Wright		0.70
	Yamamoto		0.20
XIV. Biology, Behavior, Ecology	Axtell	0.15	
	Bradley	0.05	
	Campbell	0.10	
	Mistric	0.25	
	Rabb	0.40	0.20
	Yamamoto	0.50	
XV. Morphology	Campbell		0.10
	Young		0.10
XVI. Pathology	Brooks	0.70	0.20
XVII. Physiology, Biochemistry	Hodgson	0.40	0.25
	Rock	0.20	
	Yamamoto	0.30	
XVIII. Taxonomy	Axtell	0.05	
	Farrier	0.25	0.20
	Mitchell	1.00	
	Neunzig	0.50	0.20
	Smith Rabb	0.75	0.05
	Young	0.50	0.40
XIX. Toxicology	Dauterman	0.85	0.15
	Guthrie	0.70	0.15
	Hodgson	0.35	
XX. Genetics			
Totals		9.60	5.45
	GRAND TOTAL	27.15	

*All figures are in percent of man years.

PROPOSED ENTOMOLOGY DEPARTMENT FACULTY DEPLOYMENT IN 1971-73

February 16, 1970

A. Applied Responsibilities

AREA	Person: Name	Person: specialty	% commitment: Research	% commitment: Extension
I. Southern Field Crops	Robertson	total area	0.10*	0.85
	Bradley	cotton	0.50	
	Mistric	tobacco	0.75	
	Campbell	host plant resistance & peanuts	0.30	
II. Man & Animals	Falter	total area	0.30	0.70
	Axtell	total area	0.25	
III. Grains, Soybeans, Forages	Campbell	host resistance throughout	0.30	
	New man"A"	total area	0.50	0.50
IV. Forestry Ornamentals Flowers, Turf	Robertson	turf		0.50
	New man"B"	ornamentals flowers	0.50	0.50
	Whitfield	forestry		0.10
V. Vegetables	Scott	home garden		0.25
	Brett	Vegetables	0.20	
	New man"C"	Commercial Vegetables	0.50	
	Vacant(1/2)			0.50
VI. Wood-destroying Insects	Moore	total area		0.10
VII. House & Industrial Insects	Wright	total area	0.30	
	Moore	total area		0.20
VIII. Fruit	Scott	home fruits		0.10
	Smith	peaches	0.25	
	Neunzig	blueberries	0.20	
	Rock	apples	0.60	
	vacant(1/2)	fruits	0.50	0.50
IX. Beekeeping & pollination	Scott	beekeeping		0.15
	Meacham	beekeeping		0.05
X. Survey, Identification, Curating	vacancy (research assistant for survey & ident.)	total area		1.00
XI. Science Education	Scott	total area		0.50
XII. Pesticides	Weekman	total area		0.50
	Sheets	residues	1.00	
Totals			7.05	6.55
	Administration		1.50	

*All figures are in percent of man years

B. Fundamental Responsibilities

AREA	Person	% commitment: Research	% commitment: Teaching
XIII. Pest Management (incl. Biol. Control & Host Plant Resistance)	Brooks	0.10	
	Rabb	0.35	
	Axtell	0.30	0.25
	Moore		0.70
	Brett	0.10	0.70
	Campbell	0.20	
	Farrier	0.15	0.40
	Guthrie		0.15
	Rock		0.20
	Yamamoto		0.20
	Wright		0.70
	Neunzig	0.10	
	Bradley	0.30	0.15
XIV. Biology, Behavior, Ecology	Bradley	0.05	
	Axtell	0.15	
	Yamamoto	0.50	
	Campbell	0.10	
	Rabb	0.40	0.25
	Mistric	0.25	
	New Man "D"	0.40	0.10
XV. Morphology	Campbell		0.10
	Young		0.10
XVI. Pathology	Brooks	0.70	0.20
XVII. Physiology, Biochemistry	Hodgson	0.40	0.25
	Rock	0.20	
	Yamamoto	0.30	
XVIII. Taxonomy	Axtell	0.05	
	Farrier	0.25	0.20
	Mitchell	1.00	
	Neunzig	0.50	0.20
	Smith	0.75	
	Young	0.50	0.40
XIX. Toxicology	Dauterman	0.85	0.15
	Guthrie	0.70	0.15
	Hodgson	0.35	
	New man "D"	0.40	0.10
Totals		10.60	5.45

Grand Total----31.15

ENTOMOLOGY DEPARTMENT DIVISION OF LABOR FOR 1969-71

SUMMARY BY AREAS

APPLIED RESPONSIBILITIES

AREA	RESEARCH	EXTENSION
I. Southern Field Crops	1.65*	0.85
II. Man and Animals	0.55	0.70
III. Grains, Soybeans, Forages	0.30	----
IV. Forestry, Ornamentals, Turf	----	0.15
V. Vegetables	0.20	0.25
VI. Wood-destroying Insects	----	0.10
VII. House and Industrial Insects	0.30	0.20
VIII. Fruit	1.05	0.10
IX. Beekeeping, Pollination	----	0.20
X. Identification and Survey	----	----
XI. Science Education	----	0.50
XII. Pesticides	1.00	0.50
TOTALS	5.05	3.55

FUNDAMENTAL RESPONSIBILITIES

AREA	RESEARCH	TEACHING
XIII. Pest Management, Biological Control, Host Resistance	1.60	3.45
XIV. Biology, Behavior, Ecology	1.45	0.25
XV. Morphology		0.20
XVI. Pathology	0.70	0.20
XVII. Physiology, Biochemistry	0.90	0.25
XVIII. Taxonomy	3.05	0.80
XIX. Toxicology	1.90	0.30
TOTALS	9.60	5.45

Administration --------- 1.50

Grand Total -- 25.15

*Figures are in man years.

Division of Labor in:

Extension-----14%
Research------58% (34% in applied, 66% in fundamental)
Teaching------22% (does not include graduate student advising)
Administration 6%

February 16, 1970

ENTOMOLOGY DEPARTMENT DIVISION OF LABOR FOR 1971-73

February 16, 1970

SUMMARY BY AREAS

APPLIED RESPONSIBILITIES

AREA	RESEARCH	EXTENSION
Southern Field Crops	1.65*	0.85
. Man and Animals	0.55	0.70
I. Grains, Soybeans, Forages	0.80	0.50
. Forestry, Ornamentals, Flowers, Turf	0.50	0.65
Vegetables	0.70	0.75
. Wood-destroying Insects		0.10
I. House and Industrial Insects	0.30	0.20
II. Fruit	1.55	0.60
. Beekeeping, Pollination		0.20
. Survey, Identification, curating		1.00
. Science Education		0.50
I. Pesticides	1.00	0.50
Totals	7.05	6.55

FUNDAMENTAL RESPONSIBILITIES

AREA	RESEARCH	TEACHING
XIII. Pest Management, incl. Biological Control, Host Plant Resistance	1.60	3.45
XIV. Biology, Behavior, Ecology	1.85	0.35
XV. Morphology		0.20
XVI. Pathology	0.70	0.20
XVII. Physiology, Biochemistry	0.90	0.25
XVIII. Taxonomy	3.05	0.80
XIX. Toxicology	2.30	0.40
XX. Genetics		
Totals	10.40	5.65

Administration----1.50

Grand Total 31.15

Division of Labor in:

Extension---------21%
Research----------56%(41% in applied, 59% in fundamental)
Teaching----------18%(does not include graduate student advising)
Administration---- 5%

*Figures are in percent man years

APPENDIX D

NORTH CAROLINA STATE UNIVERSITY

SCHOOL OF AGRICULTURE AND LIFE SCIENCES

DEPARTMENT OF ENTOMOLOGY
BOX 5215 ZIP 27607

August 17, 1972

APPENDIX D

MEMORANDUM

To: Dr. R. J. McCracken
Assistant Director of Research

From: Kenneth L. Knight, Head KLK
Department of Entomology

Subject: Departmental Review of Task Force Reports

On August 2, 1972 the faculty of this department participated in a half-day review of the task force reports. During this process several areas were exposed where entomology should have been involved but was not. Details follow.

Task Force No. 1. Soil, Water and Forest Resources Inventory. RPA 104P - Alternative Uses of Land. Also, RPA 106 - Efficient Drainage and Irrigation Systems and Facilities.

Although these are probably intended to apply to agriculture only, we have work in medical entomology (Project No. 3363. R. C. Axtell. Insect Pest Management in Coastal and Estuarine Areas. Also, WRRI Project No. B-057-NC. Evaluation of Ditching and Impoundment for Mosquito Control in Coastal Marshes.) which applies directly to land use planning and to the study of systems for the handling of excess waters.

Task Force No. 2. Fish, Wildlife and Recreation. RPA 904. Control of Damage by Vertebrate Pests. The situation statement says that the Station is not now directly involved in any phase of this project. We do direct efforts to the study of the control of commensal rodents in both urban and rural situations (Project No. 3252. Control of Urban and Industrial Pests. C. G. Wright), although this is by no means an intensive effort. Its importance, however, is heightened by the recent discovery that we have rat populations in North Carolina that are resistant to anticoagulant rodenticides.

Also, RPA 902. Outdoor Recreation. Our medical entomology program has as one of its objectives the development of better controls for human annoying or biting arthropod pests in outdoor recreational areas. The project of Dr. Axtell's described previously directly applies here.

Task Force No. 4. Trees, Forests, Forest Production.

We feel there to be a serious need for more work on wood deterioration - there is more loss to forest resources here than from any other source. Although there is research at N.C.S.U. on deterioration caused by diseases, etc., there is none on such losses caused by insects. This is a serious deficiency.

Task Force No. 5. Field Crops. There is a strong feeling by the entomologists involved with crops that considerably less effort should be devoted to the production problems of alfalfa and that work on corn production problems should be markedly intensified. I am speaking across the board here, but with particular emphasis on pest insect control.

Task Force No. 6. Tobacco. Strong exception was expressed to the statement contained in line 4 of p. 49, i.e. that "... the task force feels compelled to recommend investigations designed to impart feelings of safety and comfort to consumers using our product." Perhaps the inappropriate philosophy expressed here is due simply to incautious wording. I would think they meant to say"... investigations designed to make tobacco safer for human use..." there is a similar intemperate statement "after C) Tobacco Leaf Analysis on p. 52." These statements could be badly misinterpreted by large segments of the general populace.

Task Force No. 8. Fruit Production and Marketing Systems Task Force. Both here and with Vegetables (No. 7), there needs to be extensive effort on the study of pesticide residues on the product, the factors involving their retention or reduction, and such other work as is essential to having residue tolerances established for each type of crop. This is a principal problem to us today in the control of weeds, diseases, nematodes and insects. No mention is made of this problem in either task force report.

Task Force No. 13. Poultry Production. We are concerned that no mention was made here of the problems of preventing insect infestations in the droppings in the ranges or when the droppings are disposed of outside the ranges. Many people, particularly those living in the environs of poultry houses, consider this problem to be very serious.

General. The control of insects infesting food and dwellings of impoverished or low income peoples is not covered anywhere. In view of "Hard Tomatoes, Hard Times," this is an area that merits some effort. I am not sure to which Task Force this problem would belong.

Left unanswered by the task force review program are such interdisciplinary personnel needs as ours for a population ecologist to serve as the principal resource man in the very large pest management research and extension programs in which we are engaged. President Nixon, himself, has taken cognizance of the need for pest control in this country to move to the adoption of integrated and/or managed systems. How can we do this adequately with the basic personnel resource need unfilled?

A similar requirement exists for the need to strengthen our capabilities to identify accurately the host of organisms that must be precisely recognized if pest management systems are to work. We have no support for work in this area.

I doubt that there is much which can be done about the points raised here.. However, to prevent their falling "through the cracks" completely unnoticed, I am taking the liberty of submitting these comments to you.

cc: J. C. Williamson, Jr.

APPENDIX E

NORTH CAROLINA STATE UNIVERSITY

SCHOOL OF AGRICULTURE AND LIFE SCIENCES

DEPARTMENT OF ENTOMOLOGY
BOX 5215 ZIP 27607

May 17, 1973

APPENDIX E

MEMORANDUM

To: J. C. Williamson
Director of Research

From: Kenneth L. Knight, Head KLK
Department of Entomology

Subject: Submission of Department of Entomology's 5-Year Research Projections

Enclosed is the material requested by NCAES 723-015 of March 23, 1973. It is felt important to point out that the SMY reductions for field crops and for apples does not mean a reduction of research effort for the control of the insect pests of these commodities. Rather, it is conceived by the time five years have elapsed, that our Pest Management Program will be handling the major portion of these control problems. The SMY's still designated for specific commodities will largely be used to insure that necessary insecticide screening efforts will continue. The SMY's picked up by the above reductions will be used to institute new efforts in the control of soil insect pests (particularly of corn), to support a new position for a population ecologist, and to support a considerable effort in host plant resistance studies.

Your attention is also called to the fact that Dr. T. J. Sheets is reporting separately on Enclosure 1 for the Pesticide Residue Laboratory. His report is also enclosed. As stated in his memo, he did not report on Enclosure II nor fill out the RPA evaluation sheets. This was at my request, since I covered the Laboratory in preparing the materials for the Department.

rr

Enclosure 1
NCAES 723-015

APPROPRIATED FUNDS FOR RESEARCH

IN THE BASE YEAR, FISCAL 1972-73

DEPARTMENT OF ENTOMOLOGY

(Dollars)

I.	Tenured Faculty Salaries *	320,640
II.	Non-tenured Faculty Salaries	37,496
III.	Graduate Research Assistant Salaries (Excludes those payrolled against vacant positions or reserves)	19,800
IV.	SPA Personnel Salaries	182,982
V.	Non-salary Support (Includes all Station funds in current departmental budget plus continuing Overhead Receipts handled through Administration)	104,416
VI.	Total Research Base	665,334

*IA. Tenured Faculty Positions, Showing Fraction of Yearly Salary Paid From Research Funds

	Faculty Position	SMY Charged to Research 1/
22006	K. L. Knight	.5
22014	C. H. Brett	.6
22018	D. A. Young	.8
22024	C. F. Smith	1.0
22030	W. J. Mistric	.9
22032	R. L. Rabb	.8
22034	H. M. Farrier	.6
22036	W. V. Campbell	.9
22039	R. T. Yamamoto	.9
22050	H. H. Neunzig	.9
22052	J. R. Bradley, Jr.	1.0
22054	E. Hodgson	.9
22060	W. C. Dauterman	.9
22061	W. M. Brooks	1.0
22062	G. C. Rock	1.0
22064	C. G. Wright	.5
22065	R. C. Axtell	.8
54007	F. E. Guthrie	.8
22122	T. J. Sheets	1.0
	Total SMY Charged to Research	15.8
		14.8

1/ Includes tenured faculty payrolled against soft funds.

With Pesticide Residue Laboratory Removed by Permission of J. C. Williamson.

Enclosure 1 - A
NCAES 723-615

APPROPRIATED FUNDS FOR RESEARCH

IN THE BASE YEAR, FISCAL 1972-73

DEPARTMENT OF Entomology

(Dollars)

I.	Tenured Faculty Salaries *	297,040
II.	Non-tenured Faculty Salaries	7,810
III.	Graduate Research Assistant Salaries (Excludes those payrolled against vacant positions or reserves)	19,800
IV.	SPA Personnel Salaries	144,414
V.	Non-salary Support (Includes all Station funds in current departmental budget plus continuing Overhead Receipts handled through Administration)	78,196
VI.	Total Research Base	547,260

*IA. Tenured Faculty Positions, Showing Fraction of Yearly Salary Paid From Research Funds

	Faculty Position	SMY Charged to Research
22006	K. L. Knight	.5
22014	C. H. Brett	.6
22018	D. A. Young	.8
22024	C. F. Smith	1.0
22030	W. J. Mistric	.9
22032	R. L. Rabb	.8
22034	M. H. Farrier	.6
22036	W. V. Campbell	.9
22039	R. T. Yamamoto	.9
22050	H. H. Neunzig	.9
22052	J. R. Bradley, Jr.	1.0
22054	E. Hodgson	.9
22060	W. C. Dauterman	.9
22061	W. M. Brooks	1.0
22062	G. C. Rock	1.0
22064	C. G. Wright	.5
22065	R. C. Axtell	.8
54007	F. E. Guthrie	.8
	Total SMY Charged to Research	14.8

[illegible]
HCRMS 7[illegible]-[illegible]

DOMESTIC [illegible] PROGRAM

DEPARTMENT OF Entomology

EXPENDITURES OF APPROPRIATED RESEARCH FUNDS

ADJUSTED 1972-73 BASE AND PROJECTED 1978-79

BY MAJOR RESOURCE CATEGORIES

(Dollars)

Resource Category	Adjusted 1972-73 Base	1978-79 Projections by Funding Level[1/]			Department Option[2/]
		100	90	120	
	(1)	(2)	(3)	(4)	(5)
I. Tenured Faculty Position Salaries	297,040	304,850	274,368	364,282	423,715
II. Non-Tenured Faculty Position Salaries	7,810	-	-	-	-
III. Graduate Research Assistant Salaries	19,800	19,800	19,800	25,273	41,690
IV. SPA Personnel Salaries	144,414	144,414	127,996	173,309	191,260
V. Non-Salary Support	78,196	78,196	70,370	93,848	109,499
VI. Total Budget	547,260	547,260	492,534	656,712	766,164

1/ Based on percentages of 1972-73 Funds

2/ Department Option is 140 percent of 1972-[illegible] Base

Enclosure 1.2
NCAES 723-015

DOMESTIC RESEARCH PROGRAM

DEPARTMENT OF Entomology

DESCRIPTION OF RESEARCH AREAS OF TENURED FACULTY POSITIONS

Research Area Identification Number[1]	Brief Narrative Description of Research Area	RPA and Sub-RPA
(1)	(2)	(3)
1.	Biology & control of soybean, peanut and forage insect pests	207
2.	Biology & control of corn insect pests	207
3.	Biology & control of cotton insect pests	207
4.	Biology & control of tobacco insect pests	207
5.	Biology and control of vegetable insect pests	204
6.	Biology and control of apple insect pests	204
7.	Biology and control of peach insect pests	204
8.	Biology and control of small fruit insect pests	204
9.	Biology and control of forest insect pests	201
10.	Biology & control of structural and stored products insect pests	706
11.	Biology & Control of man and animal insect pests	210,706
12.	Pest management	207
13.	Insect behavioral studies	318
14.	Insect nutritional studies	318
15.	Insect pathological studies	318
16.	Insect taxonomic studies	318
17.	Insect toxicological and biochemical studies	214
18.	Administration	
19.	Population ecology	318
20.	Control of soil insect pests	207
21.	Host plant resistance studies	304, 307
22.	Control of ornamental insect pests	204
23.	Insect pollination studies	314
24.	Insect physiological studies	318
25.	Graduate student support	
26.	Biology and control of grass insect pests	207

[1] Use consecutive numbers beginning with 1

Enclosure 1.3
NCAES 723-015

DOMESTIC RESEARCH PROGRAM

DEPARTMENT OF Entomology

1972-73 BASE AND 1978-79 PROJECTED RESEARCH PROGRAM BY RESEARCH AREA

IN SMY OF TENURED FACULTY POSITIONS

Research Area Identification Number[1/]	Adjusted 1972-73 Base	1978-79 Projections by Funding Levels[1/]			
		100	90	120	Department Option
	(1)	(2)	(3)	(4)	(5)
1.	0.8	0.5	0.4	0.5	0.5
2.	0.1	0.3	0.3	0.3	0.3
3.	0.5	0.3	0.3	0.3	0.3
4.	0.6	0.3	0.3	0.3	0.3
5.	0.6	0.8	0.8	0.8	0.8
6.	0.6	0.4	0.3	0.4	0.4
7.	0.4	0.2	0.0	0.2	0.2
8.	0.4	0.4	0.4	0.4	0.4
9.	0.3	0.3	0.3	0.8	0.8
10.	0.5	0.3	0.3	0.3	0.3
11.	0.8	0.8	0.8	1.2	1.6
12.	1.9	1.9	1.9	2.4	3.0
13.	0.9	0.8	0.4	0.8	0.8
14.	0.4	0.2	0.0	0.2	0.2
15.	0.7	0.7	0.5	0.7	0.7
16.	2.2	2.3	2.0	3.0	3.0
17.	2.6	2.6	2.6	2.6	2.6
18.	0.5	0.5	0.5	0.5	0.5
19.		0.4	0.4	0.7	0.7
20.		0.4	0.4	0.7	0.7
21.		0.4	0.4	0.7	0.7
22.					0.7
23.					0.7
24.					0.5
25.					
26.					
Total SMY	14.8	14.8	13.3	17.8	20.7

1/ Use identification numbers from Enclosure 1.2

Enclosure 1.4
NCAES 723-015

DOMESTIC RESEARCH PROGRAM

DEPARTMENT OF Entomology

ESTIMATED GRANT AND CONTRACT FUND EXPENDITURES 1972-73 AND 1978-79

BY MAJOR RESOURCE CATEGORIES

(Dollars)

Resource Category	1972-73	1978-79
II. Non-Tenured Faculty Position Salaries	$146,165	Estimated to remain approximately the same.
III. Graduate Research Assistant Salaries	75,660	
IV. SPA Personnel Salaries	61,481	
V. Non-Salary Support	345,190	
VI. Total Budget	628,496	

DOMESTIC RESEARCH PROGRAM

DEPARTMENT OF Entomology

ESTIMATED GRANT AND CONTRACT FUND EXPENDITURES

1972-73 AND 1978-79 BY RESEARCH AREA

(Dollars)

Research Area Identification Number[1/]	1972-73	1978-79
1	58.882	Grant and Contract Funds available in 1978-79 are expected to be about the same. However, they could well have a rather considerably different distribution than that existing in 1972-73. This different distribution cannot be predicted since changes in personnel and in the national scene between now and then will so markedly affect these factors.
2	-	
3	19,100	
4	19,066	
6	6,150	
10	2,935	
11	82,001	
12	82,307	
13	14,600	
14	19,357	
16	30,502	
17	283,417	
26	10,179	
Total	$628,496	

1/ Use Identification Numbers from Completed Enclosure 1.2

PART A

DOMESTIC RESEARCH PROGRAM

DEPARTMENT OF Entomology

PROJECTED CHANGE IN SUPPORTING SERVICE REQUIREMENTS BY 1978-79

Supporting Service	Percentage Change From 1972-73 Level in Supporting Service Requirements at Alternative Departmental Resource Levels[1/]			
	100	90	120	Department Option
Research Stations	0%	-4%	+19%	+53%
University Farms	0	-4	+19	+53
Phytotron	0	0	+10	+30
Electron Microscope	0	0	+15	+35
Pesticide Residue Laboratory	0	0	+17	+25

[1/] Relative to 1972-73 Base

PART B

SUPPORTING SERVICES NOT NOW AVAILABLE WHICH ARE NOW NEEDED

OR WILL BE NEEDED FOR THE 1978-79 PROGRAM

An expanded electron microscope facility with scanning scope equipment is badly needed.

Enclosure 1.7
NCAES 723-015

DOMESTIC RESEARCH PROGRAM

DEPARTMENT OF Entomology

PROJECTED CHANGES IN FACULTY COMPETENCIES

Column 1 Tenured Faculty (Position Number)	Column 2 Proposed Competency Change and How to be Accomplished	Column 3 Probable RPA Change
22006	None	None
22014	Attrition by retirement. Recruitment of population ecologist anticipated.	None
22018	None	None
22024	Anticipate shift by 0.5 SMY to vegetable insect research.	None
22030	Anticipate shift by 0.3 SMY to Pest Management. Already beginning.	Pest Management
22032	None	None
22034	None	None
22036	Anticipate shift by 0.5 SMY to Host Plant Resistance work.	Host Plant Resistance
22039	None	None
22050	None	None
22052	Anticipate shift by 0.2 SMY to Pest Management. Already beginning.	Pest Management
22054	None	None
22060	None	None
22061	None	None
22062	Anticipate shift by 0.2 SMY from insect nutritional studies to apple insect control.	None
22064	None	None
22065	None	None
54007	None	None

REACTIONS TO TASK FORCE AND PANEL REPORTS

NCAES 723-015 requests SALS department heads to submit a narrative summary in behalf of their departments of reactions to those Task Force and Extramural Panel Reports dealing with subject matter of interest to their respective departments. This report is from the Department of Entomology. Under each task force, the Task Force Reports (TFR) are given first, followed by the Extramural Panel Reports (EPR), and finally the departmental reactions.

Task Force No. 1. Soil, Water and Forest Resources Inventory.

TFR. Although this Task Force is probably intended to be concerned only with agriculture, we have work in medical entomology (Project No. 3363. R. C. Axtell. Insect Pest Management in Coastal and Estuarine Areas. Also, WRRI Project No. B-057-NC. K. L. Knight. Evaluation of Ditching and Impoundment for Mosquito Control in Coastal Marshes.) which applies directly to land use planning and to the study of systems for the handling of excess waters and could well have been included in the considerations of this Task Force.

EPR. Entomological problems are not specifically referred to in this report. However, at the bottom of page 3 it is stated that ".... the state has extensive areas of salt marshes that provide habitat for part of the life cycle of a number of marine organisms. Improving our knowledge of the salt marsh is considered a definite need in projected plans for service to the state. Use is being made of other funds whenever possible, but the Agricultural Experiment Station should be prepared to backstop any decrease in these funds." It is felt by the medical entomological personnel of the department, that the ecologically sound management of the man-annoying and disease-carrying insects of the coastal areas should be the subject of ongoing research supported by state funds. The present need to rely very largely on federal funds for this work is not conducive to the establishment of a soundly based research program.

Reaction. Covered above.

Task Force No. 2. Recreation, Fisheries, Wildlife and Multiple Use.

TFR. RPA 904. Control of Damage by Vertebrate Pests. This report states that the Station is not now directly involved in any phase of this RPA. However, in the Department of Entomology we do direct efforts to the study of the control of commensal rodents in both urban and rural situations (Project No. 3252. Control of Urban and Industrial Pests. C. G. Wright), although this is by no means an intensive effort due to the shortage of operating funds. Its importance to the people of North Carolina, particularly to the farmers and to the urban poor, is greatly heightened by the recent discovery that we have rat populations in North Carolina that are resistant to the anticoagulant rodenticides. This means that we may in the relatively near future be faced with rodent populations for which no adequate chemical control exists.

Also, RPA 902. Outdoor Recreation. Our medical entomology program has as one of its objectives the development of better controls for human annoying

or biting arthropod pests in outdoor recreational areas. The project of Dr. Axtell's described previously directly applies here, although extreme limitation of funds presently precludes doing any work except in coastal areas.

EPR. This report does not refer directly to the relationship between outdoor recreation and pest insect populations, even though this was called to their attention during review. In the Department, we consider this to be a serious oversight. They do refer to the possibly serious consequence to the marine fisheries resources of North Carolina of agricultural pollution (would certainly need to include pesticides), of dredging and filling of marshlands (would include the work done there in the guise of mosquito control), and of channelization and drainage projects (mosquito control work also involved here). However, no recommendations are made that entomological research work should be funded by the Station for support of work at an adequate level designed to alleviate some of the problems detailed above.

Another oversight in this report relates to their writeup on RPA 904, Control of Damage by Vertebrate Pests on North Carolina Farms. The report states (page 13) that "The Station is not now directly involved in any phase of this project. The control of vertebrate pests, inherently less important economically than control of insect pests, tends to be neglected by most Agricultural Experiment Stations. High priority." They are both right and wrong here. They are wrong in saying that the Station is not now directly involved in research relating to the management of vertebrate pests of agriculture. I have pointed out above that we do have a project dealing with the control of urban and industrial pests which does concern itself with the control of commensal rodents. However, they are right in saying that research on the control of vertebrate pests of agriculture does not receive the attention it needs. This work properly belongs in the area of economic zoology, but has traditionally been done by entomologists. Wherever it is done, it should receive considerably more emphasis than presentfunding permits.

Reaction. Covered above.

Task Force No. 3. Environmental Protection and Minimization of Pollution.

TFR. This report dealt with the environmental problems of (1) animal waste management, (2) plant nutrients as pollutants, (3) pulp and paper production, (4) wood production and processing, (5) food processing, (6) pollutants from non-agricultural sources, (7) pesticide use, and (8) land use. No where did they speak directly of insect problems. The panel comments and recommendations on pesticides were obtuse and provided little or no guidance. In this connection, they stated that the current effort seemed to represent an adequate attack on pesticide pollution problems, although they did not mean to imply that certain reallocations of personnel and funds might not be in order.

EPR. Considerable attention to pesticides as agriculturally-caused pollutants is given in Extramural Panel Report No. 3. The term pesticide is interpreted broadly by them, being defined to cover herbicides, fungicides, insecticides, nematocides, rodenticides, growth regulators, defoliants, desiccants and some others. However, since the Pesticide Residue Laboratory

and the Toxicology Program are both within the Department of Entomology, the remarks of the Panel on pesticides can be taken to apply quite largely to this department. The Panel recommended that a comprehensive project be initiated on the effects of pesticides on nontarget organisms and recommended a 1.5 SMY increase to accomplish this. In addition to this, an increase of approximately 1.0 SMY from existing projects should be reallocated to this new effort (which would of a necessity be a team project involving several departments). As a part of this effort but without extra manpower, they considered it essential that some personnel concerned with testing and recommending pesticides be involved in evaluating off-target effects and interactions of pesticides with other crop production practices. Additionally considered was the behavior and fate of pesticides in air, water, and soil and an additional 0.5 SMY was recommended to be added to ongoing work in this area, with the new effort to be primarily concerned with the fate of pesticides in soil. In view of the already-existing commitment of the Pesticide Residue Laboratory to this type of work, it would seem to be essential that this increase in manpower be placed in the Laboratory.

Although the attention of the Panel was directed to the mosquito and fly breeding problems of truly significant size which are being created by the mountains of animal waste being produced in agriculture, even when these wastes are processed in an otherwise satisfactory manner, they did not speak to this point in their report. We in Entomology believe this to be a serious shortcoming in their report.

Reaction. Given above.

Task Force No. 4. Trees, Forests, Forest Production and Marketing Systems.

TFR. Although not brought out in this report, we feel there is a serious need for more work on wood deterioration - the present loss to forest resources in this area is greater than from any other source. Although there is research at NCSU on deterioration caused by diseases, etc., there is none on such losses caused by insects. This is a serious deficiency.

EPR. The Panel questioned that so much attention should be given to the matter of Christmas tree production in North Carolina as is being done at NCSU. I disagree with this. The value of this research to our state does not lie so much in a volume potential as it does in creating a new thriving industry, even though small, which will provide additional livelihood funds for currently underpriviledged mountain people.

The Panel stated that the recommendation of the Task Force of a 2 SMY increase in forest entomological research is not unrealistic in terms of the damage done to North Carolina forests by insects. However, they stated further that the justification statement on RPA 201 of the Task Force did not address the question of what research resources are involved from other institutions and agencies in the area. They then went on to say: "When the present effort overall in North Carolina is assessed and cooperative opportunities determined it is likely that the addition of one forest entomologist could be more readily justified, mainly to achieve better balance in the overall forestry research program, and

to effect a better bridge to the strong U. S. Forest Service team effort in the Triangle laboratory."

Reaction. The Department is in agreement with the Panel's statement that forest entomological research is at an extremely low level of commitment. In line with this opinion, the Department joined with the School of Forest Resources to add a request for a full-time forest entomologist to the 1973 Change Budget. If granted, this request would provide for a joint appointee between the two schools involved. We also agree that a greater degree of cooperation should be developed between the federal forest entomology group at the Research Triangle, the forest entomologist at Duke and our own specialist in this area. A previous difficulty has been the lack of sufficient personnel to develop a real "critical mass" of interacting personnel. The addition of a forest entomologist to our staff would do much to make such an effort meaningful. Dr. M. H. Farrier of our staff teaches the forest entomology on the campus and is an excellent forest entomologist. However, he has become a well-known authority on the taxonomy of plant-attacking mites and demands on his time for this type of work have become heavy and important, and it is essential that he be permitted to continue to work principally in that area.

We do not agree with the Panel in their statement that "Large scale research effort on Christmas tree production problems does not appear to merit a high priority rating." The establishment of new land-use industries in our mountains is important in refuting the "Hard Tomatoes..." type charges made against experiment station research in this country. We also do not agree with the failure of the Panel to call attention to the need for entomological research on wood deteriation by insects. In fairness to them, the Task Force did call this problem to their attention.

Task Force No. 5. Field Crops.

TFR. Our reaction to the Task Force Report was that considerable less effort should be devoted to the insect control problems of alfalfa and that work on corn insect problems should be markedly intensified.

EPR. The Panel commented as follows concerning entomological research on field crops: "RPA 207. The projected increase is limited to 1.0 SMY in soybeans and 0.6 SMY for host resistance to the alfalfa weevil.... We heard a good bit of discussion related to insect problems and perhaps the most forward looking discussions were related to this RPA. Yet not much additional effort is projected. The bulk of the effort on insect problems on field crops seems to be done by one man. This effort is very good, but we wonder if there isn't great opportunity for additional effort from entomologists in view of emerging pressures for changes in pest control schemes." Under "Forages", they commented that they found it difficult to support the recommendation of the Task Force for a stronger effort in alfalfa weevil control. They believe that with the genetic tolerance available and the limited insecticide usage now possible, the operation of biological control agents should (when applied under pest management techniques) provide adequate alfalfa weevil control. Essentially, we agree with this. However, some continuing effort will have to be maintained by an entomologist on this problem in order to perfect the timing of treatments and the monitoring of pest populations so that a workable pest management system for this insect pest can be established and maintained. The additional effort recommended for soybeans

is essentially being applied already through the efforts of Dr. John Van Duyn at Plymouth and by the initiation of the IBP grant program on soybean pest insect management. Entomology is not specifically mentioned elsewhere in the report except that host plant resistance to insects was detailed in describing how an interstate research program might be set up for peanut research. With Dr. Campbell on our staff and a specialist in host plant resistance work, we would be ideally equipped to be the state to do this portion of that program.

Reaction. See above.

Task Force No. 6. Tobacco Production and Marketing Research.

TFR. The Task Force commented on tobacco pest insect control needs as follows (p.4): "Investigations on insect control must be continued, with emphasis on the tobacco moth in cured tobacco. Current research support should be increased by 25%. An additional scientist is needed to conduct field research on insect infestations as they occur in burley and flue-cured tobacco." Under RPA 709 (Reduction of Hazards to Health and Safety), they commented on pesticide residue needs as follows (p. 49): "Two SMY's are required in expanded Pesticide Residue Laboratory...."

EPR. The Panel supported the above Task Force recommendation as follows (p.4): "In the opinion of the review panel the recommended increase in research support of 25 percent and the addition of a scientist is reasonable. They should be considered in the light of the overall priorities already mentioned." They supported the expanded manpower recommendations of the Task Force for the Pesticide Residue Laboratory by indirection only (p. 10): "Another compelling reason why North Carolina should increase its activity in the broad area of tobacco quality research...." and in the Summary (first paragraph) where they accepted the overall SMY recommendation of the Task Force.

Reaction. We are gratified by the expressions of support for our tobacco research expressed by both the Task Force and by the Extramural Panel and would be pleased to have both the additional manpower and the operational funds recommended there. Additional manpower is requested in the Enclosure 1 materials being submitted separately by Dr. T. J. Sheets in his report for the Pesticide Residue Laboratory. However, in the Enclosure 1 materials for the insect control research program of the Department of Entomology, we have not given priority to the needs expressed under RPA 207, provided we can maintain present levels of Station, grant and contract support. This is true because, with current support, we can do the necessary work through our present pest management research and extension operations, keeping only such direct support on tobacco proper as necessary to continue screening insecticides for use in the pest management programs. However, to operate in this manner, we do very much need to get the fulltime services of the population ecologist which we have so long requested. Also, since one area of tobacco insect control not now included in our tobacco pest management program is that of the soil insects which attack tobacco, we will require eventual supply or the soil insect SMY requested (0.4) in Enclosure 1.3 if a complete tobacco insect pest management research program is to be accomplished.

Task Force No. 7. Vegetable Production and Marketing Systems.

TFR. The Task Force felt that two major voids presently exist in the Station

vegetable research program and gave these top priority in their recommendations. The first of these dealt with entomology and is a need for a vegetable crops oriented entomologist. The primary function of this position would be to cooperate in the development of insect resistant vegetable varieties. The fifth priority of the Task Force was assigned to a need for research on bees and other pollinating insects. A 0.5 SMY was requested here which could complement a similar request by Task Force No. 8.

EPR. The Panel did not comment specifically on the Task Force recommendation for a vegetable crops entomologist but supported it indirectly by commenting in several places on the need for host plant insect resistance studies in the vegetable crops breeding programs. The need for an entomologist to do research on pollination by insects was supported directly by their recommendation 16 (p. 9), which reads in part: "We recommend the employment of a scientist to work in the area of pollination of fruit and vegetable crops...." In recommendation 10 (p. 8), they also spoke to the need for work designed to insure the clearance of pesticides for use on minor crops. This is support for the additional manpower being sought by the Pesticide Residue Laboratory in the separate report for that agency.

Reaction. We are in full accord with the recommendations of both the Task Force and the Panel. In our 5-year projections report, we have planned on orienting position 22024 to 0.8 SMY in vegetable crops research through retirement (Enclosure 1.7) at all projection levels (Enclosure 1.3). Also, we have planned for a 0.7 SMY (Enclosure 1.3) in insect pollination research for the 140% projection level.

Task Force No. 8. Fruit Production and Marketing Systems.

TFR. Under RPA 204 (Control of insects, mites, snails, and slugs on fruit and vegetable crops), the following recommendations were made by the Task Force: (1) Peaches. Requested addition of 1 technician, plus operational support of $2,500, in order to have full time help to study the life histories of the various peach pests and to coordinate control efforts with the biology of the pest and climatic conditions. (2) Apples. Requested that the operating budget be increased to $5,000 to cover costs of conducting research in this area. (3) Blueberries. Requested that the operating budget be increased by 25%. (4) Grapes and strawberries. Requested that 1 SMY, 0.5 technician time and $1,500 in operating funds be made available for work with these small fruits.

EPR. Except for their recommendation that a scientist be employed to work in the area of pollination of fruit and vegetable crops, the Panel did not directly comment on the manpower and funding requirements developed by the Task Force. Indirectly, they perhaps lent their support to these requests by stating in Recommendation 12 (p. 9) that "We recommend an increase in research on reducing the amounts of chemical pesticides used in North Carolina vegetable and fruit production."

Reaction. Although, we agree fully to the needs expressed by the Task Force, facing reality and potential funding levels, we have actually indicated a slight decrease in SMY levels for fruits. This does not indicate any plan to decrease our efforts in this important area, but rather that we expect within the next 5 years to be able to handle 80% of our research needs in fruit insect control within our Pest Management Research Program (which is oriented to our total commodity needs rather than to any one specific commodity). Regarding the increase in operating funds requested by the Task Force, a serious need does exist for a 25% increase. This cannot be met by reallocation of current resources.

Task Force No. 9. Ornamentals and Turf Production and Marketing Systems.

TFR. The Task Force recommended that insect pest insect control research in this area be increased by 0.25 SMY for turf and lawn grasses, 0.4 SMY for floriculture, and 0.4 SMY for ornamental horticulture.

EPR. The Panel accepted the entomological recommendations of the Task Force without question, except to raise that for turf and lawn grasses from 0.25 SMY to 0.4 and to recommend that the present 0.15 SMY devoted to insect control research on Christmas trees be raised to 0.25 SMY. Additionally, in nearly every case they spoke to the need for providing the entomologist with adequate non-professional assistance and with adequate greenhouse and laboratory accommodations.

Reaction. We agree fully with these recommendations. However, due to the many needs facing us in entomology, we were not able to implement the ornamentals recommendation until the 140% projection and the turf grass one not at all. In view of the strength of the Panel recommendations in this area, it may be necessary for us in the department to reconsider some of our projections here.

Task Force No. 10. Beef Cattle Grazing, Production and Marketing Systems.

TFR. The Task Force (p. 1 of Summary) recommended an increase of 1 SMY for a veterinary entomologist to work across the livestock and poultry industry with .3 ($13,500) of this devoted to beef cattle problems. Specifically, it was recommended that research be done on face fly, horn fly and filth fly control through environmental manipulation and chemical and biological control. They stated further that this was not one of the most critical problems but would become more so as the livestock intensity increases. In regards to pasture forage, they stated (p. 5 of Summary): "New cultural practices and the release of new pesticides permit reasonable control of alfalfa pests. Should now concentrate more effort on identification and control of pests on clovers. No change in SMY is requested, but shift 50% of present effort on alfalfa to clover. Requires an additional $3,000 per year for supplies, labor and travel."

EPR. The Panel was not very sympathetic with the recommendations of the Task Force regarding entomology. They wrote as follows on the recommendation for a veterinary entomologist (p. 1): "There does not seem to be any overriding reason or justification under present production systems for an extensive research program to control external parasites in cattle. We concur with the recommendation of the Task Force in this research area. The request for the addition of a Veterinary Entomologist to work on external parasites should receive low priority." In connection with the recommendation of the Task Force relative to pasture forages, the Panel stated only that the entomologist should cooperate with the pathologist and weed specialist to assess the amount of support needed for a program designed to improve pasture in North Carolina. More specifically, they stated that the cooperation of the entomologist and the pathologist should be increased since it appears that diseases and insects are responsible for the lack of persistence of white clover and alfalfa. They speak of additional operating funds being necessary for this work but are otherwise severely noncommittal. All-in-all, the report does not address very well the points made in the Task Force Report.

Reaction. As just stated, this is a disappointing report. Nonetheless, the Department of Entomology has conceived a veterinary entomologist to be essential to its program and a request for one went forward from us last year

for inclusion in the 1973 Change Budget. However, it was not accepted. In our 5-year projections (Enclosure 1.3), we show the veterinary entomologist coming in at the 120% level. The additional emphasis upon the control of the insect pests of white clover recommended by the Task Force is now being implemented through redirecting certain parts of Dr. Campbell's efforts from alfalfa to clover. A small increase in operating funds for this work would be most useful since the work requires considerable travel.

Task Force No. 11. Dairy Cattle Production and Marketing Systems.

TFR. No mention made of entomological problems.

TFR. No mention made of entomological problems.

Task Force No. 12. Swine Production and Marketing Systems.

TFR. The only mention of entomology in the Task Force Report is in Enclosure II under RPA 210 where it is stated that much of the information needed for control [of external parasites] is already known and should be applied in work under RPA's 311 (genetics), 312 (nutrition), and 317 ( ).

EPR. The Panel stated on p. 3 that one of the Animal Science Department members had proposed definitive studies on swine lice, but that they felt his limited available time for research would be more effectively utilized in parasitological studies.

Reaction. Pressing entomological problems with swine have not been brought to our attention and there are no plans at the present time to instigate any research in this area.

Task Force No. 13. Poultry Meat Production and Marketing Systems.

TFR. Under RPA 210, the Task Force states that "Presently there is no research in this area dealing with poultry. It is not a high-priority problem in poultry and therefore, we recommend no change."

EPR. The Panel concurred with the Task Force recommendations of no increase in funds or SMYs. However, they pointed out that chiggers and other external parasites may become serious problems, especially to turkeys (p.4).

Reaction. Essential agreement with the above reports.

Task Force No. 14. Egg Production and Marketing.

TFR. Under RPA 210, the Task Force stated that there is "Immediate need for effective control methods for flies and ectoparasites, especially mites. Cooperative research with engineers, entomologists and veterinarians." It is further urged that research money be made available for immediate initiation of research on these problems. (p. 6).

EPR. The Extramural Panel for this research area was the same one that reviewed Task Force No. 13 and their reaction to the material under RPA 210 is quoted under No. 13 above.

Reaction. We know from first hand experience that there is a need for more entomological work in the poultry area. It would be quite applied in nature and would consist of doing additional work with the development of a total insect pest management system for both broiler and egg production. It could be accomplished by an extension entomologist just as readily as by a research man. Some additional operational funds would be required.

Task Force No. 15. Food Consumption, Service and Nutrition.

Entomology not specifically involved.

Task Force No. 16. Food Processing and Food Safety.

TFR. Under RPA 701 (Insure Food Products Free of Toxic Contaminants Including Residues from Agricultural and Other Sources), the Task Force points up the problem of toxic materials being present in food, either natural or added, as essential steps in man's competition against predators. Their report (p. 9 of Enclosure II) goes on to say that such chemicals must be completely understood and that increased research effort to obtain this understanding must be accomplished. An increase of 1.0 SMY is recommended for evaluation of residues in minor food crops and for the development of methodology for detection of pesticides, and an additional increase of 0.5 SMY is recommended to provide information on the fate of pesticide residues during processing treatments appropriate to various natural foods. It is pointed out that much of the present effort along these lines is conducted in the Department of Entomology through its pesticide and toxicological laboratories and, while this has been partially funded by federal funds, the Station should be prepared to take up the total funding if federal grants cease.

EPR. Under RPA 701 (p.7), the Panel states: "The panel interprets the request and the priority given RPA 701, work relative to pesticide research and toxicity, as being primarily an endorsement of the current activity in entomology and a recognition of the importance of this type of activity under our present situation. In addition to agreeing with the current importance of this activity, the panel recommends that this type of activity be maintained as an Experiment Station or Campus-wide effort rather than develop a new program in the Department of Food Science. In view of the limited discussion relative to this area of endeavor, it is difficult for the panel to concur with the high priority given this item by the Task Force when this need is compared to other needs of the Food Science Department.... Clearly, Food Science must maintain a level of awareness in this area."

Reaction. We agree with the Panel.

Task Force No. 17. Family living.

TFR. Under RPA 706 (p. 3 of Enclosure II), ongoing work on insects affecting family living is mentioned but no recommendations for any changes are made.

EPR. No comments made.

Reaction. It is believed that such work as is needed is being accomplished (Research Area No. 10, Enclosure 1.3 of Station Research 5-Year Projection Report).

Task Force No. 18. Rural Community Development.

Entomology not specifically involved.

Task Force No. 19. Economic Analysis.

Entomology not specifically involved.

Task Force No. 20. Biological Sciences, Technology and Biometry.

TFR. The Task Force recommended the increase by 2.0 SMY of work under RPA 214P, Protection of Plant, Animals, and Man from Harmful Effects of Pollution. All of the projects of the Toxicological Research Program of the

Department of Entomology fall under this RPA. The Task Force reported as follows: "The committee feels that in the present climate of increasing pollution and increasing concern about pollution, additional attention must be paid to basic aspects of biochemical and environmental toxicology. This is of importance to agriculture from two points of view, an understanding of the effects of pollution on man and domestic animals and the design of selective agricultural chemicals. The degradation of pollutants by living organisms, particularly microorganisms is of particular importance to the ecology of pollution. The two positions recommended are for an environmental toxicologist and a biochemical toxicologist, the first to be concerned with the effect and movement of toxicants in natural ecosystems and the latter to be concerned with mode of toxic action and design and synthesis of selective pesticides." The Task Force also recommended the addition of a systems analyst in population ecology, which could well be the position which the Department of Entomology has so long and so earnestly sought.

EPR. The Panel did not speak specifically to the Task Force recommendation for an environmental toxicologist, a position which could be expected to fall to the Department of Entomology if approved. They did speak favorably of the systems analyst in population ecology and indicated that he would be a joint appointment in statistics and a biology department (e.g., entomology).

Reaction. Although we had previously sought an environmental toxicological position, it is now our feeling that we can accomplish this by reorientation within our present toxicological group. However, we do very definitely want and need the population ecologist (Research Area 19, Enclosure 1.2 of the 5-year research development report).

APPENDIX F

APPENDIX F

1/25/73

Report of Departmental ad hoc Committee on
Taxonomy and Entomological Collections

In late 1972, Dr. K. L. Knight, Head of the Entomology Department, appointed a committee to study the position of Insect Taxonomy in North Carolina State University. The detailed results of the study follow. Some highlights of the report are:

1. Insect Taxonomy, in its brief span, has made important contributions to the culture of North Carolina and of the World, embodied in research publications of enduring worth from both local and universal standpoints (cf. Appendix B).

2. Competently trained professional personnel have gone out from North Carolina State to proliferate their accomplishments in other learned institutions (Appendix C).

3. The results of 1 and 2 above have been universal recognition of North Carolina State University as a center of excellence in Insect Taxonomy.

4. The North Carolina State collection of insects is a material cultural effect of the professional workers in Insect Taxonomy at this institution. Its holdings, in principle, are a part of world culture. It is of great local function and importance as a part of that culture. It is especially strong in certain areas of concentration.

5. The support given to taxonomy at this institution as a fitting contribution of a University has been, and continues to be justified.

6. The University should continue to seek support from outside sources (e.g. The Federal Government) for taxonomy and for the collection but should not permit itself to become dependent on unpredictable support for a function of such intrinsic value.

7. Undirected growth in Insect Taxonomy, and of the insect collection, because of the breadth of the field, and the corresponding cost of such growth, is impractical and inadvisable. Resources should be directed towards sustaining areas already strong, and in more general growth in all areas to the end of strengthening the collection's holdings from the southeastern region. Such directed growth should be a part of long-range activities related to personnel hiring and collecting.

Respectfully submitted, January 25, 1973

J. R. Baker — David Stephan
Maurice H. Farrier — T. B. Mitchell
Clyde F. Smith — H. H. Neunzig
David A. Young, Chairman

I. Name of Collection. The committee voted to retain the name "North Carolina State University Collection" because:

a. The name has become established in the literature, and to change it would cause confusion. The example of the name-change in the Smithsonian Institution from "United States National Museum" (abbreviated "USNM" in hundreds of entomological papers) to "National Museum of Natural History" was offered as the sort of thing we need to avoid.

b. The present name locates the collection for systematists without the task of cross-reference.

c. Collections named for individuals often are sources of confusion. The collection of Dr. Gordon Ferris, whom almost everyone associates with Stanford University, is now in the National Museum in Washington.

d. Collections named for individuals often fail to give proper credit to major contributors. The Francis Huntington Snow collections at the University of Kansas owe a large part of their excellence to the activities of Dr. R. H. Beamer.

e. The name is sufficiently broad to cover the possible amalgamation with taxonomic efforts of other departments should such event arise.

II. Nature and location of collections.

A. The N. C. State University collection of insects and related arthropods includes the following (For a complete account see "Appendix A", below).

1. A general collection, fairly representative of our section of the U.S.A. This is located in 4321 Gardner Hall.

2. The collection of Homoptera Auchenorrhyncha, from all zoogeographic regions of the world. Most of these were acquired by the late Dr. Z. P. Metcalf, but there have been important subsequent additions (see section III). Dr. D. A. Young estimates that there are only five collections in the world more complete than this one. This group of insects is housed with the general collection in Gardner 4321, except a small portion temporarily in room 4322.

3. The collection of bees, from all parts of the world. Most of the specimens were acquired by Dr. T. B. Mitchell, over the better part of a lifetime. This group is housed in the Annex on Hillsborough Street.

4. The collection of aphids of the world. This group has been acquired through the efforts of Dr. C. F. Smith. It is also housed in the Annex on Hillsborough Street.

5. The collection of Orthoptera of the U. S. A. This collection was acquired by Dr. B. B. Fulton as the result of the work of a lifetime. It is kept with the general collection in Gardner 4321.

6. The Aphidiinae (Braconidae) of North America. This is a reference collection, but a very complete one. It resulted from the research efforts of Dr. C. F. Smith. It is located in the Annex, on Hillsborough Street.

7. The immature insects. This collection, mainly from eastern North America, compares well with others of its kind. It has been added to in recent years mostly through the efforts of Dr. H. H. Neunzig and Dr. R. L. Rabb. It is located in Gardner 4321 with the general collection.

8. A small collection of Lepidoptera, especially important to research because it contains immatures and associated adults, is located in the office of Dr. H. H. Neunzig, Room 3301 Gardner Hall.

9. The collection of Acarina (arthropods related to insects, including the mites) is located in 4318 Gardner in the care of Dr. M. H. Farrier, and in the care of Dr. L. J. Metz in the Forestry Sciences Laboratory at the Research Triangle.

III. History of the N. C. State University Insect Collection

When the Department of Entomology moved into Gardner Hall in 1952, space was provided for a general collection of insects and other arthropods. Prior to this move, more limited collections had been accumulating, the first, that of Z. P. Metcalf, who came to Raleigh in 1908 and served for four years as Assistant Entomologist in the North Carolina Department of Agriculture before becoming Head and sole member of the Department of Zoology and Entomology at the North Carolina College of Agriculture and Mechanic Arts (N.C.A.& M.).

He served in this capacity, in the constantly growing Department, until 1950, when he was succeeded by C. F. Smith. At this time the Department was divided into the separate departments of Zoology, Entomology and Genetics. During all of this period (1912 - 1950) he accumulated a large collection, chiefly of the Homoptera, both by personal collecting and by purchase from collectors in many parts of the world.

T. B. Mitchell served as Nursery Inspector in the N. C. Department of Agriculture for five years before becoming a member of the Department. During his service in the Department of Agriculture he had become interested in the systematics of bees, and maintained that interest after his move. Three successive projects resulted in the accumulation of an extensive collection

of bees. First, a Revision of the Genus Megachile (the leaf-cutters) of North America; second, the preparation of a 2-volume manual of all the groups of bees of the Eastern United States; and third, since retirement, revisional studies of the leaf-cutters (Megachile) and their close allies (chiefly Coelioxys) , of the Western Hemisphere. Not only has the collection been greatly augmented, but many types, of the numerous new species that were discovered, have been added to the collection. Also material collected during personal field studies in many parts of North and South America is especially valuable, because of the inclusion of more adequate field data.

B. B. Fulton contributed substantially to the collection during the early years, coming to the Department from Iowa State College in 1928. He served until his retirement in 1954. Although much of his work was economic in outlook, he had broad interests in biology, ecology and systematics, and was especially interested in the Orthoptera. His collection, chiefly of this Order, resulted from field studies in such diverse areas as Ohio, New York, Oregon, Iowa, and throughout North Carolina and the Southeast in general.

C. F. Smith came to the Department in 1939, from Ohio. He has collected aphids and studied their biology and taxonomy for 35 years, preparing 45 papers, as author or co-author, on their biology, taxonomy and control. This has resulted in the accumulation of a large slide collection. Also, he taught the first course in immature insects at this University, and started the collection of immatures. He was followed by James R. Dogger and Paul Ritcher, who shared the teaching of the course and added materials to the collection. Recently additions to the collection have been made by R. L. Rabb and H. H. Neunzig, with an emphasis on the Lepidoptera.

M. H. Farrier became a member of the Entomology Faculty in 1955, after having completed his doctoral research program on the taxonomy of the Acarina. He instituted the first course in Acarology taught in the Department, but one of his first assignments was taking over the conduct of the Insect Survey started by T. B. Mitchell. They worked together on one survey, and both contributed considerable material, using light traps and other specialized collecting devices and techniques. Such equipment was also used by Farrier in the collection of Acarina, and yielded additional types of the microfauna of the soil and duff layers of wooded areas. Thus a large slide collection has resulted.

David A. Young, a specialist in the taxonomy of leafhoppers, joined the Entomological Faculty in 1957, following the death of Dr. Metcalf. He has had the responsibility for the care of the main part of the collection of adult insects, housed in Gardner Hall, from that time until the present. He was also helpful in obtaining grants for the completion of the Metcalf catalogues, and occasionally served as a consultant to Miss Virginia Wade during her immense accomplishment of completing these catalogues. He alerted the librarian to the availability of the Tippmann library, more than 6,000 volumes, which was purchased and is now a major asset in the taxonomy program at N. C. State. In the process of integrating the 800 Schmitt boxes of the Metcalf collections

of auchenorrhynchous Homoptera into the general collection, he encountered great difficulties in curating leafhoppers because of the undeveloped condition of knowledge in several of the groups best represented in the collections. This led to a major research undertaking and the publication of the first part of the results in 1968, a treatment of 55 genera and approximately 420 nominal species. The second part, nearing completion will include more than 125 genera and 975 nominal species.

Some of our former graduate students have made contributions to the collections, either of materials or of service in the organization and identification of some of the groups. Both H. F. Howden and his wife Anne were interested in the Coleoptera, as was also Donald Weisman. Don Duckworth worked with the Microlepidoptera and probably identified some of that group in the collection, and Duncan Cuyler identified much of the Odonata.

IV. The importance of the collections to N. C. State University.

A. The collections contribute directly to research papers in Systematic Entomology by the faculty and staff. Many of these publications have established a world-wide reputation for excellence in this field. Examples follow (for a complete bibliography, see Appendix B):

1. Dr. B. B. Fulton: systematics of Orthoptera, of United States.

2. Dr. Z. P. Metcalf: a complete bibliography of world systematic papers on the auchenorrhynchous Homoptera; and many of his own systematic papers on this group of insects.

3. Mrs. Virginia Wade Burnside: completed many of the parts of the Metcalf bibliographies after the death of Dr. Metcalf.

4. Dr. T. B. Mitchell: comprehensive systematic revisions of large groups of bees of the world.

5. Dr. C. F. Smith: biology and systematics of aphids, mostly of the Western Hemisphere and a complete bibliography of world systematic papers on the aphididae.

6. Dr. M. H. Farrier: systematics of mites of eastern U.S.A.

7. Dr. H. H. Neunzig: classification and bionomics of moths of the family Pyralidae, of eastern U.S.A.

8. Dr. D. A. Young: classification of leafhoppers (Cicadellidae) of the world.

B. The collections contribute directly to the research efforts of N.C. State graduate students. They provide material for students to develop competency in and sufficient basic knowledge of certain groups to enable them to borrow specimens from all the major museums of the world. Their theses and resulting publications reflect credit

on North Carolina State University. Their subsequent professional positions (see "Appendix C") enhance the prestige of our institution. Some of these students, and the group in which they work follow (see "Appendix B" for complete citations):

1. Dr. and Mrs. Henry Howden, Carleton University, Ottawa, Canada - on classification of beetles and related philosophical considerations.

2. Dr. A. T. Olive, Wake Forest University - classification of aphids.

3. Dr. Jose Ramos, University of Puerto Rico - classification of Homoptera Auchenorrhyncha.

4. Dr. W. D. Duckworth, National Museum of Natural History, Washington, D. C. - classification of Lepidoptera.

5. Dr. S. H. Mahmood, University of Karachi, Pakistan - classification of leafhoppers.

6. Dr. W. J. Knight, British Museum of Natural History, London - classification of leafhoppers.

7. Dr. Herbert Schoof, Communicable Disease Center, Atlanta - research on classification of weevils.

8. Dr. James McGraw, now a graduate student at the University of Florida in Gainesville - mites associated with bark beetles in southern pines (an important paper with Dr. M. H. Farrier).

9. Mr. James P. Greene, N. C. Department of Agriculture - on the Western Hemisphere representatives of a group of grass-feeding leafhoppers that contains a disease vector in Europe (an important paper).

10. Dr. H. Derrick Blocker, Kansas State University - a revision of Western Hemisphere representatives of a cosmopolitan grass-feeding genus of leafhoppers.

11. Mr. H. O. Langlitz - classification of economically important Genus Empoasca (the "cigarrita verde") of the coastal valleys of Peru.

12. Mr. Duncan Cuyler - papers on the classification of neuropteriod insects.

C. The collection is a standard for comparison in the identification of problem species of which examples have been submitted to University personnel for identification. It has also been a source of material for training personnel in techniques of recognizing species involved in commodity-oriented investigations, for example in problems relating

to apples, blueberries, corn, cotton, forests and shade trees, peanuts, soybeans, tobacco, alfalfa, ornamentals, and vegetables. In 1972, there were more than 1,400 samples of specimens received for identifications through the Plant Disease and Insect Clinic in Gardner Hall. The aphid collections have served as a reference for many additional identifications of pests submitted by County Agents. The bee collections have provided the means for study of alfalfa pollination. Ecology-oriented research has been aided recently by reference material in the collection in the areas of mites and insects associated with soybeans.

V. Statement of philosophy

To be true to its name, a University with taxonomy as one of its components should nurture taxonomic activities that are universal in scope and importance — activities that transcend political boundaries — activities that surpass the restrictions of temporality, expediency, and exigency. Taxonomists in a university must be charged with placing their institution proudly and prominently among other members of the world intellectual community. Not to keep this goal steadily in view, in spite of whatever pressing lesser contingencies may exist, is to fail to see the forest for the trees.

This is not to say, or to advocate, that more local problems be ignored by taxonomists in a University, for the institution is also properly a member of a smaller community. Its activities should be a contribution to, not a depletion of, the resources of that community.

It is probably a reflection of the compatibility of local needs and those of the world community that taxonomic efforts have been fostered in so many universities for so long a time. Taxonomic efforts have been traced back through the history of universities to an origin dim in the smoke of time — even to Plato and Socrates. Of necessity, the basis of taxonomic works were local organisms. From such a basis the work grew to philosophical dimensions as taxonomic thinking was able to exceed its local and temporal workshop and to apply its findings universally, and to test them in such a context. The association of the two theatres, local and universal, has been and continues to be as natural as the consideration that the former is merely a part of the latter.

Taxonomy at North Carolina State University has been consistent with the above — responsive to local considerations and expansive to those of the universal scene (See Appendix C). It has been supported by citizens because of its contribution to their welfare, and as part of their contribution to world welfare. The publications listed in Appendix B reflect responses to both needs - local and universal.

The healthy growth of insect taxonomy at N. C. State University needs to continue. This is well-emphasized:

1. in the local needs of workers in ecology and pest-management who must report their findings in terms of the identities of the organisms with which they are concerned.

2. in the needs of the extension service who must seek published information in terms of the names of the problem organisms and who must therefore discover the names of these organisms.

3. in the needs of the academic program in the biological sciences, which has been able to count on insect taxonomy as an area of excellence and of universal renown.

4. in the needs of the world to know of its biota before large parts of it become extinct as a result of the activities of man (a recent unpublished statement by well-qualified experts estimated the number of species threatened by extinction, without ever having been recognized by man, in the tens of thousands, and by the turn of the century!).

As a means to fulfill these needs, the insect collection should be continued and adequately supported. It is properly the property of the community of North Carolina; and to the extent that it contributes to world culture, it is the property of the world community in charge of the citizens of North Carolina.

The emphasis of the collection cannot be undirected, for cost considerations. But a continued development of the areas wherein it excels presently, and a continued development in the area of the regional fauna is both fiscally feasible and practical in terms of responsible participation of the University in the local and wider theatres. The collection is not supported now to a degree adequate for the realization of these ends.

VI. Future plans and needs.

A. Policy. A statement of the aims of the insect taxonomy program at this University is greatly needed, even though it should merely endorse the aspects which have received emphasis in the past (see section II above). The committee recommends that items enumerated in V as factors of healthy growth (above) be made a part of such a policy statement.

B. Members of the entomological faculty should be encouraged to attack problems at the highest level their training and interest permit; and problems at lower levels should be solved through technical assistants trained by the faculty, wherever such a division of labor is possible.

C. Technical assistance and funds for travel and equipment should be provided where needed for the taxonomic research efforts of the faculty.

D. The total taxonomic effort should be operated under budgetary assets that are clearly stated and understood by those affected.

E. Funds from Federal Government should be sought to support the collection, but responsibility for its support should be accepted as a University function.

F. The possibility of combining the insect collections with those of the State Department of Agriculture, should be examined periodically, but the University should not lose its influence in matters essential to its proper function in insect taxonomy (see Section V) as a result of any amalgamation.

G. The possibility of combining the physical needs of the insect taxonomic efforts with those of other departments, for example Botany, Plant Pathology, and Zoology should be examined periodically.

H. The Metcalf library of publications in taxonomy of the auchenorrhynchous Homoptera, one of the most complete in the world, should be properly provided for. The D. H. Hill librarians have expressed a lack of interest in caring for collections of separata, of which a considerable portion of the Metcalf library consists. Present housing is inadequate. The aphid publications acquired by C. F. Smith present the same problem.

I. A full-time technician should be provided to assist in the insect collections in Gardner 4321.

J. Long-range planning should include provision of a scanning electron microscope, rearing facilities, space and equipment for visitors.

K. Existing strong portions of the collection should be an important consideration in the selection of future faculty, or else great assets will be ignored.

Appendix A

Summary of the Holdings of N. C. State University Collection*

Location	Description	Form	Space (sq. ft.)
4321 Gardner	General Collection, all orders of insects, adults	975 USNM drawers	655
	General Collection, all orders, mostly immatures	12,200 vials	90
	Shaftesbury Collection of fleas	4,680 microscope slides	22
4322 Gardner	Research collection of cicadelline leafhoppers	48 USNM drawers	16
3301 Gardner	Research collection of Lepidoptera	1,000 vials	50
Hillsborough Annex	Collection of aphids	50,000 slides (200,000 specimens)	200
Hillsborough Annex	Collection of bees	144 USNM drawers	96
4318 Gardner	Research collection of insects of forests	12 USNM drawers	8
	Forest Insects	Examples of damage	15
	Collection of mites	8,000 slides	12
		and 300 vials	5
Research Triangle	Collection of soil fauna	233 boxes	6
1305 Gardner	Reference collection of pest species	12 drawers	8

* Bookshelves, file drawers, and work space are not included

APPENDIX G

APPENDIX G

LIST OF DEPARTMENTAL REVIEWS

1961	CSRS Comprehensive Review.
1965	Self reassessment of department research program.
1968	Conference on departmental academic program, Faculty Club (9/11/68).
1968	Review of departmental extension program, Harbor Island House (10/1-2/68).
1969	Review of future research personnel needs, Quail's Roost (7/17-18/69).
1970	Departmental meeting to consider role of the biological sciences in the SALS, University and State, Quail's Roost (7/16-17/70).
1971-73	Major Agricultural Experiment Station research review of all departments in the SALS.
1971-73	"A Self-Study Report for North Carolina State University" for accreditation by the Southern Association of Colleges and Schools (report issued March 1973).
1971	Review by department heads and administrators of Agricultural Experiment Station's research program, Quail's Roost (2/2-3/71).
1971	Departmental planning for next biennial budget askings, Quail's Roost (7/19-20/71).
1972	Departmental special committee issued report on "Taxonomy and Entomological Collections" (issued 1/25/73).
1973	Departmental consideration of SALS Task Force Research Review, Yates' Pond Laboratory (3/23/73).
1973	Departmental review of teaching program, Quail's Roost (6/5-6/73).
1974	Review of departmental extension program, Quail's Roost (7/29-30/74).
1974	Participation in preparation of NCSU Long Range Report (1975-1980).
1977	Updating of NCSU Long Range Report (1977-1980).
1977	Comprehensive CSRS review (3/20-25/77).
1978	Departmental self-study session, Quail's Roost (5/18-19/78).
1978	Issuance of departmental response to CSRS Review (4/15/78).

APPENDIX B

LIST OF DEPARTMENTAL REVIEWS

1981 CSRS Comprehensive Review.

1980 Multi research at department research program.

1980 Conference on departmental academic program, Faculty Club (9/11/80).

1980 Review of departmental extension program, Harbor Island Hotel (10/7-2/80).

1980 Review of future research personnel needs, Quail's Roost (11/17-18/80).

1970 Departmental meeting to consider role of the biological sciences in the SAIS, University and Estate, Quail's Roost (7/24-27/70).

1971-72 Major Agricultural Experiment Station research review of all departments in the SAIS.

1971-72 "A Mid-Study Report for North Carolina State University" for accreditation by the Southern Association of Colleges and Schools (report issued March 1972).

1971 Review by department heads and administrators of Agricultural Experiment Station's research program, Quail's Roost (2/3-3/71).

1971 Departmental planning for next biennial budget analysis, Quail's Roost (7/29-30/71).

1971 Departmental special domestic issued report on "Technology and Environmental Collections" (issued 1/23/71).

1971 Departmental consideration of SAIS Task Force Research Review, Tucson' Food Laboratory (1/21/71).

1970 Departmental review of teaching program, Quail's Roost (8/3-6/70).

1970 Review of departmental extension program, Quail's Roost (7/28-30/70).

1970 Participation in preparation of NCSU Long Range Report (1970-1980).

1970 Updating of NCSU Long Range Report (1971-1980).

1969 Comprehensive CSRS review (3/20-23/69).

1969 Departmental self-study session, Quail's Roost (5/18-19/69).

1969 Response of departmental response to CSRS Review (4/15/69).

APPENDIX H

APPENDIX H

A Self Study Report for the
Department of Entomology, SALS
North Carolina State University

10/1/71

As a part of the university-wide self study being initiated this year in compliance with decennial reaccreditation requirements, academic faculty and representative graduate students of the Department of Entomology cooperated in the production of the following report. It is constructed on the framework established by the University Self Study Steering Committee and as transmitted by the SALS Self Study Committee.

Mission of the University

The most important mission of the university is to provide an educational environment and experience conducive not only to the acquisition of knowledge but more importantly to the development of wisdom. The mission should not be only for the training of technologists but, perhaps more importantly, for the cultivation of leadership. Wisdom and leadership are individual attributes and can best be realized in an atmosphere of freedom in which each student can find and develop his or her unique qualities while becoming more fully appreciative of nature and of mankind as a part of nature.

The educational experience should include a full spectrum of perspectives, with ample provision being made for frequent interchange among students of widely varied geographic and cultural backgrounds. To further combat provincialism, cooperative teaching and research programs with other states and countries should be developed and maintained. Throughout, extensive modifications in curricula and degree requirements should bemade as needed to meet the needs of our rapidly changing society. At all times, the university through its students, faculty, and graduates should provide the visualization of social, political, technological, economic, and cultural changes which must be implemented if our civilization is to solve its most pressing problems.

Research is essential in the expansion of knowledge and understanding required for the solution of problems and the development of a rich and satisfying life for mankind. Therefore, research must be strongly represented in the university environment. However, research programs, in the context in which many students receive their educational experience, must become more relevant to the pressing needs of society. This may well call for an extensive realignment of faculty talent and facilities and even extend to the establishment of restrictions on the type of contract and grant support accepted. Technological services to special interest groups may in some cases have to yield to the more pressing and important problems affecting society generally, such as deterioration of our cities, pollution, resource exhaustion, and other problems resulting from the explosion of population and technology.

In the past, much of our energy, material resources and talent has been expended in training technologists and developing technology to master our environment and to exploit our natural resources for an ever expanding economy. However, nothing, including GNP, can grow at a compound interest rate forever and all growth processes are ultimately limited by depletion of some resource. Rather than stressing the development of technology per se, now, we must stress the use of technology for resource conservation and management and for the improvement of the quality of life.

In striving for the optimum balance in teaching, research and extension, university administration and faculty should never lose sight of the precedence of teaching. Since the educational environment and experience are of paramount importance on a university campus, teaching must never be relegated to a secondary role in spite of the importance of research and extension. Each faculty appointment is in some measure unique in terms of instructional and research responsibilities. Therefore, flexible guidelines must be used with respect to faculty promotion. Adequte faculty must be assigned the teaching function, and key instructional positions should be assigned to faculty with only minor other obligations. These personnel should be rewarded primarily on the basis of teaching performance.

An essential mission of the university is the constant re-evaluation of teaching, research, and extension for the purpose of re-channeling resources from obsolete and ineffective courses and projects to instructional and research programs of more relevance to the education of students and the solution of society's problems. The degree to which this mission is accomplished will determine in large measure the success of our university in meeting the changing needs of the citizens of our state.

In addition to its fundamental role of being a university as discussed above, North Carolina State University has specialized goals as North Carolina's Land-grant University. One of its major challenges is to accomplish its responsibilities of specialized service to agriculture and industry in North Carolina in a manner compatible with its role as one of the state's leading universities.

As stated in the long range planning report of 1968, this University must commit itself to conduct basic and applied research related to the State's problems and opportunities, to disseminate the results of this research, and to lend the professional competency of its faculty and staff to groups who need it. However, North Carolinian fortunes are so significantly related to national and international problems that research and extension programs within the state must not be unduly restricted by state borders.

Mission of the Department of Entomology

Within the framework of the overall campus mission, the departmental mission is conceived to be as itemized below.

1. Provide undergraduate and graduate training

   a. To "professional" entomologists (from two-year program to PhD and postdoctoral programs).
   b. To individuals wishing a professional background in entomology (undergraduate and graduate minors).
   c. To individuals wishing an "appreciation" of entomology (service courses)

2. Conduct research in entomology

   a. To answer immediate, short-term problems
   b. To answer continued, long-term problems
   c. To investigate basic hypothesis and facets of interest unrelated to problems solving.

3. Extend information relating to entomology

   a. Within the university system.
   b. Within the state
      (1) In problems related to the environment (for example, training of formulators and dealers in the safe use of pesticides).
      (2) In problems of insect control (for example, farmer and professional short courses).
      (3) County agent training
      (4) On-farm demonstrations, field days, etc.
   c. National and International
      Through professional meetings and conferences concerning research, training, and extension.

4. Develop within the society an awareness for the impact of entomology on the problems of resource utilization and management as it concerns entomology and to make society aware of the changes that will be necessary to effect a transition from the pest-free concept, taught since 1945, to a pest management concept.

5. Cooperate with individuals, departments, and governments of foreign countries to develop broadly-based research and training programs for dealing with international problems of concern to entomology.

Involvement of the Department in industrial, govenmental and societal problem areas includes:

1. Providing assistance to industry in the development of chemicals, supplies, and equipment that are of benefit to the citizenry (from such diverse activities as providing insect control and residue data to assisting in label registration and altering equipment to suit the specialized needs of entomologists).

2. Cooperating with local, state, federal, and foreign governments in the improvement of research, training, and extension activities. Examples might include the NSF Sea Grant activity in cooperation with the Consolidated University, the USDA-funded Pest Management Program in Tobacco, training and research programs with NSF, PHS, and other governmental organizations, and participation in international programs sponsored by A. I. D. and U. N.

3. Assisting with problems relating to society such as working to prevent damage to the environment from pesticides and aiding in the protection of food designed for comsumption by low income groups.

Major new goals of the Department of Entomology for the next decade include the development of:

1. A program of pest management for the more important field crop, and possibly sea coast, insects which will include inputs from all segments of the department - applied entomology, behavior, taxonomy, toxicology, and extension. Pest management is a more dynamic concept of control than has been practiced in the past and includes an understanding of insect populations so that interactions of such control methods as chemicals can be predicted and evaluated in light of the total ecosystem.

2. A program of insecticide safety for the overall public (housewife, farmer, formulator, dealer, applicator, etc.) to prevent accidental poisoning, avoid long-term environmental problems, and increase efficiency of control.

3. A program of graduate training designed to place the NCSU program among the distinguished training programs in the United States. Although this department was the only NCSU training program selected for the top category by the 1970 Roose-Andersen report, improvement of this position is a desirable goal. However, a balance must be maintained between output and need of trained personnel and this balance requires continuous re-evaluation to avoid over production.

In response to the question of what would be done if the present level of resources was reduced by 10 percent while enrollment remained stable or increased, it should be pointed out that we are already operating under these conditions. Departmental operating funds have remained relatively stable for the past several years, while costs of operation have increased materially during that period and additional work programs have been undertaken. In the face of this situation, a reduction in resources would of a necessity require a new look at priorities and a likely subsequent elimination of some programs.

From our present perspective, development of the ability to protect man from insect pests in an environmentally sound manner would appear to be the single most important problem facing our department in the next decade.

Enrollment Level

In reference to the four levels of enrollment outlined in the cover memorandum from the Steering Committee, it is our opinion that enrollment on this campus should be a "constant or a stable condition, with slight growth to a top enrollment of around 15,000 in 1980." The chief rationale for a stable condition is that there is a tendency in an ever expanding enrollment to take short-cuts in instructional programs such as excessively large classes and temporary and marginally qualified instructional personnel. In addition, the demand for university graduates seems to have reached the asymptote. Although the immediate causes for this situation may be of a temporary nature, there is some reason to believe that the pressure of enrollment at universities will be relieved by the more effective development of a greater variety of educational opportunities in vocational schools and community, junior and four-year colleges. In addition, there are signs of decline in our population growth rate.

Departmentally, it is felt that enrollment in the undergraduate 4-year program in entomology should probably be reduced to zero (see statement on Crop Protection program below). Entomology is a specialized biological discipline which should be addressed primarily at the graduate level and only by students with a thorough foundation in the biological and physical sciences. The curriculum in biological science at North Carolina State University provides an excellent undergraduate experience for students desiring to major in entomology at the graduate level.

Concerning the graduate program in entomology, faculty and facilities exist adequate to permit the training of up to a total of 50 students.

This number has also been chosen with the following in mind: (1) The predicted future demand, (2) The critical mass size needed for the support of the specialized courses prerequisite for a quality graduate training program, and (3) the number of graduate students needed to support the departmental research programs.

Entomology is significantly involved in the interdepartmental program in Crop Protection. It is felt that this program should be restructured and given new emphasis in order to provide the pest management practitioners which our new concern for environmental quality is going to require in ever increasing numbers.

Our department is strongly represented in the two-year training program of the Agricultural Institute. This is also an important program for training practitioners in pest management and as such should be modified as required in order that it be kept relevant to societies ever changing needs.

Academic Programs

Departmental academic programs. Major changes in the departmental academic programs over the past 5 years include the following:

1. Two-year Program. The name of the "associate degree" program has been changed from "Pest Control" to "Urban and Industrial Pest Control" to more adequately describe the content and objectives. Many revisions of courses have been made and a new course in "Ornamental and Turf Insects" has been added. Two courses relevant to the problems of pesticides have been developed. These are "Agricultural Chemicals", to serve several curricula in the Agricultural Institute, and "Urban and Industrial Pesticides" to serve the majors in the entomology program.

2. Four-year Program. The major change in the past 5 years has been the move to strongly encourage undergraduates to major in "Biological Sciences" with an option in entomology rather than simply majoring in entomology. In either major the student has an opportunity for broad training, but the Biological Sciences major reflects this better than the entomology major. The option in entomology is generally comprised of 3 entomology courses.

   Other changes include initiation of a 500 level course (seniors and graduate students) in agricultural entomology, a summer course at the 300 level, and plans to initiate a 400 level course attractive to the general biologist.

   The "Plant Protection Curriculum" includes entomology courses and is considered the best route for "technical" training within a 4-year period for those desiring employment in various aspects of pest control related to agricultural production.

3. Graduate Program. Several revisions of the 500 and 600 level courses have taken place. The emphasis has been on the development of a "core" of basic courses upon which the various specialty courses could be built. The two core courses in general entomology (ENT 502 - Insect Diversity and ENT 503 - Functional Systems of Insects) have undergone several revisions so that now they are each 4 credit hours and taught by a team of 3-4 faculty members. Further revisions may be desirable to meet the problems of under utilization of the more advanced specialty courses. It may become desirable to reduce ENT 502 and ENT 503 to 3 hours and one instructor each so that more students will have time to take other courses in entomology.

   In the "applied" aspects of entomology a 3-course sequence has been developed with "Fundamentals of Insect Control" the basic course. The other 2 courses are in "Agricultural Entomology" and "Medical and Veterinary Entomology". Courses in "Applied Entomology" and "Forest Entomology" have been dropped.

   Interdisciplinary courses and training programs have evolved. Most frequently used are the interdisciplinary major and minor in physiology and the minors in ecology and toxicology. Training programs in the Department of Entomology are: "Molecular Toxicology and Comparative Biochemistry", "Medical Entomology" and "Pest Management".

Strengths and weaknesses of programs. Some of the strengths and weaknesses of the departmental academic programs are:

1. Two-year Program. The 2-yr program is strengthened by the curriculum which allows a double major and about 25% of the students take that opportunity. It is apparently the most successful program of its type in the U. S. Problems are arising, however. Notable is the small enrollment and the difficulty of serving the region rather than just the State of North Carolina. A need is developing for 2-yr training in agricultural chemicals and in agricultural pest control. The present curriculum is not presently sufficient for these areas of training.

2. Four-year Program. The 4-yr program has very few students as formal entomology majors. Recently, efforts to encourage students to major in biological sciences with an option in entomology have been made with a small measure of success. The Plant Protection Curriculum has an adequate number of students, but is an obscure curriculum suffering from neglect.

3. Graduate Program. The graduate program is the strong program of the Department and was the highest ranked graduate program at NCSU according to a recent study by the American Council on Graduate Education. This distinguished program is hampered by erratic staffing and curriculum development in allied departments. Faculty and course changes in such areas as ecology and physiology have been unpredictable and detrimental to graduate program development. The entomology graduate program has grown strong and earned national recognition by the efforts of a progressive faculty working in the context of entomology as a biological science with a healthy balance between the "basic" and "applied" aspects. Over 90% of the funds for graduate students support and much of the funds needed for their research has come from research and training grants and contracts from sources other than the University of the N. C. Agricultural Experiment Station. A large part of this support has been from non-agricultural agencies. The prominence of the Department of Entomology as a part of the Institute of Biological Sciences has clearly facilitated the obtaining of this outside support. These outside funds may become more difficult to obtain, however, and the abolishment of the Institute of Biological Sciences will not make the task easier. There are increasing possibilities that the nature of the graduate program will be distorted by the nature of the source of funds available for graduate student stipends and research funds. University support for the program is sorely needed.

   The graduate program at the PhD level has been working well with great flexibility in programs tailored to the individual student. At the Master's level (M.S.) there are problems of inflexibility in the course requirements of the Graduate School which need rectification.

Course policy. Concerning departmental policies and rationale for handling curriculum matters, the Department has a standing "Curriculum Committee," one of whose members is a graduate student. The faculty members represent different areas of interest. Critical course or program considerations are discussed by the entire faculty.

Actual curriculum changes. Actual curriculum changes have been initiated by the general faculty, individual faculty members, and ad hoc committees. The most serious problem is a lack of input from other departments.

Teaching assignments. In connection with teaching assignments, advanced specialized courses are usually initiated by an individual and reflect his area of interest. Other assignments are made both informally and by the department head.

Teaching evaluation. There is no teaching evaluation, other than hearsay evidence, beyond that provided for in the University evaluation program.

Academic policies. In the area of problems caused by current academic policies, the course requirement policies for the M. S. degree (previously mentioned) frequently make it difficult to design some students' programs. The policies of the records division hampers flexibility in that the titles of ad hoc "special topic" courses are not printed on the transcripts. With the current trend towards flexibility in training, this problem needs special consideration.

Interdisciplinary and service courses. The interdisciplinary courses (e.g. ecology and physiology) are essential, but under present circumstances are erratic and unreliable. This is due to the lack of interdisciplinary control over the courses and the teaching. Changes in faculty assignments by individual department heads, as well as hiring and firing practices, can destroy a program overnight. Strong interdisciplinary courses and programs are essential, however, and it is a waste not to cooperate in such endeavors which single departments cannot handle alone. The Entomology Department needs to participate more in interdisciplinary courses and programs and to have more authority in the operation and future of such programs.

Service courses in the Entomology Department are essential to the programs of other departments. Unfortunately there is too little communication with, and input from, those departments.

Honor's program. Individual faculty members have participated in the honors program of the majors in Biological Sciences. There is no need for an honor program for majors in entomology since they are so few.

Advising, counseling and grievance. Several faculty members (usually assigned by the Department Head) are advisers for undergraduate students. The Graduate Student Executive Committee serves as an agency for the channeling of student needs and grievances to the Department Head. Where required ad hoc faculty committees are appointed to consider these.

Most of our students are graduate students and they have the required "Graduate Advisory Committees". A weakness in our system is in the case of new graduate students who are not supported on a specific project within the Department. They are often at loose ends at first. There is a need for some sort of temporary advisory committee for these cases.

There is a lack of clear understanding among the faculty as to how much credit is given for performing advisory functions.

To improve communications within the Department, a policy should be established that meetings of at least certain departmental committees should be open in the hearing phase to all faculty and students, and when appropriate, to the staff.

Admissions. The departmental admissions procedures have undergone much discussion and revision, but are now a function of the Graduate Student Affairs Committee. A good job is done by them with this. However, a clearer policy is needed in regard to the admittance of graduate students on "provisional" status and clear criteria for ending the "provisional" status. There should be extremely limited use of this category and one would expect to find only 1 or no such provisional students in the Department in any one academic year.

Admission requirements for graduate work in entomology should be reviewed and we should become more highly selective, using all types of criteria, not just grades in courses. Supplemental information should be required by the Department beyond what is included on the University forms. A system of interviews would be most helpful for this.

The University admissions procedures for Graduate School are inadequate and hamper our program because of the time-lags involved and the difficulty of maintaining contact with an applicant. Admission forms, etc. should be mailed from the Department and returned to the Department. The Graduate School should receive only the completed application for those students we wish to recommend for admittance.

Foreign graduate students present special problems. The Department should examine this in light of our international obligations and the job market in the United States. Informally, we tend to limit the number to no more than 25% of our students. Preference should be given to those students being "sponsored" for training here with subsequent return to their homeland assured. These students should receive appropriate training which may necessitate a special program.

Ten-year plan. In the coming 10 years the Department of Entomology will need to place more emphasis on the teaching of the basic or core courses in its program. This will best be accomplished by addition to the faculty of at least one "generalist" whose primary responsibility is teaching the introductory graduate level course(s).

Other course offerings will need continual revision. Most important will be the initiation of more informal courses with the graduate students participating in the design and functioning of such "advanced topics" presentations.

The 4-year major in entomology will need further evaluation. Most likely it will be dropped in favor of the two alternate majors: "Plant Protection" and "Biological Sciences (with option in entomology)".

The Masters program will need further evaluation with some mechanism being developed to provide this level of training in Pest Management as distinct from the M. S. program leading to the PhD program.

There is no apparent need for a non-research doctorate degree in entomology.

The 2-year (Agriculture Institute) program will have to undergo changes to accommodate the future needs for persons trained in Agricultural Chemicals and in Agricultural Pest Control.

The problems of pest control, human health and food requirements, and environmental pollution are so complex that personnel are needed at many levels of sophistication. Short courses, associate 2-yr degree programs, 4-yr programs and graduate programs all supply different "cogs" in what is hopefully the evolving mechanism of rational pest control. The Entomology training program at the PhD level should be strengthened to make it the strongest research degree possible. Below that level, the next 10 years will require a complete reordering of conventional procedures. The results are not certain. However, the result should provide a mechanism for students to study for varying lengths of time for 1 to 6 years and as a result obtain increasing levels of competence. For example, they might complete requirements for the following after the indicated periods of time:

1 yr - Certification in Chemical Pest Control

2 yr - Associate degree in Pest Control

3 yr - Associate degree in Pest Management

4 yr - B. S. degree in Pest Management

6 yr - M. S. degree in Pest Management

These programs would involve a work-study plan so that practical "on-the-job" experience was obtained. The program would be designed to train the kinds of operational personnel, at the various levels, who will be needed in the future. The PhD program would be separate, draw on a different clientele, and train personnel for research in all phases of entomology, including Pest Management.

Biological field facilities. With the present interest in ecology and the environment, increased use and support of biological field facilities should be made. The acquisition and development of the Yates Laboratory was an excellent step towards this, and it is to be hoped that the Consolidated University System will move to take over the Highlands Biological Station and to provide there opportunities for field biological instruction and research.

Interdisciplinary programs. There is a great and ever-expanding need for much interdepartmental programs and institutes such as Marine Science, Water Resources and Coastal Research and it is hoped that their funding resources can be increased.

Faculty

Changes over past five years. The growth of the academic faculty of the department has been of significance over the past 5 years. In that time, a new department head was appointed and 4 new faculty positions were filled at the assistant professor level. These appointments represent a 16% increase in the total academic faculty. The new faculty positions measurably strengthened the department's capabilities in research and teaching.

Work distribution policies. Faculty members may be 100% responsible for either research or extension, but more commonly responsibilities for a faculty member are distributed among teaching, research and extension. The responsibilities of a new faculty member are broadly specified, but may change according to the needs of the department. These changes are made at the discretion, after faculty consultation, of the Department Head.

The departmental practice regarding faculty efforts among teaching, research, and extension is governed by the need in each of these areas. Departmental academic faculty man years total 25 and the percentage distribution of these man years is approximately as follows: research 59%, teaching 22% and extension 19%. Generally, faculty with primarily research responsibilities are expected to contribute to teaching programs and to a lesser extent to extension programs.

Faculty with primarily extension responsibilities generally contribute most of their efforts directly to extension, the remainder being concerned with applied research.

No faculty member devotes 100% of his efforts to teaching, although 2 faculty members contribute 70% of their efforts to teaching. The number of classroom contact hours varies among the faculty. The contact hours generated by a faculty member is primarily dependent upon his interest and enthusiasm in teaching and the department's need. Because of the small number of undergraduate students majoring in entomology, all of the undergraduate student advising is done by the Department Head. The administration of a graduate student's program involves the personal supervision of the student's plan of work by a special advisory committee of the graduate faculty. Each student advisory committee consists of a chairman and two or more graduate faculty members representing the major and minor fields of study.

Faculty assignments to departmental service committees are made by the Department Head. Preference for appointment to a particular committee is generally granted by the Department Head.

The above policies regarding the distribution of workload, classroom contact hours, student advising and committee services appear to be satisfactory to the faculty.

Salaries and benefits. Salary and benefit levels have generally not been an obstacle in hiring and retaining faculty. The starting salary at the Assistant Professor level has been sufficiently competitive with comparable institutions so that salary has not been a problem in the hiring of new personnel at that level. However, a discrepancy with regard to salary between the Assistant Professor level and the upper professorial ranks does exist, with the result that the salary levels of the upper ranks are not comparatively elevated. This discrepancy of salary levels between the Assistant Professor and the upper professorial ranks has caused faculty morale problems.

Faculty fringe benefits have not been competitive with benefits offered by comparable institutions. A major portion of fringe benefits are actually paid by the faculty (life insurance, retirement, and hospitalization) and even these benefits are the result of programs formulated by the faculty.

We hope that more emphasis will be placed on bringing the salaries of upper rank faculty into line with those of the junior faculty. With regard to fringe benefits, it is urged that these be expanded so that a larger portion of retirement, hospitalization and insurance costs are paid by the state. Also, we hope that the state will inaugurate a program to exempt faculty from tuition payments for the education of their dependent children at this University.

Recruitment and retention problems. The Entomology Department either experiences or anticipates problems in the recruitment and retention of faculty due to (1) lack of adequate office and laboratory space, (2) lack of sufficient subprofessional help and (3) over-diversity of responsibilities.

The teaching, research and extension programs in Entomology have grown to the point that the space allocated to the Department on the main campus is filled to capacity. In several cases offices which were designed to accommodate one faculty member may house 2 or more individuals. A number of faculty are stationed at facilities located off campus, which handicaps them in regard to communications regarding departmental affairs.

The lack of sufficient subprofessional help, including Technical Assistants and Graduate Research Assistants, is a weakness in certain departmental programs. Support for additional research technicians and graduate students should be forthcoming from permanent state sources for existing and new programs. Further, a mechanism should be provided to ensure that technician and assistantship funds are allocated in a manner that assures stability to both the personnel and to departmental programs.

An over diversity of faculty responsibilities may create a problem in the recruitment of faculty interested in teaching and non-commodity oriented research. New faculty positions are needed in the more fundamental aspects of entomology, and if possible, these positions should not be concerned with commodity oriented research.

Equal employment. Faculty members in rank from Instructor to Full Professor total 25 and all are male and 24 are caucasian. Although no females are represented in faculty rank from Instructor to Full Professor, the acceptance of application forms or actual appointment of an applicant to a faculty position is determined only by the qualifications of the applicant.

Departmental positions without faculty rank, which are exempted from provisions of the State Personnel Act (EPA), total 14 (either Research Assistant, Research Associate or Extension Specialist) and all these personnel are male and 13 are caucasian.

Departmental positions without faculty rank, which are under the provisions of the State Personnel Act (SPA), total 29 (either Agricultural Research Technicians, secretaries or bookkeepers, of which 14 are female, and 25 are caucasian.

The department does not knowingly discriminate with regard to minority groups or sex in the hiring of personnel. Emphasis is placed entirely on the qualifications of the applicant.

Criteria for salary increases and promotions. Achievement criteria utilized by the Department Head in evaluating personnel for promotion and merit salary increase include the following:

1. Work habits (punctual, full day's work, etc.).
2. Participation in classroom teaching program.
3. Participation in graduate student training.
4. Accomplishment of assigned extra tasks.
5. Participation in affairs of department (seminars, social affairs, etc.).
6. Participation in affairs of profession.
7. Contribution of critical judgment to policy formulation.
8. Publication record - quality first, quantity second.
9. Participation in fund raising (grants, contracts, etc.).
10. Response to needs of outside public.
11. Approach to research (enthusiasm, diligence, etc.).
12. Personality traits.

For promotion, the Department Head evaluates the above criteria and after consultation with the full professors of the department reviews the case and gives a recommendation to the Administration regarding promotion of a faculty member. Salary increases are determined solely by the Department Head.

All faculty members have been informed of these policies (practices) regarding salary increases and promotion.

The university and school policy of permitting the department head to make recommendations for promotion which are not in line with the recommendations of the full professors was discussed. It appears that there is a concensus in favor of this policy. However, it is their recommendation that, if the administration at any level reverses the concensus opinion of the full professors on a promotion matter, it should be brought back to that group by the dissenting administrator for an open discussion.

Faculty-student interaction. Informal faculty-student interaction is encouraged in the department by placing students on several of the departmental committees, by student participation in departmental seminars, and by holding one or more faculty student social affairs per year.

A committee of graduate students (Graduate Student Executive Committee) exists to provide the graduate students in the Department with a formal opportunity for the expression of ideas, suggestions and complaints relative to their role within the department. This committee consists of 4 graduate students elected by the student body of the Department. This committee reports directly to the Department Head.

Future manpower and salary needs. The projected manpower needed over the next 10 years to maintain and/or improve the Department's quality and relative position among comparable universities will be obtained essentially through a constant reappraisal of missions and goals and a concomitant reorganization of manpower and financial resources. Additionally needed, however, will be an insect biologist with primary responsibilities for teaching and an insect population ecologist, also with teaching responsibilities. To meet the anticipated continued buildup of the livestock

and poultry industry in this State, it would be appropriate to bring a veterinary entomologist to the faculty. Similarly, with the increasing importance of forest resources in North Carolina, a forest entomologist should be on the faculty.

Regarding salary increases it is felt that these should at least be sufficient to meet annual increases in cost of living. Also, see under "Salaries and Benefits" of this section where it is recommended that the salaries of the higher ranks be restructured upward to make them more comparable with salaries being paid today to newly hired faculty.

Research

Changes. Significant changes in departmental research activities during the past five years include:

1. Applied Entomology. Increased, due primarily to recent emphasis in pest management programs.

2. Biology (behavior, physiology, ecology). Remained approximately the same.

3. Medical and Veterinary Entomology. Increased, due primarily to federal research and training grants.

4. Taxonomy. Decreased relative to the other areas.

5. Toxicology-Biochemistry. Increased, due primarily to federal research and training grants.

If research as a whole is considered in relation to other functions of the department, its proportion of the total departmental program has decreased due to the recent rapid increase in size of the department's extension staff.

The changes probably reflect the availability of federal funds in different areas and the extent to which different sub-disciplines were successful in obtaining the funds available. Change during the next decade will continue to depend on the availability of federal funding and thus to some extent will lie outside the control of the department.

Publications. Data on this subject are being gathered directly by the school committee.

Problems in Research Training. The question was raised about the existance of pressures to turn a student's program and thesis work in a direction dictated by vested interests, i.e. by the source of funds. Such pressures do exist and will probably continue to exist. If the student is guided into a problem which is acceptable to him and which has enough intellectual content to provide a suitable challenge and to form an adequate thesis for an advance degree this may not be serious. If, on the other hand, the student is guided into a project which he would not have taken except for economic necessity or more importantly, if he is guided into a project which is routine and without the intellectual content to provide an adequate challenge, then the problem is indeed serious. The solution would appear to lie in obtaining department funds for fellowships and maintaining enough flexibility that students can be appointed before they have chosen an adviser or research project.

Problems in research funding. Problems of the Department relating to research funding include:

1. Not enough flexibility in funds for graduate research training.

2. Long term research is frequently neglected at the school, university and state level in favor of the more expedient approach of finding solutions to short term problems of interest to special interest groups. The solution may lie in an attempt by both faculty and administration to "sell" research as a whole rather than make unrealistic distinctions between "basic" and "applied" research.

3. Administrative structures may be inadequate for the job at hand. The office of the administrative dean for research appears to have little communication with the faculty. The recent demise of the Institute of Biological Sciences will make the acquisition of federal and foundation funds, particularly for interdisciplinary research, much more difficult while at the same time no obvious benefits are apparent.

4. The concept of tenure should include adequate support by the university for the individuals research program. Grants and contracts should represent the individual's desire for a larger program, not merely a desire for any program at all.

5. Although the committee recognized that a rigid plan of priorities for the future would be deleterious, there could be a more planned and less opportunistic expansion. This could possibly be initiated by more rigorous discussion of research priorities and content at the department and school levels.

New areas of research. Since new research areas arise from breakthroughs they are difficult to predict. By definition a breakthrough is unanticipated. Some areas are obviously going to progress along particular paths, for example, the use of such tools as electron spin resonance spectrometers, mass spectrometers and the concepts of molecular biology are going to make toxicology function more at the molecular level; the use of mathematical models and systems analysis will make more practical some of the new concepts of pest management. Similar developments could be anticipated in many areas but whether or not they occur at this institution will depend on the availability of funds from local and federal sources and the use to which these funds are put. The input of faculty, active in research, in developing a unified concept of research and the allocation of the funds to finance it would be desirable at both the local and national levels.

Special Activities

Overall Area of Special Activities

Basic Attitudes. Philosophically, this Department is strongly committed to public service beyond its conventional responsibilities and the total activities of its faculty well supports this. Inevitably, these public service activities serve to strengthen abilities to accomplish better our statutory missions.

Administrative Arrangements. Taxpayers and politicians seldom understand the positive feedback that exists between special activities and our universities' traditional mission of teaching, research and extension. Consequently, such activities as serving as an officer for one's national professional organization, serving abroad as a consultant in a foreign aid program or participating on a national policy making board have to be administered with understanding and finesse. The SALS, NCSU has a fine long-standing tradition of permitting and even encouraging such action on the part of its faculty and adequate administrative devices exist to permit such activities to be accomplished.

Resources. The human resource needed for special activities is provided by the University through salaries, space and some basic equipment. In almost all cases, the operational funding needed is obtained through grants and contracts.

Specific Activities. Excluding extension, which is believed to be a statutory obligation of the SALS, this Department participates in the Water Resources Research Institute, coastal development, educational television, aid to the lesser developed countries, summer teaching, continuing education and international affairs.

Policy Making. Members of this Department have and continue to participate in governmental policy making, wherever expertise coincides with need. For example, through the Agricultural Chemicals Advisory Committee, departmental members have taken an active role in the development of federal and state legislation for the effective and safe management of insect pest control.

Specific Areas of Special Activities

Scope and Nature of Existing Programs.

1. Coastal Development. Through grants from the Water Resources Research Institute and the Sea Grant program, members of the Department are carrying out research designed to provide environmentally sound controls of insect pests of man and domestic animals in coastal areas. Presently, such insect pests are limiting factors in the development of coastal resources.

2. Educational Television. Participation in such regular TV presentations as "Backyard Gardner" continutes to be an active function of our entomologists.

3. Summer Sessions. During the past three summers, departmental members have provided a summer course in general entomology and participated in the presentation of an agricultural chemicals course to County extension agents.

4. International Affairs. Departmental members have undertaken the extension of entomological assistance to lesser developed countries (Peru and India) during the past few years.

Future Plans. It is contemplated that all of the above programs will be continued and that even others may be added where our capabilities happen to match need. Earnest efforts have been made to increase the scope of international work but continued lack of direction on the part of involved federal agencies presently constrains these efforts.

Resources Needed. Heavy demands upon present faculty for statutory obligations and lack of operational funds are presently the factors limiting our involvement in such special activities as are being discussed here. It is doubtful that any marked expansion in such activities will be developed in view of present national and state financial considerations and in view of the acute need which exists for work on problems of more local concern.

Organizational and Policy Changes Needed. Present organizational structure and institutional policies fully permit a reasonable amount of participation in special activities. Limitations are in the area of human and financial resources, which in turn relate to priorities established in the political arena.

Library

Resources for academic and research programs. The Departmental Library Committee has tried to maintain and encourage approachability by students and the faculty. Further, it has tried to recognize their academic and research needs before they themselves recognize their requirements.

Acquisition of the Friederich F. Tippman Library in March 1959 went a long way in meeting the library needs not only of the Department of Entomology but also other departments and schools. The collection contained not only superb entomological works but also the proceedings of many of the European scientific academies and much in the support of forestry and biology in general.

Yet, despite the Tippman Collection, when requested by D. H. Hill to submit our needs in October 1965, a documented annual need of $60,000 was indicated. When such needs could not be met, priorities were established in consultation between the D. H. Hill Library and the Departmental Library Committee. Purchases of old classical works would be limited except for classical comprehensive bibliographical works. Except for these comprehensive works with pressing need, we would try to limit purchases to those being reprinted and give attention to keeping current. Every effort would be made to begin current subscriptions to the serials in the Tippman Collection which had lapsed since its purchase and fill the gaps as monies were available. The details and responsibilities of this decision were left to Harlan C. Brown and Anne Turner of the library staff to whom the Department owes a large debt of thanks. Another recommendation of that report was that entomological and related serials be acquired from Latin America and from behind the Iron Curtain as monies are available. In the latter regard, acquisition has seriously been hampered by the lack of serial publications by the University to exchange with those countries, thus avoiding the currency exchange problems. Lack of monies has simply prevented the acquisition of Central and South American serials - a geographic area which is growing rapidly knowledgeable. Foreign acquisitions in general have been influenced adversely by inflation, the position of the dollar in international exchange and possible devaluation of the dollar.

Thus we must rely increasingly on interlibrary loan services for those materials we do not have. This service has been augmented in the last few years and cooperation with other local University libraries increased. Holdings in biology and medicine at Duke University and UNC, Chapel Hill, have been made available on call and information about them updated via computer printout - making them much more accessible to our needs.

Resource development. Concurrent with the checking of our holdings against the assessment devices normally used, items were selected for acquisition by either the D. H. Hill bibliographers or the Departmental Library Committee. Most of the time these acquisitions had to be limited to a current subscription, if serials, and the past runs left for more affluent times. Many of these requests were not limited to the field of entomology. As insects feed on plants and animals and the means of controlling the injurious ones has ranged from selection of resistant varieties through bacterial and virus diseases to chemicals, these requests included such varied fields as genetics, taxonomy, agriculture, bacteriology, human and veterinary medicine, public health, forestry, chemistry, toxicology and population dynamics as well as the more limited fields of entomology and arachnology. Particular emphasis has been placed on the bibliographical tools including bibliographical controls of publications of other governments due to continued introduction of injurious pests from other countries. All of this has been with continued consultation between the Departmental Library Committee and the D. H. Hill bibliographers. These exchanges have ranged from a telephone call to make a specific decision about one item to the submission of the unpublished list of holdings in entomology and arachnology at Iowa State University which had been retained by K. L. Knight since his employment there. One of the most recent evaluations was the preparation of a list of materials of interest to extension entomologists by Sharron W. Sopher of the D. H. Hill Library staff in cooperation with the Committee on Information Retrieval of the Entomological Society of America under the direction of John Graham in the Department of Statistics. Finally, the D. H. Hill bibliographers refer annually over two linear feet of catalogs, lists, and flyers to the Departmental Library Committee for selection and preparation of order requests. Only with the present secretarial help in the department has the preparation of order requests ever been without turmoil and consternation. For the first time now, we have secretarial help of such quality that the requests are being checked against the previous requests before ordering. This has taken a burden off the Acquisitions Department in D. H. Hill since they have indicated that for the University as a whole about half of the requests received from the faculty are already in the library.

Adequacy of resources. The level of library service to the Department is adequate. Acquisitions from behind the Iron Curtain and the Latin American countries are needed. An exchange serial would be helpful in both cases and would provide a local outlet for large works which are not readily acceptable to journals with markedly increased publications costs. Short of the exchanged materials, money is needed for current subscriptions - just to maintain those now currently received or for the new subscriptions needed. Reference is made to the Departmental Library Report to the D. H. Hill Library in 1965 for many of these details. A recent review indicated most of the new subscriptions in that report have not been entered. Many of the unusual items of the Tippman Collection have yet to be catalogued. These items take a half or even a whole day of the cataloguers time to verify and place. Time needs to be provided for this work. The Metcalf Collection also needs to be moved physically, catalogued, and integrated into the D. H. Hill collections.

Branch library policy. The Departmental Library Committee supports a strong central library concept. That which has been done could not have been completed in a departmental library in any aspect. Entomologists must bring to bear on their problems the knowledge from many disciplines. Even an elementary literature search, if conducted efficiently, requires the consultation of several of the guides to the literature of agriculture and biological science and such works as Bibliographic Index and the Library of Congress and U. S. Department of Agriculture printed catalogs as well as the public catalog of D. H. Hill. When such additional needs as those already indicated have not been met, duplication in any (even though very limited) instances in Departmental or School libraries would be folly. The space problem also becomes acutely evident when one considers that Biological Abstracts consumes 4 1/4 feet of shelf space a year During the history of the Department, three different libraries have been in its possession. All three failed because of inattention and the time required to maintain them. The last one, given by A. M. Woodside (an alumnus), distracted the attention of the Departmental Library Committee from the support of and cooperation with the D. H. Hill Library. Runs of Annual Review of Entomology and the Insecta Section of Zoological Record are maintained for quick reference and use of students and faculty.

Future resource changes. We do not foresee any significant changes in the utilization of library resources by this Department. The need for them will remain great and the problem of coping with the expanding flood of material will get ever more serious.

Problems. With the amount of knowledge doubling every eight years, it is deplorable to see baccalaureate degrees being awarded to students who have no ability to tap this knowledge. Many students are reaching their junior year at N. C. State University without having been inside the D. H. Hill Library. Outside of the initial orientation, when the freshmen (even to the most uninitiated observer are awed, confused and even scared) remain silent when asked for questions, there is no organized campus-wide instruction or emphasis in the use of a technical library. Something should be done at the sophomore or junior year to aid and encourage students to obtain information which does not come from the instructor's mouth or the textbook - both of which are limited and limiting. Should the present disinterest of faculty and students continue, the keys to open the doors of knowledge will remain forever hidden from these students.

Computer

Instructional Use. Currently the computer is little used in the departmental instruction program. There are no computer science courses. Courses employing the computer for an instructional purpose are Insect Toxicology (ENT 622) and Insect Ecology (ENT 531). A portion of one laboratory in ENT 622 is devoted to a discussion of LD_{50} (by Dr. R. Monroe of the Statistics Department), with a computer demonstration included as a part of the discussion. Special problems, involving the use of the computer for computations, are included in ENT 531.

Query as to computer utilization in instruction five years hence indicates little incrase. Little change is seen for computer use in ENT 622, "but this could rapidly change", as reported by the instructor. There will be an increase to one "full" laboratory computer exercise each year in ENT 531. There are no plans for future application of the computer by others teaching departmental courses.

Research Use. Many departmental members utilize the computer rather extensively in their research projects. Others do not use the computer, but indicate they could possibly use it, while a third group states there is no practical need for the computer in their research projects. Pesticide residue laboratory personnel employ the computer on a daily basis for routine processing of gas chromatographic data on pesticide residues. All data from the Heliothis project (NSF GB-28855) are placed on punchcards for various types of statistical treatment, with some mathematical modeling of populations. Toxicological data, such as LD_{50}'s, are computed for departmental members by statistics department personnel. A limited amount of numerical taxonomic data are handled on the computer. Types of project information secured through computer use by faculty members are means, standard error of means, variance regressions (both linear and multiple), t tests and other parameters. The greatest predicted increase in departmental computer usage five years hence will be in research, although, according to persons responding as to their future activities with computers, the increase will not be nearly as great as might be expected. Several respondents indicate their computer utilization will not increase, with one person stating "there will definitely not be an increase in computer use". Of those indicating greater utilization of the computer, most stated that it will simply involve "more of the same", and not an increase in new techniques or procedures. Specific examples of increased future use include: modeling of a pest management system for the Heliothis project, an analysis of insect taxonomic characters, model simulating and for the prediction of population data, with corresponding graphs.

Management Use. Managerial and/or administrative activities in the department do not utilize the computer, nor is any utilization planned for the future.

Funding. Departmental members, in most cases, indicated the 12% paid for computer support by a user is too low. However, response to the query as to how much should be paid by a user varied from 0% to 100%. Most persons indicate 50-100% of the charge should be levied to the individual user, with the actual % charged to all users determined by the administration.

Support for TUCC. Personnel with a working knowledge of the University's participation in the Triangle University Computation Center (TUCC) strongly support NCSU participation. Individuals report that it: gives a better capability than any campus can easily afford alone, should lead to more efficient and cheaper cost, makes possible a greater volume and variety of work, is an extremely powerful tool to help with and supplement research, and relieves one of the boring computations which would otherwise be necessary.

Problems. There are few problems in managing computer resources. The greatest problem is the lack of knowledge in computer use, including poor programming, coding and computer operation. Other problems reported are the lack of time to study the value and need for computers, the availability of a computer technician when needed (when considering user's schedule) and the lack of an operator's guide.

Physical Facilities and Equipment

Buildings. Restraints placed on present programs by existing physical facilities are:

1. Classrooms and teaching laboratories - The seating capacity of the graduate classroom and laboratory is inadequate and the arrangement of the room provides awkward communication between the teacher and students.

Also, there are insufficient sinks, electrical outlets, microscope storage cabinets, and spaces for storage of materials needed for class use. Facilities for undergraduate and agricultural institute instruction are also crowded, and more space and modern furnishings are needed.

2. Seminar room - The present facility, an undergraduate biological science classroom, is inadequate because of inappropriate lighting, poor ventilation, excessive noise, and lack of central air conditioning.

3. Conference room - The conference room is inadequate because of small size, poor seating arrangement, and lack of central air conditioning.

4. Office space and research laboratories - Many of the available spaces are overcrowded and it has not been possible to provide space for all of the activities of the department. This has led and is still leading to the migration of certain projects to West and South campus.

5. Storage space - No storage areas are available, resulting in short term storage in officies and laboratories and necessitating the frequent re-ordering of supplies. Storage space provided on South campus is not suitable for many types of items.

6. Lounges - The conference room is available as a lounge only when it is not being occupied for a conference or oral examination of a student.

7. Internal environment and sound insulation - Internal environment is rather poor because of inadequate ventilation in halls and inner rooms and in outer rooms blocked by other buildings, heat build up at certain points throughout building due to poor insulation of heating pipes, vibration and noise from window air conditioning units and laboratory equipment and closeness to the railroad.

8. Building maintenance - Janitorial service has deteriorated steadily in recent years and is now considered to be below minimum standards. Cost or repairs and new installations by university personnel is much too high, sometimes being several times higher than that of an outside jobber.

Equipment. The maintenance, utilization, and inventory of equipment is satisfactory.

Grounds.

1. Parking - The extreme shortage of parking spaces presents a serious problem to the majority of employees, and inhibits the activities of some employees more than others - depending upon the nature of their duties. Giant parking decks and/or regular bus service on both North and South campus are needed.

2. Walks - Some walks are used heavily, but others are rarely used and there are foot paths between shrubs and across the grass. More attention should be given to locating walks where people walk.

3. Pedestrian and automobile traffic - Some streets have no walks, and students of necessity block these streets between classes. Attention should be given to providing walks along all streets traveled heavily by students.

4 Recreational areas - Suitable recreational facilities have been built or are under construction, except that a faculty club (not a family recreation center) is needed on the campus.

5. Class change interval - The present interval is adequate.

6. Environmental liabilities and assets - There is a need for better landscaping and a regular program for maintenance of flowers, shrubs, and turf.

Long Range Facilities Planning. This has been adequate. The principal problem is the lack of priorities sufficiently high to get the new space which we so badly need. We have an overall personnel group as large as some departments which have twice the space that we have.

Limitations on Future Development. Available space does not adequately meet the requirements of existing programs, and any enlargement of existing programs or addition of new programs will require new space.

Financial Resources

It goes without saying that the acquisition, management and expenditure of funds is as of fundamental importance to an academic institution as it is to industry. However, it is doubtful if any industry could long survive dependence upon the arbitrary decisions of an Advisory Budget Commission and the capricious whims of a General Assembly for the acquisition of operating funds. Nor could they manage their resources effectively if constrained on all fronts by accounting procedures established by an absentee State government for a multitude of operations in no wise related to those needed to run a good university. These are problems of considerable magnitude to the university and to the school and have reently been compounded by a closer legislative scrutiny of the financial activities of all state-supported institutions of higher education. Unfortunately, no ready solutions are evident for these problems of resource acquisition and management.

Strengths and Limitations. Both budget planning and budget control in SALS are handled in an exemplary manner. As pointed out above, such limitations as are encountered by the departments are imposed upon our system at a higher level and principally outside of the university itself.

Departmental Expenditure Patterns. Expenditures during the past five years have been divided between personnel and operations roughly as follows:

	1967-68	1968-69	1969-70	1970-71	1971-72
Personnel	83%	87%	87%	88%	89%
Operations	17%	13%	13%	12%	11%

These figures point up the fact that funds for personnel have continued to increase (principally due to annual salary increases), whereas operational funding levels have remained static.

Adequacy of Resources. Resources, both state and federal (Hatch, etc.) have remained essentially static for the past six years and consequently are not adequate today because of the continued rise of the cost of living. However, because of the acquisition of funds through grants and contracts programs have not had to be curtailed. This has been satisfactory except that utilization of such funds usually results in a dilution of research efforts and in a decrease of overall efficiency in pursuing planned goals.

Endowment Funds. This Department has no funds of this type.

Future Needs. A modest expansion of financial resources is visualized as being needed during the next decade. Expanded personnel needs were described earlier in this document and if these are obtained there must of a necessity be an increase in operating funds.

Capital fund needs are more difficult to visualize. If the Department remains housed in several locations as it is presently, the acquisition of another 15,000 square feet of space would probably care for the expansion in personnel and programs considered essential for a fully developed entomological program. Ideally, the Department should be housed under one roof and this would require a very extensive capital outlay and would probably only be accomplished by the addition of an additional building for the biological sciences. Currently, we are badly in need of expanded insect rearing laboratory and field facilities and of storage space.