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GRASSLAND BIOME GRADUATE STUDENT SYMPOSIUM--A REVIEW

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ABSTRACT

This paper reports on the organization and results of a two-day meeting involving 83 graduate students and technicians from the intensive and comprehensive sites of the Grassland Biome Program, US IBP. The considerations and hang-ups of small group (interest area) discussions are included along with a summary of the individual critiques and evaluations submitted by the participants.

INTRODUCTION

The idea for a symposium involving graduate students and technicians in the Grassland Biome Program was generated by the review committee of the National Science Foundation who examined and commented on the program in July 1970. There was concern evidenced on the part of these individuals as to whether or not the graduate students in the program were grasping the big picture as to their interconnecting roles in the program. A related question was whether or not these students really were benefiting by having their projects funded through a large program as opposed to small individually-funded research projects.

After some reflection, we came to the realization that the students on the Pawnee Site were indeed cognizant of the holistic concept of the program and their position in the framework. These students are constantly being exposed to many individuals of varying disciplines throughout the summer field season and have the opportunity to attend the series of winter seminars on the Pawnee research efforts. This, however, is probably not the case with those students on the Comprehensive Network Sites (which are small and have less diversity in the number of disciplines represented) and for many of the technicians (at both the intensive and comprehensive sites), who are closeted away in some research laboratory. The most feasible answer to this problem was to pull all of these individuals together in a common meeting.

FORMULATION

As we formulated the symposium, three guiding concepts soon emerged. First, as we began to assemble distribution lists for possible attendees, it soon became apparent just how many people we were talking about. These lists also indicated how many of these people must feel "on the outside," lacking a complete picture of the entire program. This dictated an informal program structure where each individual would feel free to contribute regardless of his role.

Secondly, to enhance this informality and promote the freest possible exchange of ideas, we limited attendance to graduate students and technicians, i.e., no senior scientists. It is a commonly noted phenomenon that, in the presence of their superiors, many students have a tendency to take a back seat and be less honest or blunt in their criticisms.

Thirdly, we felt that, very commonly and not facetiously, most students and technicians have a clearer idea of what is being done on their individual project, and the problems encountered than do their major professors. From these concepts evolved the major objectives we sought in the symposium.

Objectives

i. To introduce people to the basic framework of the program, its history and future, to some of the basic ecological concepts which underlie the entire research effort, and to show those people, especially from the Comprehensive Network Sites, what has been and will be done on the Intensive Site.

ii. To bring the individuals together in group discussion, meeting those who are involved in common subject matter areas and open future lines of communication.

iii. To discuss and document both the methodological and conceptual problems encountered by individuals in the program, with particular emphasis to those people from the comprehensive sites.

iv. To see if some of these problems could be solved or directed toward a solution, both through the exploration of new methods and better communication and interaction between individuals in specific subject areas.

Organization

As indicated above, informality was one of our major objectives in the symposium, and therefore dictated the framework of the meetings (Table 1). Recognizing that many of the individuals who would be in attendance were new to the program or had not been exposed to much of the program planning, we thought it necessary to have an introduction giving an overview of the program including its historical aspects. This was given by George Van Dyne, the Biome Director. A synopsis of his paper is found in the succeeding section. We also realized that it was essential to devote some discussion to the systems concept around which the program revolves. This is especially true in view of the multidisciplinary status of the graduate students and technicians. This was done through a discussion of the concept of the energy flow through the grassland ecosystem. Nine presentations covering the various energy levels in the grassland ecosystem were given by various students in the program. The abstracts of these presentations, along with the energy flow diagrams for each level, are found in a later portion of this report.

We felt that it was necessary to provide the opportunity for many of the visitors and technicians to visit and discuss the research occurring on the Pawnee Site. The tour of the Pawnee took place in groups led by the various graduate research leaders in each field.

The second day of the symposium was very informally structured and centered around small discussion groups following the framework of the papers given in the first morning. In the morning session, participants were encouraged to discuss their own hang-ups, not only in the research methodology, but to delve philosophically into the position that this research and they themselves fulfill in the program. Following these "group sensitivity" discussions the major points of disagreement and confusion, and questions were presented by discussion group coordinators to all participants. The afternoon was devoted to similar types of group discussion in which the participants were urged to try to resolve some of the problems encountered in the morning session. Participants were encouraged to circulate among groups at all times and especially to go to those groups in which they had felt they had some input. The structure of the afternoon, as seen below, was altered in response to the demands of the participants.

We had intentionally planned to avoid placing undue emphasis on the modelling aspect of the program simply because we felt that, if we were to do so, we ran the risk of "turning off" the participants. Also, the three key modellers would be gone at the time.

As the symposium progressed, our original de-emphasis of modelling proved to be overdone. In fact, the interest of the group was encouraging enough to change the original schedule to include discussion of modelling.

As luck would have it, Bob Francis, one of the key modellers, had returned and was more than willing to discuss the ideas and concepts of modelling. In as much detail as the short notice permitted, he enlarged on the modelling status for all participants. One of the questions that concerned nearly everyone was: What will be done with the data we send in? A second pressing question was: How much of the detailed information we are submitting will actually be useful? Bob's frank, honest answers were accepted. In some cases, all detailed information has a specific use in modelling; in others, the extent of detail necessary was unknown at present. The important point was for us not to be caught needing more detail and having to re-sample to obtain it.

THE GRASSLAND BIOME PROGRAM--A HISTORICAL PERSPECTIVE

George M. Van Dyne

The International Biological Program (IBP) was conceived in 1965, because of the tremendous need for coordinated international cooperation in biology. IBP was developed by the International Council of Scientific Unions as a five-year program to begin in July 1966.

The overall purpose of the IBP is to examine "the biological basis of productivity in human welfare." Major objectives are worldwide studies of (i) organic production on the land, in fresh waters, and in the oceans so that estimates may be made of the potential yield of new, as well as existing natural resources; and (ii) human adaptability to different and changing environments.

IBP in the United States was initiated through the National Academy of Science. The overall research program was originated in October 1966.

This meeting saw the development of the Integrated Research Programs for the Analysis of Ecosystems.

Of paramount importance to the Integrated Research Programs was a study of the entire ecosystem in each of the following biomes: grassland, tundra, desert, coniferous forest, deciduous forest, and tropical forest. The intensive studies at one location in the biome would be augmented by an extensive network of comprehensive studies throughout the same biome.

Three of the biomes (grassland, deciduous forest, and coniferous forest) are of special importance on a worldwide basis, because it is here that man either lives or derives his living. The remaining three biomes will assume increasing importance in the future because they are the ones which will be exploited for human welfare. The major emphases in the biome studies were to be concerned with land-water interactions, the flow of energy, and the cycling of nutrients.

During the winter of 1966-1967, much of the groundwork for the grasslands biome was laid. In May 1967 the shortgrass or mixed prairie grassland was chosen for intensive study. Three conditions led to this decision: (i) Both Canada, at the Matador Site, and Mexico, at the Campaña Site plan intensive studies of shortgrass or mixed prairie. Our study would contribute to an international latitudinal comparison. (ii) On these drier prairies the largest and least altered areas of grassland can be found. (iii) These prairies contribute to man through both primary and secondary production. The goal of optimizing both levels simultaneously is challenging.

From possible mixed prairie grassland research areas, the Pawnee Site, located on the Central Plains Experimental Range in northeastern Colorado, was chosen for intensive study in October 1967. Other areas possessed some of the advantages listed below; only this site combines all of them:

i. It is an excellent example of shortgrass (and some mixed) prairie, large enough to accommodate the planned research and adjacent to the larger Pawnee National Grassland.

ii. It has a long history of data and management.

iii. It is located centrally between the Canadian and Mexican sites, and also centrally within the U.S. range of such prairies.

iv. It is close to five colleges and universities, with a combined enrollment of over 60,000 students. Support and active participation from the Agricultural Research Service is also available.

Also at the October 1967 meeting, Dr. George M. Van Dyne was nominated for Director of the Grassland Biome.

The general plans for the grassland research project were presented to and endorsed by the National Committee of the IBP in Washington, D.C. in late October 1967. A meeting was held in November 1967 and subprojects were discussed by 61 potential participants. Subproject proposals for grassland studies were solicited from interested investigators for the intensive site and for the comprehensive network, and working meetings of small groups were held to discuss proposed research. These proposals were evaluated by external committee experts from around the nation in a meeting in late November 1967.

Funding

An initial proposal was developed for the Grassland Biome program and was submitted to the National Science Foundation in January 1968. The original proposal requested $\$1.9 \times 10^6$ for the 12-month period beginning in April 1968. The proposal was reviewed by the Interagency Coordinating Committee in March 1968 and was finally funded by the National Science Foundation in June 1968 for $700,000. Also, in June 1968, Donald Jameson joined the program as director of the Pawnee Site.

A continuation proposal was submitted in January 1969 for $\$2.2 \times 10^6$ for the 16-month period beginning in September 1969. The amount awarded was $\$1.8 \times 10^6$ for 16 months, which allowed implementation of the comprehensive network program. Funds were available in the fall of 1969, and in October 1969 Norman French joined the staff as director of the Comprehensive Network Sites.

In April 1970 a continuation proposal for $\$2.5 \times 10^6$ for the 12 months beginning in January 1971 was submitted.

Analysis of Ecosystems

Some of the immediate objectives of the IBP are to assess primary and secondary production in a variety of ecosystems. Implicit in these goals is the possibility of increased production through better management. This in turn requires a better understanding of the ecosystem. It was with this in mind that an effort on the Analysis of Ecosystems was proposed.

Emphasis in the program is to be placed on interrelations among all components of such systems. Wherever possible, the interactions of aquatic and terrestrial systems are to be included. Immediate goals include the analysis of such aspects of ecosystems as energy flow, nutrient cycling, trophic structure, spatial patterns, interspecies relations, and species diversity. Further goals include the understanding of these ecosystem processes, in the sense of analyzing the mechanisms by which observed characteristics of flow, cycling, density, diversity, etc., are achieved and maintained. The ultimate goal is to enable man to manage his environment more wisely. Each intensive analysis will combine research projects from many disciplines.

THE FLOW OF ENERGY THROUGH THE GRASSLAND ECOSYSTEM

This section presents the abstracts of the nine presentations in the first morning session of the symposium. Following these abstracts are the diagrams, the first one depicting the overall flow of energy within the ecosystem, and the remaining diagrams showing the relationship of the energy flow to the compartments discussed.

Abiotic Components--Alan F. Galbraith

The abiotic components of a grassland ecosystem are reviewed. Abiotic structure and processes are considered in relation to the biotic elements of the system. A comparison of certain abiotic processes in other biomes is given to show the significance of these processes in the grassland. The feedback effect of abiotic-biotic interaction is illustrated by a specific case. The hydrologic cycle is used as an example of the modelling aspect of ecosystem analysis.

Primary Producers--Dale Bartos

The primary producers play a major role in the ecosystem by initial fixation of energy (sunlight) through the process of photosynthesis. This bound energy is transferred successively throughout other trophic levels until it is essentially lost from the system.

A distinction should be made between net and gross primary production. Net primary production is that biomass (total energy content) minus that respired which becomes part of the plant community. On the other hand, gross production is the total amount of energy fixed by the plant community, usually measured over a specific period of time. The gross production figures contain the amount of energy lost due to plant respiration.

The predominant autotrophs in a grassland ecosystem are grasslike plants, various forbs, and shrubs. In a shortgrass community the major contributors would be grass and grasslike plants.

Aquatics--K. J. (Jerry) Grubbs

Aquatics of the western grasslands of the U.S. are restricted to temporary ponds dependent on water from annual rainfall and permanent ponds whose water supplies are underground springs. Due to the rapid evaporation rate of this area, salts such as Ca, Na, Cl, P, K, Ti, nitrates, and oxides make the water of the ponds alkaline. Exchanges of organic and inorganic compounds between the water and the land of the area are also influenced by abiotic and biotic factors. The flow of energy in the pond habitat is influenced by wind-borne terrestrial material. Within the pond these materials are decomposed and used either by the phytoplanktons and macrophytons in photosynthesis, or by the zooplanktons directly as food. Insects and aquatic herbivores feed on plankton and aquatic vegetation and, in turn, provide food for birds and amphibians of the ponds. Aquatic and terrestrial reptiles found surrounding the ponds feed on birds and amphibians, thus carrying energy back onto the land and into the terrestrial community.

Large Herbivores--Don Peden

Large herbivores act as a prime gateway through which man may exploit natural or seminatural grassland ecosystems. Energy and nutrients are removed from the ecosystem in the form of wool, skin, meat, bone, and blood. Thus, there exists a need to understand ecosystem dynamics in order to optimize or maximize the flow of energy and nutrients through large herbivores subject to constraints which limit depletion of soil quality, floristic richness, aesthetic resources, and other desired resources. Toward fulfillment of this need studies have commenced on a variety of herbivores which include cattle, sheep, goats, antelope, and bison. Burros and deer may be studied in the future.

Floristic and chemical composition of the diet, total intake, forage digestibility and energy, and chemical partitioning within the individual is being or will be determined for each large herbivore species for each phenological stage of the available vegetation. Decomposition of large herbivore feces will be conducted in the future. Population dynamics are being investigated for antelope.

Studies of Small Mammals at the Pawnee Site--Jerran T. Flinders

Small mammals play an important, dynamic role in the shortgrass ecosystem. They are important users of herbage, and seasonal dietary selection is apparent. Intraspecific and interspecific dietary competition is under investigation. The rodents seasonally fluctuate, in varying degrees, between primary consumers and secondary consumers, and therefore have a marked effect on the pathway of energy flow. Jackrabbits respond to, and may affect, the occurrence and distribution of vegetation within the shortgrass ecosystem.

The objectives of the small mammal studies on the grassland biome are (i) to form an initial understanding of the nature and extent of the role of small mammals in the functioning of the grassland biome, (ii) to identify a minimal framework of data that will realistically delimit the numerical and functional mechanisms that tend to stabilize or perturb the various populations of small mammals, and (iii) to obtain comparable modelling information through combined research on a common group of animals.

The three circles shown on the accompanying model, between the primary producers and small-mammalian-consumers, represent the three spheres of small mammal biome studies: habitat and dietary studies, energetics, and population dynamics.

Insects--Virginia Yount

Insects play an important role in the transfer of energy and nutrients from the primary producers to the large carnivorous and omnivorous consumers. Insects may greatly affect plant and, consequently, animal distribution by their feeding and reproductive behavior. First, explorations of the insects' impact on the grassland ecosystem were begun by sampling several plant species to determine the kinds of insects present and their relative abundance. Approximately 3,000 species have been collected so far. Population trends coincide with plant successions. Insect predator numbers reflect insect abundance.

Diet studies are presently being carried out to establish associations between the known plant and insect species by direct observation in the field and by examination of the crop contents of the larger chewing insects in the laboratory. Vacuum devices are being used to collect the entire insect population trapped under a dropped net over measured plots. This will give an estimate of insect biomass variation throughout the sampling period. The total amount of food intake is being estimated for one species of grasshopper by use of radioisotope-labeled blue gramma. Measurement of radioactive build-up in the enclosed grasshoppers reflects their intake of the "labeled" grass.

The role insects play in affecting plant distributions needs to be studied further. One study on insects affecting thistle seeds estimated that 60% had been destroyed by insect larvae. Their importance as pollinators and destroyers of other plant seeds should be investigated. Future studies will attempt to determine the factors controlling conversion of plant biomass to insect biomass.

Birds--Brent Giezentanner

Bird faunas of prairie ecosystems are characterized by having few species but many individuals of each species, a fact that reflects the common occurrence of each of the few different niche-types provided by the prairie.

All species are territorial at some time during the nesting season. This provides separation of nesting pairs and helps to provide adequate food supplies. These territories are non-exclusive of other species which allows for multispecies utilization. Different plant associations are characterized by different bird species. For example McCown's longspurs prefer heavily-grazed pastures; meadowlarks prefer lightly-grazed areas. Species are further separated into ground and shrub nesters. Ground nesters exhibit either camouflaged nests or camouflaged eggs, but seldom both.

Species are also separated temporally by time of nesting, the time when avian utilization of the environment is greatest. During this period all species are secondary consumers, feeding insects to their young. At other times, many of these same species are primary as well as secondary consumers. Few species are secondary consumers only, year-round. The avian food web is a simple relationship between plants, insects, small mammals, and birds, and seldom reaches higher than the tertiary consumer level.

Predators--Leonard Paur

Predation is a way of life under which a species gains a required resource (e.g., food) by preying directly on another species or group of species. Predation in the general sense occurs in nature not only within and among most taxonomic groups of the animal kingdom, but also among the plants. Our primary concern will be with mammalian predators which are as large as a jackrabbit or larger.

Predators, living at the expense of other animals, constitute the secondary consumer trophic level of the community. The quantity biomass of the predator compartment is usually quite small when compared with the biomass of the community as a whole. Thus, it appears that the major function of predators is one of regulation. The manner in which this regulation is brought about, whether by numerical response or functional response, is determined by the natural limits and habits of the predators.

Decomposers--Charles Proctor

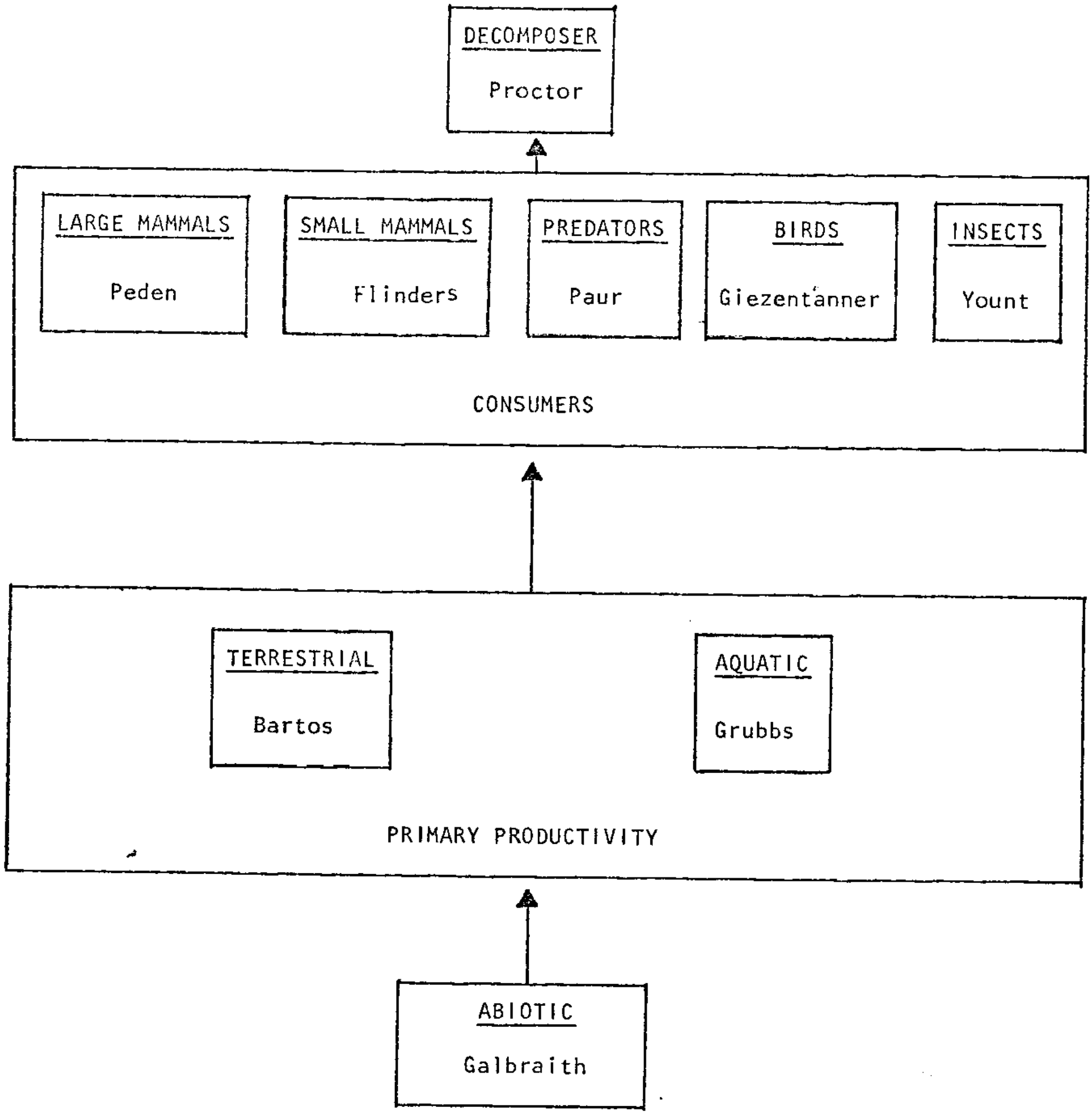
Decomposers are the various sorts of living things which destroy the dead bodies of formerly living things, turning these dead bodies into soil and reusing the minerals contained in them or freeing these minerals for reuse. There are three taxa of living organisms which contribute materially to decomposition: the bacteria, the fungi, and the arthropods. The bacteria and fungi accomplish decomposition by direct chemical lysis of dead tissues. Arthropods accomplish decomposition by direct feeding on the material and by breaking up the material into smaller pieces which enables the bacteria and fungi to more effectively do their work. Of these taxa, the arthropods alone accomplish the bulk of nutrient mineral concentration.

Primary plant production is very strongly seasonal. Decomposition may be spread over the whole year, although evidence suggests that it is at its peak in the late spring and through the end of July.

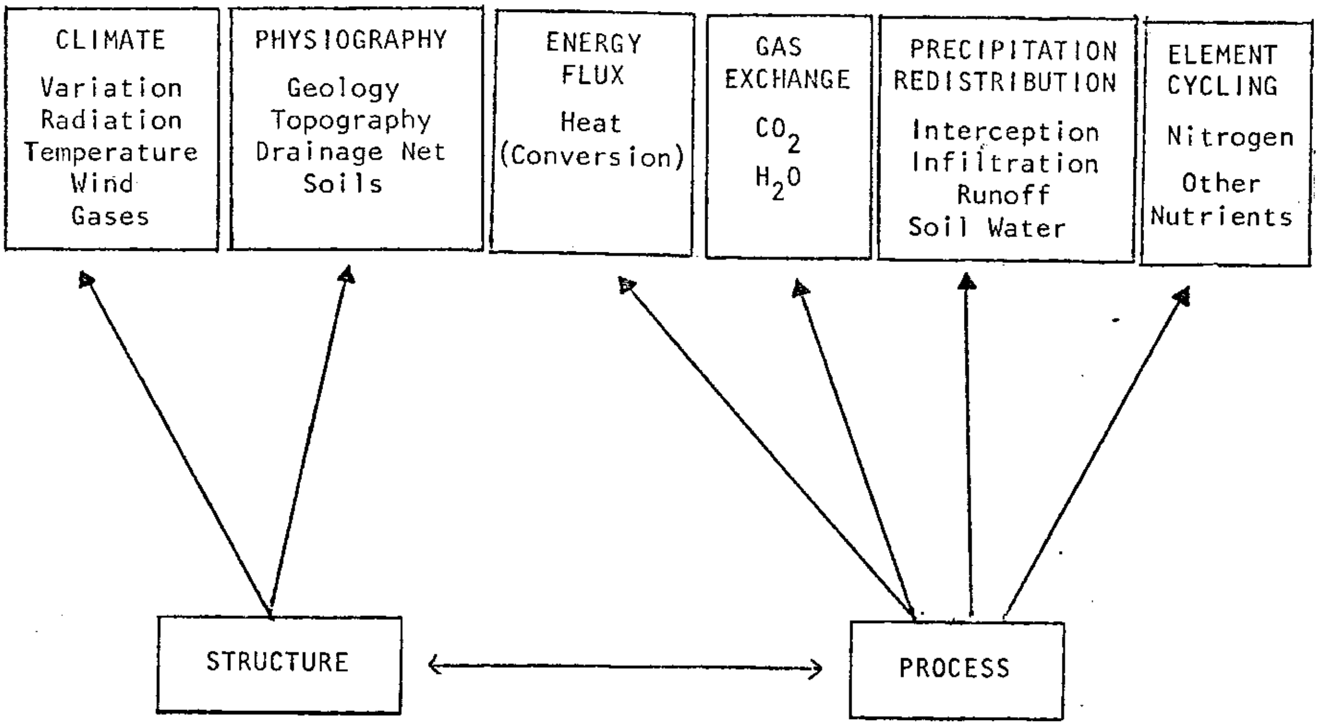
Decomposer processes are poorly understood for three reasons. First, these taxa are difficult to handle taxonomically. Second, they are very small. Third, they do their work underground where they cannot be directly observed, and the indirect methods for measuring such things as respiration are difficult to apply with consistency and are subject to varying interpretation.

DISCUSSION

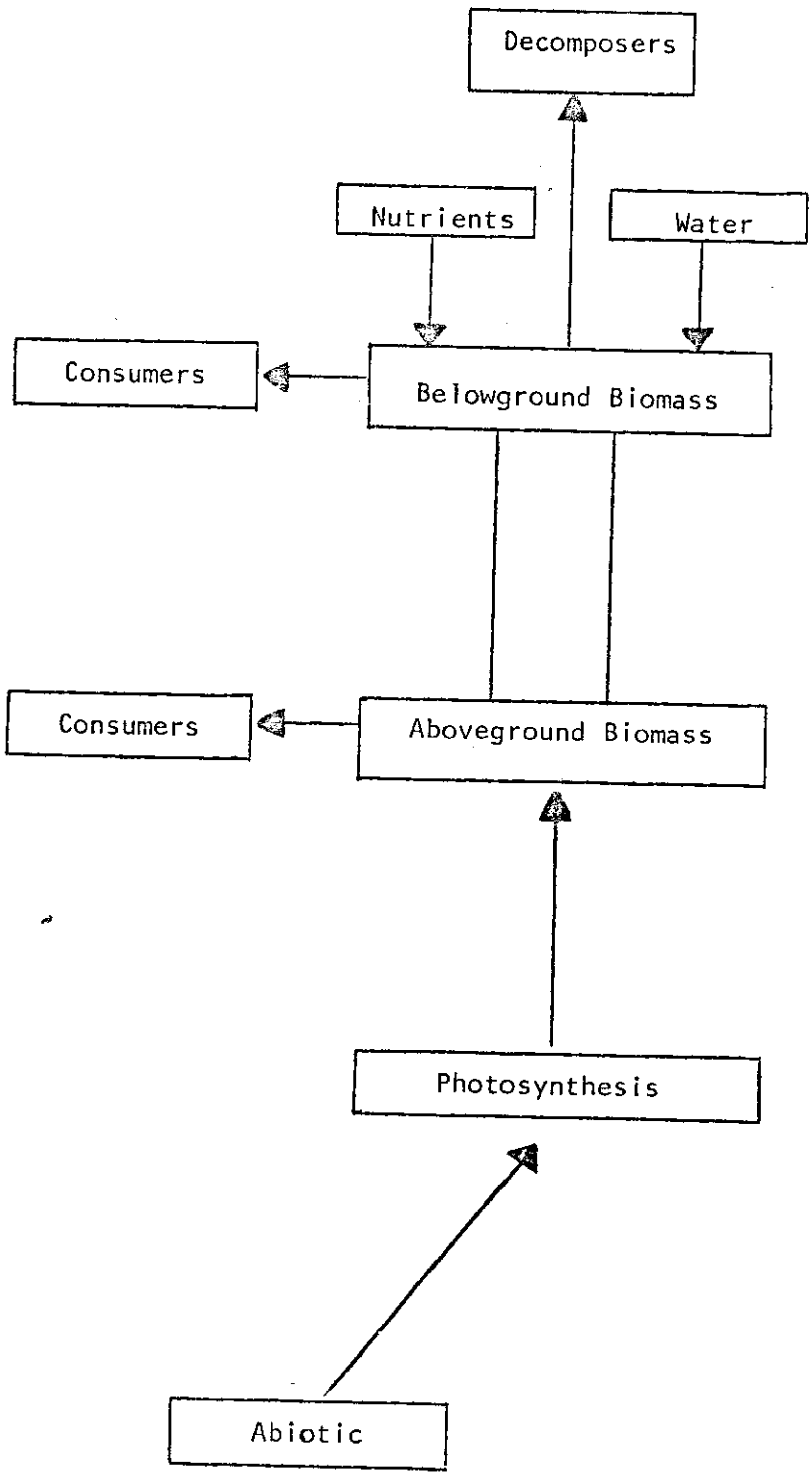
As indicated above, the format of the symposium of the second afternoon was modified. The primary producer group in particular spent a large portion of time discussing the methodology of data collection and also the dry-weight ranking program which is used on a large portion of their data. Dave Swift, the data coordinator, was brought into the meetings and resolved many of the hang-ups regarding the standardized data forms and explained



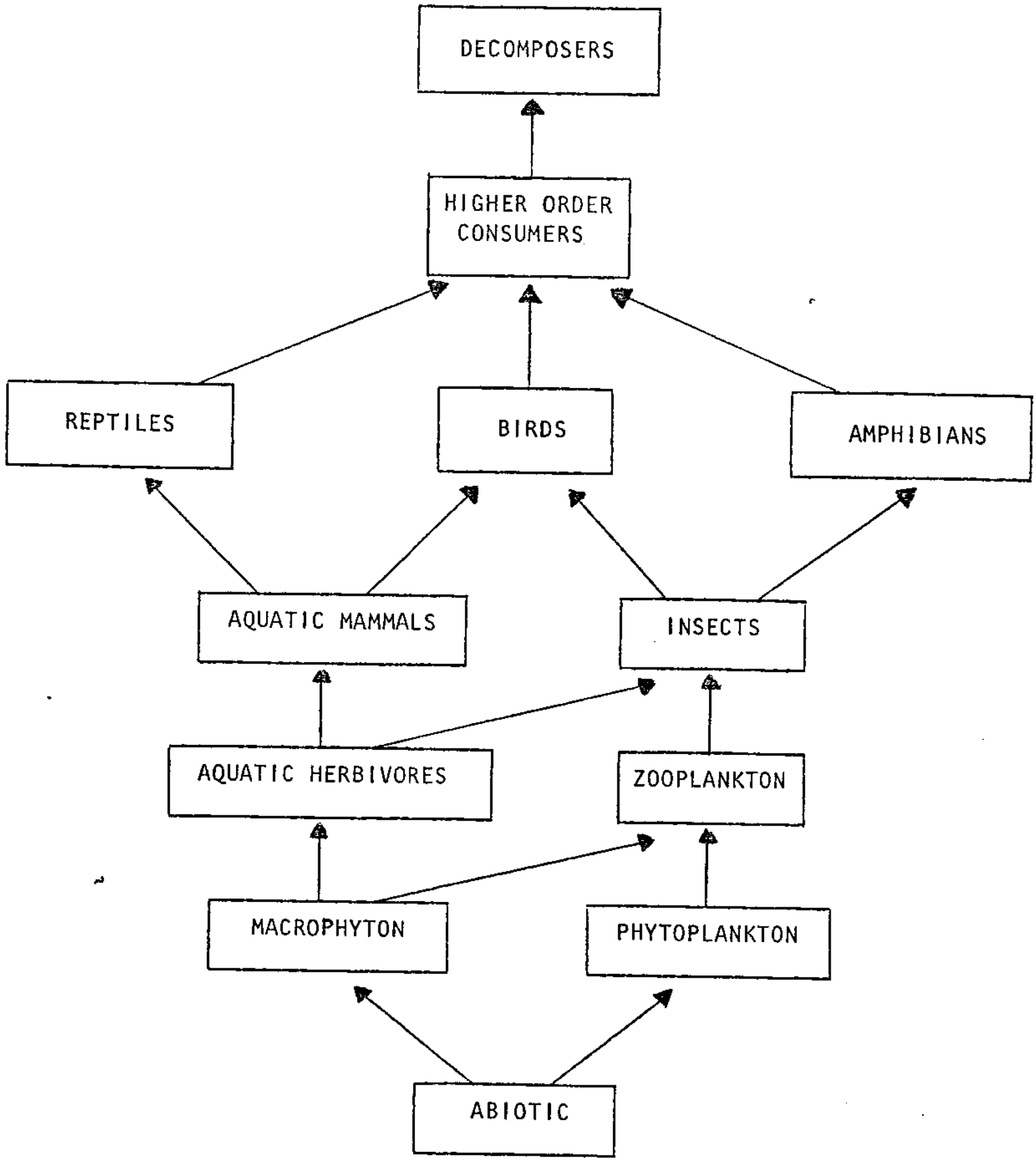
ENERGY FLOW IN THE GRASSLAND



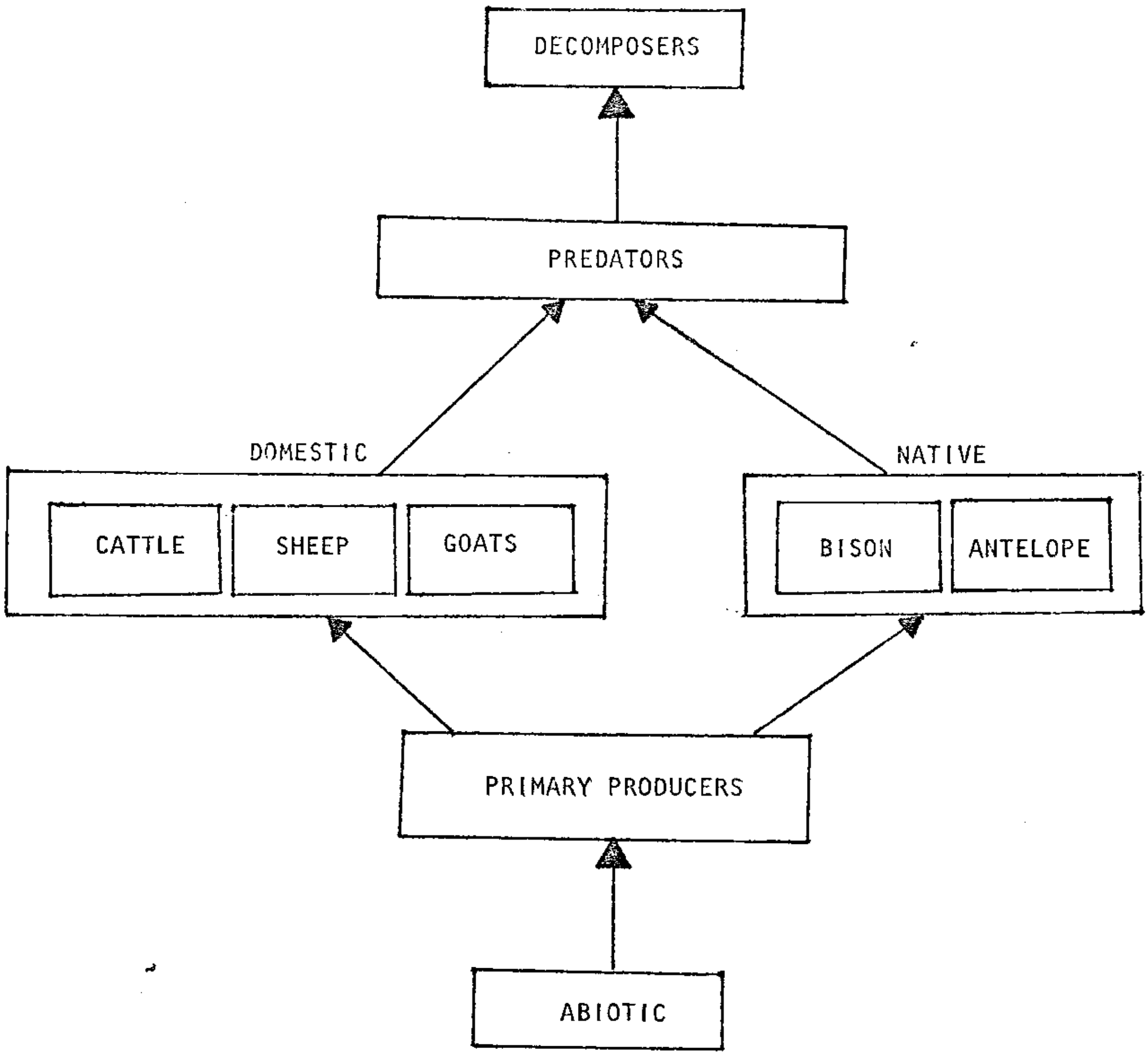
THE ABIOTIC SYSTEM



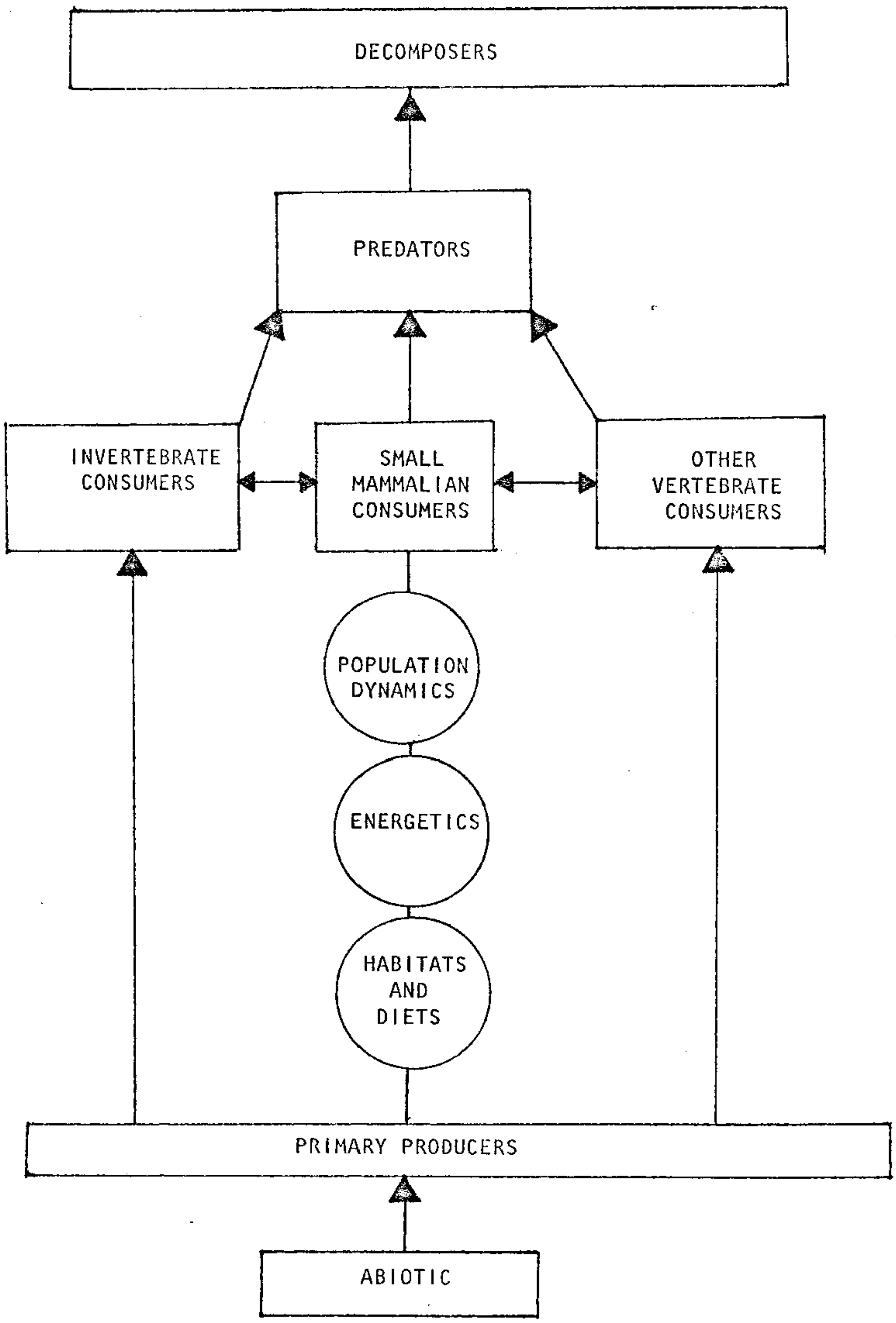
ENERGY FLOW IN THE PRIMARY PRODUCER SYSTEM



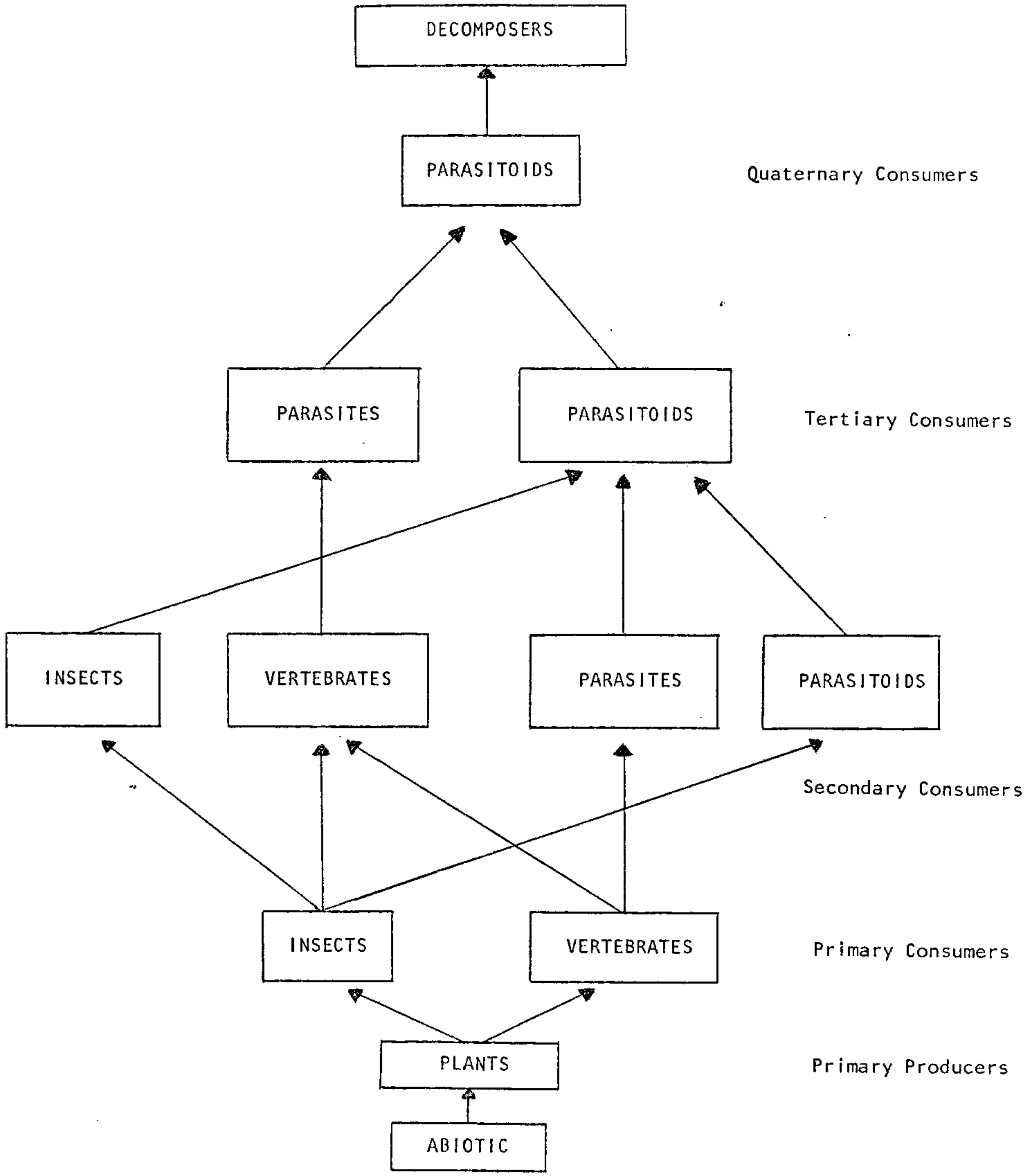
ENERGY FLOW IN THE AQUATIC SYSTEM



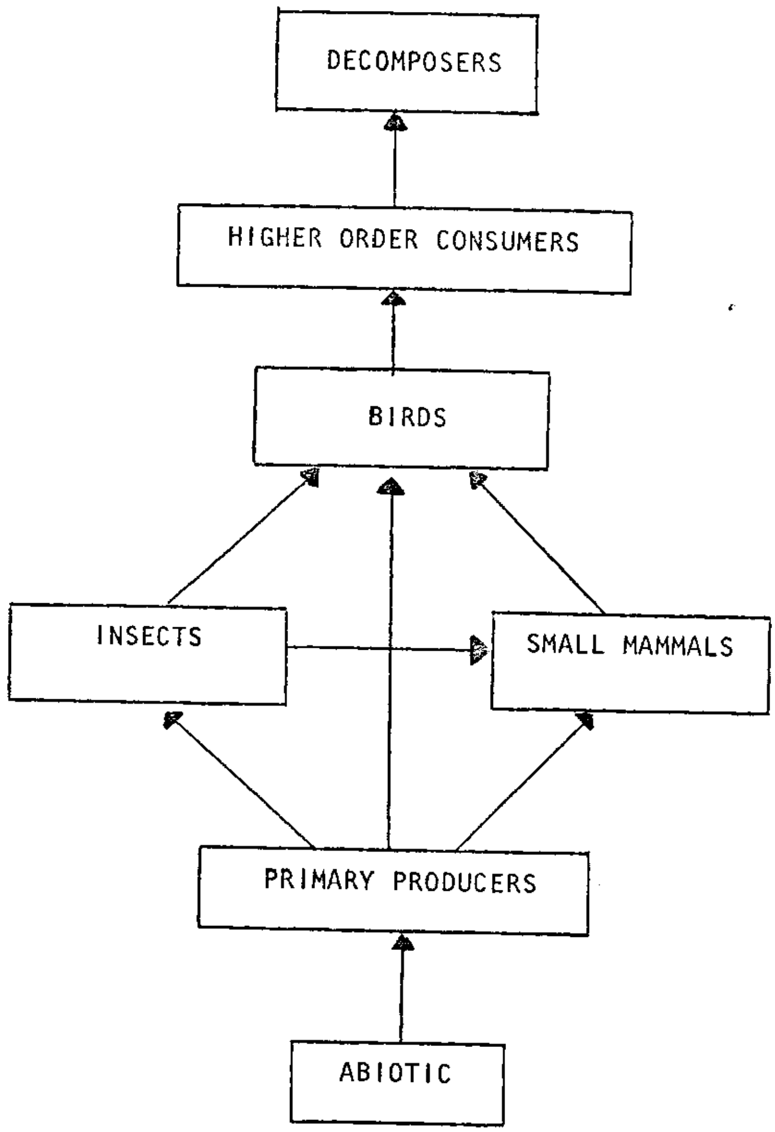
ENERGY FLOW IN THE LARGE MAMMAL SYSTEM



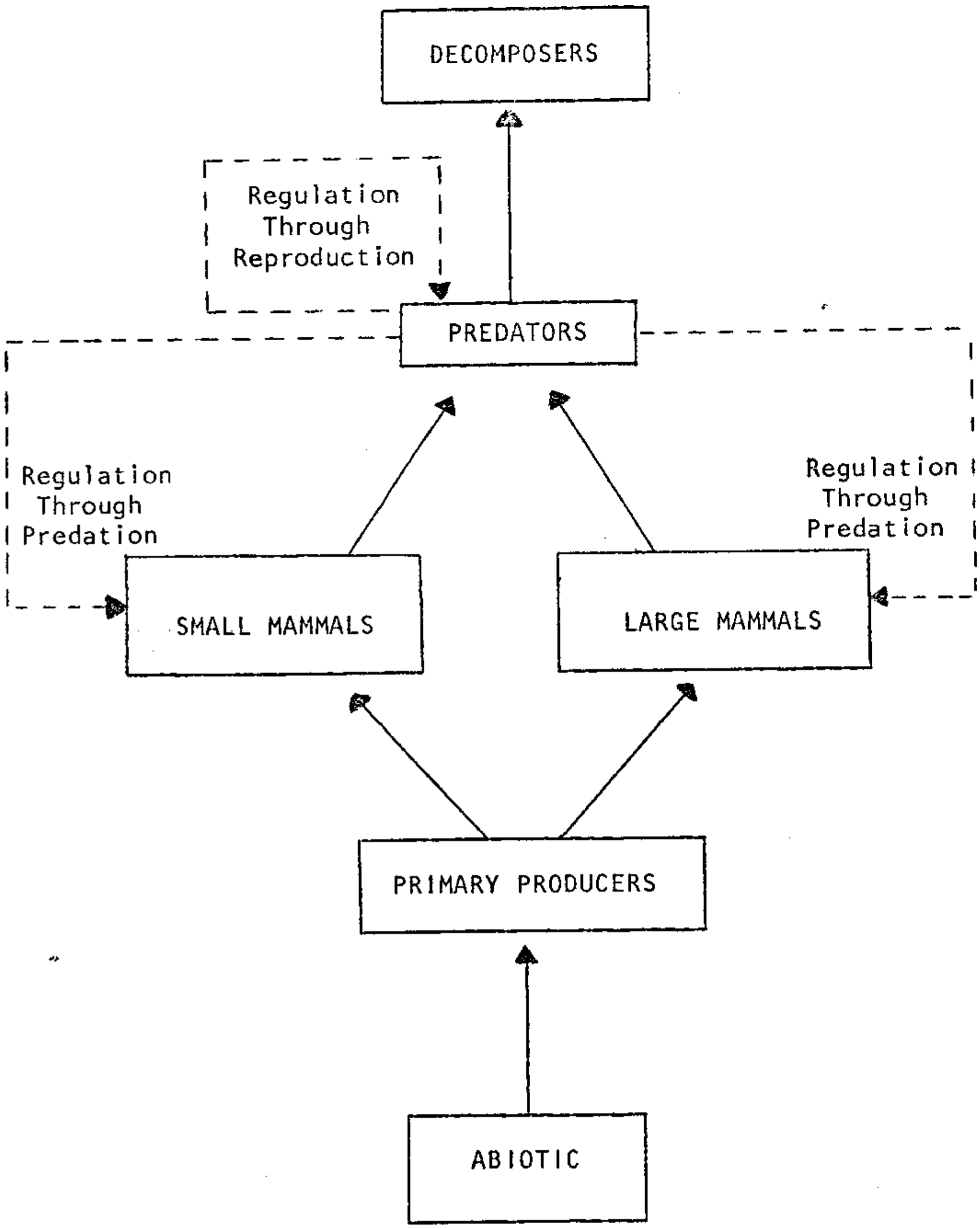
ENERGY FLOW IN THE SMALL MAMMAL SYSTEM



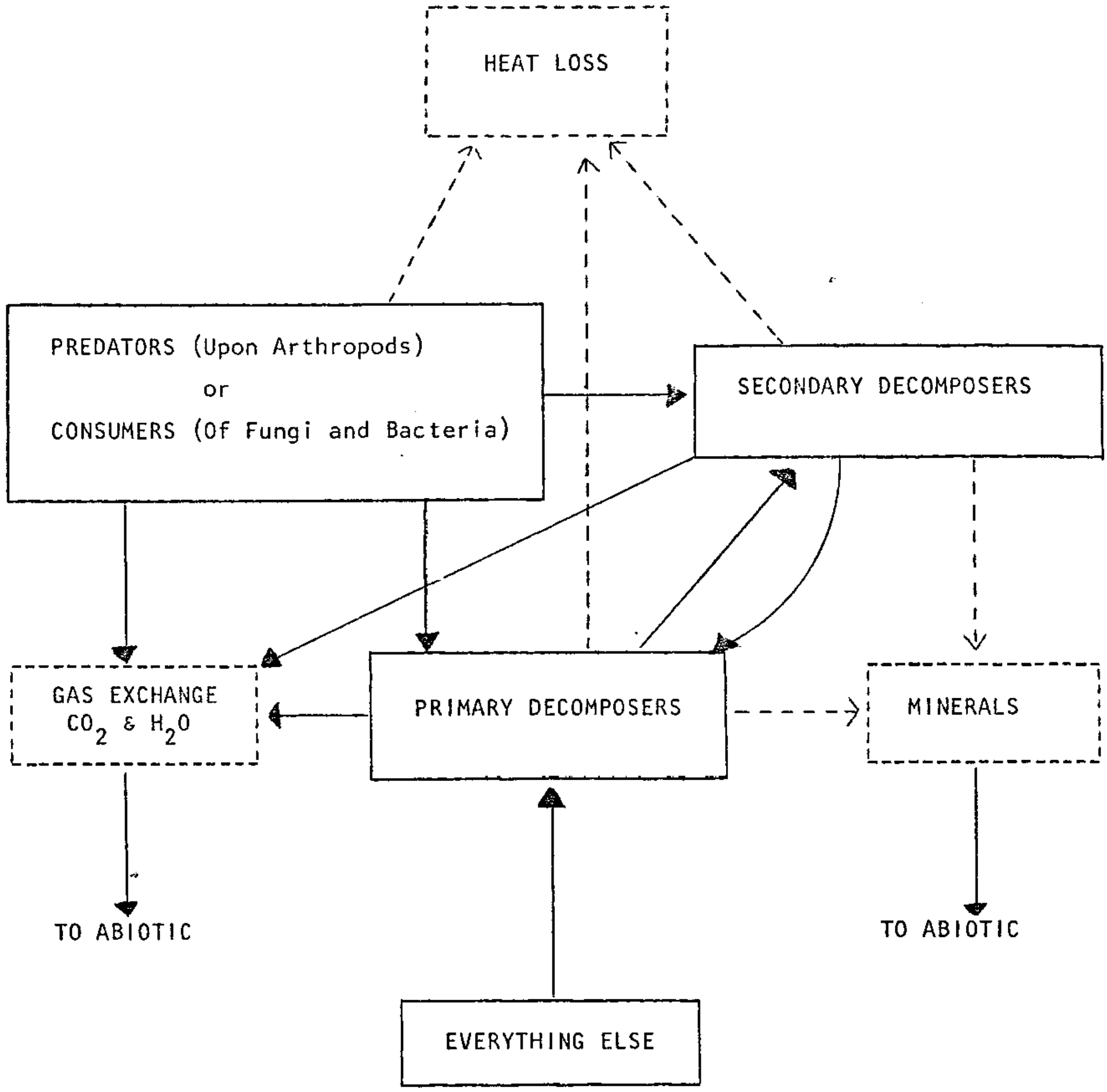
ENERGY FLOW IN THE INSECT SYSTEM



ENERGY FLOW IN THE BIRD SYSTEM



ENERGY FLOW IN THE PREDATOR SYSTEM



ENERGY FLOW IN THE DECOMPOSER SYSTEM

the theory of the dry-weight ranking program and the necessary data needed to run it.

The second change was that more participants than we initially realized were interested in the modelling segment and the role that the data they were collecting, particularly on the Comprehensive Network sites, would play in this model. Bob Francis, one of the key modellers, presented a brief outline of the ecosystem model and primarily answered questions from the group for the latter part of the second afternoon. The candor displayed by Bob Francis in answering questions honestly and admitting there were problems and that he did not know all the answers helped create an air of informality. Also, his answers clarified many of the misconceptions and misunderstandings about the ecosystem model.

As indicated previously, each of the groups meeting in separate discussions documented the hang-ups encountered. These are outlined below. Each of the participants, particularly the comprehensive site students and technicians, were asked to give a critique of their impressions of the meeting and the program in general. Following the session on the hang-ups, these critiques are summarized.

Hang-ups

Abiotic. Discussion of the abiotic components of the ecosystem was diffused throughout other groups, particularly primary production, entomology, and decomposition. The problem of main concern was the measurement of soil water. At present it is not measured at all sites. Where it is measured, the methods include:

(i) gravimetric

(ii) resistance

(iii) neutron

(iv) psychrometric

Measurement frequency is variable also. At some sites the soil water is being monitored by non-IBP groups such as experiment stations or federal agencies. Since soil water is the main driving force of the grassland, it is imperative that the measurements are standardized through common methods or cross calibration.

Primary Production (Terrestrial). Methodology was the crux of the discussions concerning primary production. Of particular concern were:

(i) a need for a phenology standard

(ii) an accepted criterion for lumping species

(iii) a uniform classification for standing dead

(iv) a standard plot size

(v) guidelines for clipping by crown or by canopy

(vi) clarification of dry-weight rank.

An apparent need to rework the procedure for dry-weight rank was obvious. Root sampling was also of some concern.

Primary Production (Aquatic). Aquatic primary production is overlooked at all sites, except at the Pawnee. Its importance is stressed by:

(i) aquatic habitats being the location of greatest production per unit area

(ii) the universal requirement of free water for all but a few species

(iii) aquatic sites being the sink for concentration of nutrients and at the same time the source of nutrients

(iv) the node of the food web through which an enormous energy flow occurs.

The dynamics of aquatic processes and the entirely stochastic nature of switching on and off present tremendous problems in techniques.

The fact that aquatic primary production is a major component of the true prairie raises the question of the likelihood of identifying the major pathways of energy and the pools of nutrients in the grassland biome.

Consumers (Vertebrate). Little discussion was directed toward domestic herbivory. This indicates a need for communication among sites. At the least, live weight gains should be made for the grazed pastures.

Small mammal studies received the most attention. And from these discussions, real progress was made in solving particular hang-ups. A list of these hang-ups follows with the possible solutions indented:

(i) Need comparable small mammal trap grids on intensive and comprehensive sites.

> Grids on the intensive site will be the same as on the comprehensive sites from now on.

(ii) Present trap methods on small mammals sample only nocturnal mammals. Trapping during the day results in death of the mammal from heat and insects (ants).

> If work load permits, have trap crews run grids during day. Sampling during daylight hours is needed in spite of destruction of the mammal.

(iii) Good census methods for gophers and lagomorphs are nonexistent.

> None given. Investigate remote sensing as a possible census method for lagomorphs.

(iv) Information is needed on differential success of live trap and snap trap methods.

> Possibly use a variety of sets at each trap site.

(v) Need a field technique for aging (juvenile-adult) live hares and rabbits.

Investigate use of cleft in upper lip.

(vi) Need standardization of methods for measuring eye lens weights to get comparable data.

Research literature showing where variation occurs. Write up standardized procedures for use at all sites.

(vii) Field men have difficulty in identifying pregnant small mammals.

None given.

(viii) Suggested change on live-trap data sheet. Need more number possibilities under sex categories.

Suggested change to be given in written critique.

(ix) Need to determine importance of carnivores. Measure numbers and energy flow.

Initiate carnivore investigation.

(x) Information regarding radio-telemetry of snakes is needed.

Work is currently being conducted at other institutions using systems which may be applicable.

(xi) Need information on the importance of mammals not currently being studied, i.e., skunk, weasel, bat, cottontail, and badger.

(xii) More coordination and cooperation is needed between botany and mammal projects for dietary studies.

Both groups should make an effort to cooperate.

Bird studies are apparently somewhat unified across all sites. Census techniques are standardized.

For both small mammals and birds more direct attention should be given to the who-eats-whom idea, particularly with respect to insects.

Consumers (Invertebrate). The main concerns of this group fell into three categories: techniques and methods, communication among sites, and the effects of insect populations.

Under techniques, problems of the Berlesé method were discussed, along with the floatation method for separating insects. The use of stains for identifying chitin were suggested.

Communication among sites could be enhanced by such things as:

(i) originating a mailing list of graduate students involved in insect studies

(ii) maintaining reference collections for each site

(iii) initiating a literature exchange

(iv) circulating a newsletter

Problems concerning the effects of insect herbivory on production are not receiving direct attention at present. Such questions as to whether or not insects retard recovery of over-grazed ranges will eventually have to be answered. Likewise, the dependencies of insect populations on precipitation and temperature are poorly understood.

Decomposers. Discussion began with informing the group of the types of studies in decomposers that are going on at the different sites. The three sites represented that have active programs in decomposers are Cottonwood, Pantex, and Pawnee. Research being conducted is as follows:

A. Cottonwood - CO_2 evolution under field conditions, cellulose and litter decomposition, nitrogen-fixing microorganisms and legumes;

B. Pantex - Microbial biomass determinations (plate count method) and litter decomposition;

C. Pawnee - (1) Soil Micro. group - microbial biomass measurements (ATP method and other parameters); decomposition of C^{14}-labeled blue grama; biomass activity studies;

(2) Micro. group - mathematical model of energy transfer in soil microbes; decomposition of cellulose; taxonomy and numbers of microorganisms in soil;

(3) Arthropods - acarine taxa, biomass, ionic composition.

The decomposer studies are plagued with problems of assessing the significance of biomass, relating biomass to activity, instrumentation, and simply operational problems. Specific problems are:

(i) techniques for measuring activity and biomass

(ii) how to assign biomass and activity to the different groups of decomposers

(iii) the field relation between critical soil water and soil temperature for decomposer activity

(iv) separation of microflora/fauna from roots.

A need for a conceptual model for decomposers was stressed. It was agreed that this would help to improve and maintain a more concerted effort in evaluating the role of the decomposers in the grassland.

A real concern expressed was the amount of time the senior scientists were contributing. It was felt that better communication among the senior scientists and among graduate students must be developed.

SUMMARY AND EVALUATION

Summary of Critiques

The following statements consist of a summarization of the most important points gleaned from the critiques requested from the participants.

Without exception, the participants pointed out that the informality of the meetings was probably the biggest factor in getting problems expressed and in finding answers to them. More than anything, this alone made the meetings a success. Some of the participants extended this factor to the point in which they stated that it was unfortunate that the senior scientists could not meet together in such a cooperative mood. They felt that the students were far more flexible and willing to compromise with each other's ideas, thereby creating a more honest and fruitful exchange. Several people felt that the interactions would help their sampling techniques and were amazed at the similarity of problems encountered at the different sites. The discussions also brought out problems or made people aware of problems that they have not yet encountered on their different sites. Several people, however, also felt that there was too much time devoted to problems of methodology and too little devoted to the concepts of the program. Other participants felt that the presence of senior scientists-subject area specialists would have been helpful in getting to the root of some of the problems encountered.

One of the most gratifying comments was that these meetings helped to develop an overall picture of the Grassland Biome Study, which one does not acquire when doing his own individual research. This certainly enables one to more easily see how each piece of individual research matches with the entire program. It was felt that more people now share a bit of the pride, challenge, and philosophy that portrays the total IBP effort. It was a concensus that more meetings of this type (preferably on an annual basis) which would go into more detail, on subject areas and on modelling, would be helpful and almost necessary to further the concepts of the program.

Analysis

In retrospect, we feel that the symposium was an overwhelming success. It was well worth the effort and money involved. It served as one of the best possible mechanisms to acquaint people with who is doing what in the program and to open new lines of communication between the individuals who are doing the field research. It allowed the airing of grievances, pin-pointed many difficulties, and acquainted people with the magnitude of the program. Finally, we feel it gave the participants a clearer understanding of the total IBP effort and possibly helped generate more program orientation or *esprit de corps* among all concerned.

We were pleased with the contributions that resulted from the small group discussions and were equally pleased with the total attendance, especially the representation from the Comprehensive Network Sites (11 out of 12 sites or potential sites were represented).

Enough of the plaudits; what were some of the discouraging aspects? We were disappointed at the total representation, or at least commitment, from certain individuals on the Intensive Site, the almost total lack of support from the University of Wyoming (the argument of classes in session notwithstanding), and of others from Colorado State University were noticeable. To put it bluntly, we feel that many of these individuals are too involved in their own little niche to broaden themselves and to contribute to the program in general.

In response to some of the participants, we would first like to thank them for their very favorable acceptance of the meeting. One often-made comment, that we would take exception to, is that participants would like to have seen some senior scientists present in the small group discussions to aid in answering certain problem questions. It is still our feeling that this type of structure and the informality we obtained are mutually incompatible. The same people who raised the questions to which answers were not apparent, may not have raised them at all in the presence of these senior people. As a final aside, it was our hope in this symposium to acquaint the participants with the systems concept of trophic level ecology and to emphasize the interrelatedness and the importance of each aspect of the research program. We do not believe that this was accomplished satisfactorily, since we did not receive very many comments one way or the other on this subject. Hopefully, however, with these beginnings, a first step has been taken.

Table 1. Schedule for symposium.

September 10	
8:30 - 9:45	Introduction--George M. Van Dyne
9:45 - 12:30	The Pathway of Energy in the Grassland
1:30 - 5:00	Tour of Pawnee Site
5:00 - 6:00	Dinner at Pawnee Site
7:30 - 10:30	Social interaction
September 11	
8:00 - 8:15	Orientation
8:15 - 11:00	Individual group discussions (Hang-ups)
11:00 - 12:00	Mass group discussions
1:00 - 4:00	Small group discussions--solutions to hang-ups
4:00 - 5:30	Modelling discussions
September 12	
(Morning)	Critique and feedback and return home

APPENDIX I

Participants in the Symposium Arranged by Interest Area

Name	Location	Specialty
	Abiotic	
Guillermo Almeyda	CSU*	Macroclimatology
Al Galbraith	CSU	Soil hydrology
Robert Oliver	CSU	Remote sensing
Denny Parker	CSU	Remote Sensing
Freeman Smith	CSU	Hydrology
Bruce Van Haveren	CSU	Hydrology
	Primary Production	
Dale Bartos	CSU	Belowground biomass
Bruce Bauerle	UNC	Aquatics
Phil Dittberner	CSU	Aboveground biomass
Jerry Dodd	SDSU	Belowground biomass
Tony Dvorak	UO	Primary production
Richard Fagen	TTU	Primary production
Jerry Grubbs	UNC	Aquatics
Forrest Johnson	UO	Primary production
Robert Kennedy	UO	Aboveground production
Knute Landreth	UNC	Primary production
Bill Lauenroth	NDSU	Primary production
Dan Pinkham	FHKSC	Primary production
Dave Putnam	CSU	Plant taxonomy
Dave Rodgers	SDSU	Aboveground biomass

APPENDIX I (Continued)

Name	Location	Specialty
	Primary Production (Continued)	
Bill Russell	NMSU	Primary production
Glenn Savelle	UC	Plant decomposition
Dave Schmer	UW	Primary production
Robert Stockhouse	CSU	Plant taxonomy
Lee Tibbs	CSU	Primary production
Larry Todd	FHKSC	Primary production
Dan Uresk	CSU	Primary production
Bill Warner	UNC	Aquatics
	Consumers	
Elmer Borney	UK	Small mammals
Alberto Cadena	UK	Small mammals
Robert Cinqmars	UK	Small mammals
Martin Connaughton	NMSU	Invertebrates
Phil Creighton	CSU	Birds
Harvey Donoho	CSU	Jackrabbits
Jerran Flinders	CSU	Jackrabbits
Walt Fournier	TTU	Insects
Hugh Genoways	UK	Small mammals
Brent Giezentanner	CSU	Birds
Russel Grow	UW	Insects
John Hedlund	Ale	Small mammals
John Hoover	CSU	Antelope

APPENDIX I (Continued)

Name	Location	Specialty
	Consumers (Continued)	
Harry Howell	TTU	Insects
Ken Matocha	TTU	Small mammals
John Mitchell	CSU	Insects
Len Paur	CSU	Large carnivores
Don Peden	CSU	Buffalo
Robert Pries	UM	Small mammals
Charles Proctor	UG	Insects
Rodman Reed	UO	Insects
Larry Richardson	TTU	Insects
Lee Rodgers	UW	Insects
Dave Schmidt	UM	Arthropods
Paula Sittner	SDSU	Insects
Harley Sweany	Ale	Small mammals
Robert Talsma	SDSU	Insects
Robert Wiley	TTU	Small mammals
Virginia Yount	CSU	Insects
	Decomposers	
Nathan Agbim	CSU	Microbiology
Elena Bautista	CSU	Microbiology
Pete Boulette	TTU	Soil microbiology
Paul Copley	CSU	Soil microbiology
Randy Griffin	CSU	Soil microbiology

APPENDIX I (Continued)

Name	Location	Specialty
	Decomposers (Continued)	
Ming-Liang Li	SDSU	Soil microbiology
Jack Nyhan	CSU	Soil microbiology
Jack Turner	SDSU	Microbiology
	Technicians	
Sherrol Arthur	MSU	Soil moisture
Van Baker	CSU	Programming
Jamie Batten	CSU	Primary production
Judi Blinderman	CSU	Service
Terry Foppe	CSU	Service
Sue Geary	MSU	Phenology
Chris Lacey	CSU	Service
John Leetham	CSU	Insects
Gertie McKinley	CSU	Service
Ken Niswinder	CSU	Service
Dave Ochoa	CSU	Service
Dave Swift	CSU	Data Analysis
Lyn Taylor	MSU	Phenology
Sarah Woodmansee	CSU	Service
Mike Yowell	CSU	Service

APPENDIX I (Continued)

Name	Location	Specialty
	Program Management	
Larry Nell	CSU	Administrative Assistant
Gerry Wright	CSU	Executive Assistant Systems Ecology
	Other Attendees	
Pete Haug	CSU	
Dennis Pendleton	CSU	
Mario Tapia	CSU	
Robert Woodmansee	CSU	

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* List of abbreviations

Ale	Comprehensive Site Location
CSU	Colorado State University
FHKSC	Fort Hays Kansas State College
MSU	Montana State University
NDSU	North Dakota State University
NMSU	New Mexico State University
SDSU	South Dakota State University
TTU	Texas Tech University
UC	University of California
UG	University of Georgia
UK	University of Kansas
UM	University of Missouri
UNC	University of Northern Colorado
UO	University of Oklahoma
UW	University of Wyoming