DEVELOPMENT AND EVALUATION OF INSTRUCTIONAL MODULES ON FIELD BIOLOGY FOR PRESERVICE SECONDARY SCIENCE TEACHERS

by

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ACKNOWLEDGMENTS

I would like to express my thanks to the following persons for their cooperation and efforts in the evaluation of the instructional modules. Those of special consideration are Dr. Harold Klaassen, Dr. Steve Fretwell, Dr. Derrick Blocker, Dr. Donald Kaufman, and Dr. Ralph Kelting for validating and correcting the content. I would also like to thank the biology teachers of the Manhattan, Junction City and Herrington public schools for taking time to help with this evaluation. Those graduate students and preservice teachers deserve my thanks for their help. Final thanks go to Dr. Robert James for suggesting I write the instructional modules being evaluated.

INTRODUCTION

This report concerns the development of instructional modules on field biology for preservice secondary science teachers. The concept of using self instructional modules to prepare teachers to do a better job using the laboratory has been discussed at length by James and Schaaf (1975), James and Stallings (1977), and James and Voltmer (1981). Their work dealt primarily with in school laboratories (Voltmer, 1980). It was recognized that science teachers should also demonstrate competencies in an outdoor laboratory. Tom Heintz, KSU graduate student in education conducted a survey of competencies that experienced outdoor biology teachers believed preservice science teachers should be able to demonstrate. Results obtained by Mr. Heintz indicated that in the area of field biology the teachers surveyed felt they needed more background in wildlife observation, identification, data collecting and recording, construction of inexpensive equipment, preservation of specimens, specimen collections, conducting field trips, and the use of field guides. A tabulation of his survey results is in appendix A. Instructional modules were written in an attempt to include a general overview of these topics while providing basic information for preservice teachers. Six modules were developed from the researchers background covering the subjects of birds, fish, herps, insects, mammals and plants. Copies of these modules are in appendix B of this report. These modules were then distributed for evaluation to identify strengths and weaknesses so that further development will make them more usable to teachers.

METHODS

The modules on field biology were developed around a format used by James for the KSU course, Laboratory Techniques for Science Teachers (415-614). The modular form involves a public statement of objectives, provision of alternative learning modes, individualization, and mechanism for feedback and revision (James and Stallings, 1977). These modules were distributed to 10 practicing teachers, 12 preservice teaching students, 4 graduate students and 5 college instructors.

Names and addresses of practicing science teachers in the Junction City, and Manhattan, Kansas area were supplied by Dr. Robert James and Dr. Terry Shaw of the Department of Curriculum and Instruction of the College of Education, Kansas State University. Each person on the list was first contacted by letter by Dr. Shaw and Dr. James indicating that I would be contacting them by phone to ask for their cooperation in examining the modules.

Due to the volume of material contained in all six modules the teachers were asked to examine only two with an option of looking at the others. Those 10 agreeing to examine the modules were mailed all six different modules indicating that the researcher would visit in person to pick them up and discuss it with them after two weeks had passed. Four graduate students suggested by Dr. James were each asked to examine all six modules and agreed to do so. They were given a set and asked to return them within 2-3 weeks time. Dr. James' laboratory techniques class, as part of their class materials for the spring of 1981, received copies of the modules on birds, plants and insects.

This group of 12 preservice teachers was asked to comment on the modules they had.

For comments on the accuracy of the contents in each module a copy was given to a specialist in that module's particular field. These specialists are college instructors with experience teaching these subjects to beginners. They were asked to write their comments directly on the module and to add other materials or additional comments on extra pages.

A two part questionnaire was prepared to measure the responses of the teachers, preservice teachers and graduate students. Questions were selected by using those competencies identified by Mr. Heintz's survey. Respondents were asked to rate them on a scale from 1 to 5 according to the degree to which they were included in the modules. Table I defines the scoring system.

TABLE I

Survey Scoring System

strongly disagree	disagree	neutral	agree	strongly agree
1	2	3	4	5

1. no information available in the module
2. some information but being insufficient and unclear
3. sufficient information but not totally clear
4. enough material present and reasonably understandable
5. desirable quantity and quality of information

An adjustment in interpreting the scores had to be made due to the way respondents marked the questions. An example is found in the module on birds. On question 15 and 16 regarding identification material, 8 of 10 people gave those two questions a score of 3. This should indicate that sufficient information was present in this module

but no information was present. The modules on herps, and insects yielded similar results. This lead the researcher to believe that the questions may have been rated to high. Thus scores between 2.5 and 3.5 indicate that more information is needed. Therefore, questions with average scors between 2.5 and 3.5 identify areas that need improvement. Those scores above 3.5 are considered adequate.

A second part of the questionnaire contained some general discussion questions that were discussed during the interview. One questionnaire was provided per module and a copy of the questionnaire is in appendix C.

RESULTS

All of the teachers and graduate students completed questionnaires on at least two modules, the preservice teachers were less cooperative. Each of the 10 teachers filled out questionnaires on at least two modules with some examining all six. The four graduate students returned their copies with completed questionnaires on all the modules. Less cooperative were the student teachers with only 3 of the 12 students completing questionnaires on the modules they had. Modules given to the respective specialist were returned with many useful comments.

To present the findings in a comprehensive manner each module will be discussed individually. Comments stated will be made without reference to the source except for the specialist's comments. All other information will be pooled and generalized.

I. Field Experiences: The Study of Birds

Persons examining this module responded favorably saying it was generally useful. The averaged scores were generally high with most responses agreeing that the objectives had been fulfilled. Still some points appeared weak as shown by the scores listed in Table II.

From these questions three weak points can be identified by being 3.0 or 3.3. Question 7 only received a score of 3.3 which could mean that the objectives and activities were not completely understood. The reason for a low score on question 14 was reflected in many of the comments from the interviews. Most of those interviewed said that the collection and preservation of birds was not an activity they would use at the secondary level.

Several commented in the interview that not enough information on identification was available which was reflected in a low score on 15.

The second part of the questionnaire with essay questions yielded some interesting results. On the first question asking if they would use this module 8 of 10 said they would use parts of it depending on what they were doing. Of the 7 experienced teachers, 5 said they could have used this module when they began teaching. The preservice teachers indicated they would use the module in the future if they were studying birds. When asked what portion would be most useful to them they indicated the portions on locating birds and places to go, the guide sheet and the five steps to guiding a bird walk. Blind construction and the preparation of study skins were suggested for elimination on the grounds of requiring too much time or special preparation. For the question on adding information to this module some suggestions were to expand on birdfeeders and nest boxes plus adding a simplified picture key of the common birds of Kansas.

Dr. Stephen Fretwell, an ornithologist at Kansas State University examined this module for accuracy of the contents. He made no corrections but indicated that it's important to consider dress when going in the field. If its cool it can get cold when standing and watching birds. He also stated that 80% of all inexpensive binoculars are out of alignment, double-image, and that if used very much they can cause headaches.

Table II

Survey Results to Module on Birds

		Average Score
1.	Module rationale or purpose was expressed clearly.	4.4
2.	Terminology is appropriate for secondary teachers.	4.5
3.	Definitions are provided where needed.	3.9
4.	Goals and objectives are appropriate for subject matter.	4.5
5.	Performance levels are clearly defined and obtainable.	3.7
6.	Conditions for performance of activities are defined.	3.9
7.	Minimum achievement levels are clearly outlined.	3.3
8.	Content is principally cognitive in nature.	3.8
9.	Sufficient information is provided to complete objectives.	4.5
10.	Sufficient information is provided to organize a field trip.	4.6
11.	Collection techniques are adequately explained.	4.1
12.	Proper use of equipment is thoroughly demonstrated.	3.6
13.	Locating or construction equipment is demonstrated completely.	3.9
14.	Use of chemicals for killing and preservation is well defined.	3.0
15.	Aids for identifying local plants and animals are sufficient.	3.0
16.	The use of identification keys or field guides is well defined.	3.8
17.	Methods of observation and recording data are outlined completely.	4.6

II. Field Experiences: The Study of Fishes

Only 7 persons examined this module with moderate results. Most scores were around 4.0 except for questions 5, 6 and 7 dealing with the instructional objectives, question 15 on identification and 17 on observation and data recording. Results to all of the questions are listed in Table III.

During the interviews no reference to the instructional objectives and activities was made by those examining this module. Most comments resolved around the content. Out of these interviews came four recommendations. First, the part on conducting a field trip should be given in step by step instructions. Two is adding the identification of freshwater habitats and the type of fish found there. Three is an explanation of fish identification in more detail with a key to the families. Four is elaboration on studies that can be done in the laboratory using an aquarium and instructions on maintaining an aquarium.

Dr. Klaassen, a fisheries biologist at Kansas State University looked over the contents of this module and had several comments. In the instructional objectives he recommends eliminating the construction of a fish trap because minnow traps can be purchased much easier and are the only traps that can be used legally without a permit. Traps with an opening larger than 1" in diameter, the opening size found in minnow traps, require a permit to operate. Also in the application activities the word seine should be included with hook or trap. For seining is the recommended method of catching fish on field trips. This allows the collectors to return game fish to the water and thus remain

within the law. He also found some erros that need correcting. Such as sunfish instead of perch, laterally flattened in place of longitudinally flattened and forage fish for feeder fish. Nest building of the Sunfish family is in May and June rather than April and May. Also in the section on fish studies the part about hybrids could be eliminated. This is a rare occurence limited mostly to strip mining pits that have filled with water. On the aquarium section Dr. Klaassen suggests that any person setting up an aquarium should refer to more detailed information on the setup and care of such. This portion needs much more detailed information. In collecting the procedures outlined are correct but this is a sensitive area. Permission from land owners is needed along with permission from the Fish and Game Commission. On the preservation of fish, Dr. Klaassen does not recommend making a cut in the side of a large fish, it tends to make messy specimens. He suggests the injection of formalin in all large specimens. Plus final storage can be in 40% isopropyl alcohol.

In the appendix and bibliography he indicated that "The Handbook of the Fishes of Kansas" by Cross (1967) is out of print.

Table III

Survey Results to Module on Fishes

		Average Score
1.	Module rationale or purposes was expressed clearly.	4.4
2.	Terminology is appropriate for secondary teachers.	4.4
3.	Definitions are provided where needed.	4.0
4.	Goals and objectives are appropriate for subject matter.	4.0
5.	Performance levels are clearly defined and obtainable.	3.1
6.	Conditions for performance of activities are well defined.	3.4
7.	Minimum achievement levels are clearly outlined.	2.9
8.	Content is principally cognitive in nature.	3.6
9.	Sufficient information is provided to complete objectives.	3.6
10.	Sufficient information is provided to organize a field trip.	4.3
11.	Collection techniques are adequately explained.	4.4
12.	Proper use of equipment is thoroughly demonstrated.	4.3
13.	Locating or constructing equipment is demonstrated completely.	4.4
14.	Use of chemicals for killing and preservation is well defined.	4.0
15.	Aids for identifying local plants and animals are sufficient.	3.3
16.	The use of identification keys or field guides is well defined.	3.9
17.	Methods of observing and recording data outlined completely.	3.1

III. Field Experiences: The Study of Herps

Eight persons examined this module giving high marks overall. Weak points are found in the objectives and activities as well as in identification as indicated by the averaged scores listed in Table IV.

From the interviews it appears the main weakness is the lack of identification material. The Kansas Extension Service publishes a condensed guide to the Herps of Kansas in a 4-H project, however, they were printing new copies when the module was written. Other comments from the interviews indicate this to be a good module due to a general lack of knowledge in this area. Most of those interviewed would use this module when studying herps. The only additions would be a key to identification and how to keep herps in the classroom. The Extension Service 4-H projects include one on aquarium pets which would be sufficient. Dr. Klaassen who teaches Herpetology at KSU looked at this module and found everything in order. His only question was on the handling of large snapping turtles. Since this technique came from Peterson's Field Guide Series, Amphibians and Reptiles of the Eastern U.S., the use of this method is left up to the individual. Some prefer the method described in the module and others prefer to use both hands on the tail to hold large snappers.

Table IV

Survey Results to Module on Herps

		Average Score
1.	Module rationale or purpose was expressed clearly.	4.2
2.	Terminology is appropriate for secondary teachers.	4.0
3.	Definitions are provided where needed.	3.9
4.	Goals and objectives are appropriate for subject matter.	4.1
5.	Performance levels are clearly defined and obtainable.	3.7
6.	Conditions for performance of activities are defined.	4.0
7.	Minimum achievement levels are clearly outlined.	3.1
8.	Content is principally cognitive in nature.	3.9
9.	Sufficient information is provided to complete objectives.	3.3
10.	Sufficient information is provided to organize a field trip.	3.8
11.	Collection techniques are adequately explained.	4.2
12.	Proper use of equipment is thoroughly demonstrated.	4.3
13.	Locating or constructing equipment is demonstrated completely.	4.2
14.	Use of chemicals for killing and preservation is well defined.	4.1
15.	Aids for identifying local plants and animals are sufficient.	3.2
16.	The use of identification keys or field guides is well defined.	2.7
17.	Methods of observing and recording data outlined completely.	3.8

IV. Field Experiences: Discovering Insects

There were eleven persons who examined this module with a wide range of opinions. From the questionnaire two areas were identified as needing more work after the scores were averaged. One is clarification of the instructional activities and the other is in identification. A complete listing of average scores is listed in Table V.

From the interviews most comments reflected an interest in places to locate insects and methods of pinning and mounting insects. The only section that appeared confusing was on the preparation of a killing jar. One part that was omitted but was asked about frequently was some information on identification. At the time this was prepared the Kansas Extension Service was out of the 4-H project on insects which contains an excellent guide to the orders of insects and is fairly brief.

The Entomology Department at KSU was very helpful in this evaluation. Dr. Blocker made several comments and so did one of his graduate students. First Carmel Sheppard, a graduate student, has taught 4 periods of seventh grade science for 10 years in the public schools and had these suggestions.

1. Identification of insects to family is very difficult, so classification should be limited to order.
2. The explanation of how to make a kill jar should be more precise.
3. Insects could be frozen rather than killed in a killing jar.
4. For most classrooms it's probably easier to purchase insect collecting equipment rather than making it.

Dr. Blocker comments are not critical of the contents in this module but he has made suggestions on things to add. In the rationale he has suggested mentioning:

1. Asthetics - many insects are beautifully colored.
2. Can destroy homes, clothing, etc. as well as food products.
3. Occupy a very important place in flood chains and in the recycling of organic material and minerals.
4. Much fewer than 1% are pests; remainder are neutral or beneficial (parasites, predators, food for wildlife, etc.).

In the instructional objectives, objective two should require some basic identification including insects other than moths and butterflies suggests Dr. Blocker. He also included a list of simple picture keys or introductory books which include:

1. Field Guide to the Insects - Borrow and White.
2. Golden Guide to the Insects - Zim et. al.
3. Golden Guide to Insect Pests - Zim et. al.
4. Golden Guide to Butterflies and Moths - Zim et. al.
5. Introduction to the Study of Insects - Barrot, Dalong, Triplehorn.

Additional information provided on preserving insects included alcohol storage. Most immature and soft bodied insects are preserved in 70% alcohol using either methanol or isopropyl (regular store-grade rubbing alcohol).

V. Field Experiences: The Study of Mammals

There were few evaluations on this module with only three filling out questionnaires. Overall this module appears to be the most complete with all scores between 4.0 and 4.6 as listed in Table VI.

Most comments were favorable with no suggestions for improvement coming out of the interviews. Dr. Kaufman who teaches mammalogy and wildlife biology at KSU had only one comment. On population studies trapping should be done for 3 or 4 days then repeated after a few days. Other than that the content is accurate.

Table V

Survey Results to Module on Insects

		Average Score
1.	Module rationale or purpose was expressed clearly.	4.1
2.	Terminology is appropriate for secondary teachers.	4.1
3.	Definitions are provided where needed.	3.8
4.	Goals and objectives are appropriate for subject matter.	4.0
5.	Performance levels are clearly defined and obtainable.	3.6
6.	Conditions for performance of activities are defined.	3.7
7.	Minimum achievement levels are clearly outlined.	3.4
8.	Content is principally cognitive in nature.	3.3
9.	Sufficient information is provided to complete objectives.	4.1
10.	Sufficient information is provided to organize field trips.	4.3
11.	Collection techniques are adequately explained.	4.3
12.	Proper use of equipment is thoroughly demonstrated.	3.9
13.	Locating or constructing equipment is demonstrated completely.	3.9
14.	Use of chemicals for killing and preservation is well defined.	3.5
15.	Aids for identifying local plants and animals are sufficient.	2.6
16.	The use of identification keys or field guides is well defined.	3.0
17.	Methods of observing and recording data are outlined completely.	3.4

Table VI

Survey Results to Module on Mammals

		Average Score
1.	Module rationale or purpose was expressed clearly	4.6
2.	Terminology is appropriate for secondary teachers.	4.3
3.	Definitions are provided where needed.	3.6
4.	Goals and objectives are appropriate for subject matter.	4.3
5.	Performance levels are clearly defined and obtainable.	4.6
6.	Conditions for performance of activities are defined.	4.3
7.	Minimum achievement levels are clearly defined.	4.2
8.	Content is principally cognitive in nature.	4.6
9.	Sufficient information is provided to complete objectives.	4.3
10.	Sufficient information is provided to organize field trips.	4.3
11.	Collection techniques are adequately explained.	4.6
12.	Proper use of equipment is thoroughly demonstrated.	4.6
13.	Locating or constructing equipment is demonstrated completely.	4.3
14.	Use of chemicals for killing and preservation is well defined.	4.3
15.	Aids for identifying local plants and animals are sufficient.	4.3
16.	The use of identification keys or field guides is well defined.	4.0
17.	Methods of observing and recording data outlined completely.	4.0

VI. Field Experiences: The Study of Plants

Eight persons evaluated this module and scores were generally low. Averages ranged from 3.2 to 4.3 indicating that there was plenty of information but using it was not clear. All the scores are listed in Table VII.

Comments on the module made in the interview suggests more clarification of identification is needed. Most favored the techniques for collecting and preserving plants for a collection in their present condition. Of major concern was the section on plant structure, definitions and the use of a key. Everyone identified many points they found confused or hard to use in the present form. Only a couple of suggestions were made on improving this module and they were to:

1. Place the definitions in a glossary at the back of the module for reference.
2. In explaining a key provide a key to plant families and discuss its use.
3. Provide illustrations on basic structure of flower parts, leaves, fruits, and arrangements of the common types with names and definitions on the same page.

Dr. Ralph Kelting, a plant taxonomist at Pittsburg State University in Pittsburg, Kansas made the same comments on his examination The information is correct according to Dr. Kelting but considered it unweildly and made the same suggestions as the practicing teachers and preservice teachers. These people generally suggest scrapping the sections on identification and the use of keys and developing new or rearranging the old in a more usable and understandable form.

Table VII

Survey Results to Module on Plants

		Average Score
1.	Module rationale or purpose was expressed clearly.	4.0
2.	Terminology is appropriate for secondary teachers.	3.7
3.	Definitions are provided where needed.	4.3
4.	Goals and objectives are appropriate for subject matter.	3.6
5.	Performance levels are clearly defined and obtainable.	3.7
6.	Conditions for performance of activities are defined.	3.4
7.	Minimum achievement levels are clearly outlined.	3.7
8.	Content is principally cognitive in nature.	3.8
9.	Sufficient information is provided to complete objectives.	3.8
10.	Sufficient information is provided to organize field trips.	3.8
11.	Collection techniques are adequately explained.	4.0
12.	Proper use of equipment is thoroughly demonstrated.	3.6
13.	Locating or constructing equipment is demonstrated completely.	3.5
14.	Use of chemicals for killing and preservation is well defined.	3.2
15.	Aids for identifying local plants and animals were sufficient.	3.6
16.	The use of identification keys or field guides is well defined.	3.8
17.	Methods of observing and recording data outlined completely.	4.0

CONCLUSIONS

Most of the people examining these modules were glad to see that this type of material was being developed because it contains the various aspects of field biology in one source. One flaw in these modules is that the instructional objectives were either not fully understood or believed inappropriate for the group using them as indicated in the interviews and the low scores on questions 5, 6 and 7. However, the general content was valuable in an of itself so even without the learning activities these materials would be used for reference. In fact many asked how they could obtain a copy of the modules. Still the largest deficit is in providing identification material which is difficult to condense for this purpose. But the overall reaction to these modules was favorable so they are indeed a worthwhile concept.

RECOMMENDATIONS

Further development of these modules should be done because it is not evident that other material combines the different aspects of field biology in a comprehensive source. The original format and information content has been retained but altered enough to include the suggestions found by this evaluation. One major concern when using these modules is to pick the activities and objectives from the module content that best fit the group using them. Simple keys or guides have been added to those modules lacking them except the one on plants. A qualified plant taxonomist may be required to produce one. Those available are to

voluminous to include in a module. Where possible, with the information available, corrections have been made in the instructional modules and are found in appendix B.

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APPENDICES

Appendix A

Tom Heintz

Tabulation of Survey Results

Tom Heintz

Tabulation of Survey Responses

		*Importance				
		5	4	3	2	1
1.	Wildlife observation	19	6	3	1	0
2.	Identification of specimens in the field (keying)	14	6	9	0	0
3.	Methods of preserving plant and animal specimens	10	9	9	1	0
4.	Building cages and traps for animal capture	6	9	7	5	2
5.	Techniques for construction of equipment for field use	14	5	5	5	0
6.	Familiarity with identification manuals for animals plants	18	7	3	1	0
7.	Methods of recording data in the field	17	8	3	2	0
8.	Qualitative data collection (sketching, verbal description)	13	8	5	3	0

* Importance - Each of 30 high school biology instructors were asked to rate each item on a scale of 1 to 5. It is a progressive scale with one indicating the item as not improtant and five indicating the item as very important. There were more items in the survey but only these eight related to field trips.

Appendix B

Instructional Modules

FIELD EXPERIENCES

THE STUDY

OF

BIRDS

RATIONALE:

Birds are one of the most watched and studied animals in the world and are found in virtually every part of the world except extreme regions of the arctic. Aside from being widely distributed they are also very visible which makes them easy to observe and study. As a result of their visibility birds are good subjects for field trips when introducing the outdoors to children, for studies in science field trips are an integral part of investigating the natural world. By intelligent use of field trips students can discover on their own many important scientific principles in evolution, ecology, geography, geology, physics, chemistry and others. By their easy accessability birds can be used to foster and encourage an interest in the natural world.

INSTRUCTIONAL OBJECTIVES:

On completion of this module the student should be able to:

1. Outline the procedures for recording information in the field.
2. Prepare bird skins for a permanent collection.
3. List the steps necessary to conduct a field trip.
4. Select a birdwatching site.

LEARNING ACTIVITIES:

Introductory Activities

1. Read the information in this module.

Application Activities

1. Use the worksheet provided and prepare a field trip.

Alternative Activities

1. Read The Habitat Guide to Birding by Thomas P. McElroy, Jr.
2. Read Watching Birds by Roger F. Pasquier.

BIRDWATCHING

Introduction

"Birds are an integral part of the American landscape and their numbers and kinds vary as the landscape varies. Our lofty mountains with their adjacent rolling hills, our wide valleys with their meandering rivers, grasslands and fields of grain, our sculptured coastlines and sandy beaches--it is to these panoramic wonders that birds add color, song, movement and above all else, life itself."

Thomas P. McElroy, Jr.
The Habitat Guide to Birding

To fully understand the meaning of McElroy's comment a person has to experience and examine birds in the wild. On the surface birdwatching appears very simple and that all you need is a pair of binoculars, a bird book and hiking shoes to study birds. But to really study birds and discover the full extent of influence they have on our lives takes an understanding of birds and the techniques to prepare and conduct field trips. The purpose of this module is to provide enough information to enable a novice to begin a comprehensive and scientific approach to the study of birds.

Planning a Field Trip

The key to success is careful planning. There are many things to consider when organizing a field trip. Some are school policy, permission from supervisors, teacher liability, acquiring transportation, class time trips or extended trips, safety precautions and cost. These have little to do with birds but are an important part of any field trip. When it is time to plan a trip to study birds there are several questions that need to be answered.

1. What are the objectives of this trip?
2. How much time is available or needed?
3. Will transportation be necessary?
4. Where should this trip be taken?
5. When is the best time to go?
6. What kind of equipment will be necessary?

The answers to these questions will determine the type of field trip and establish an outline for the purposes of the trip. From this you will be able to evaluate the benefits the students will receive from this type of experience.

Birdwatching Field Trips

Though bird watching seems no more complicated than taking a walk in the woods, there are several things to consider when taking a group on birdwatching trips. This section will concentrate on the variables involved and outline methods for watching birds as an instructional tool.

Choosing a Location

When choosing a location, time will frequently be the limiting factor in deciding how far to go and the type of area to choose. If the time is limited it's best to pick areas that are close and don't require transportation. Since most schools are located in an urban setting, let's consider the possibilities. School grounds can provide a good site if a variety of mature trees are available and a few representative birds use them. City parks also lend themselves to birdwalks if plenty of trees and shrubs have been included in the design. Cemetaries are good places to watch birds because most, especially those in dense urban areas, are well managed and a large variety of trees, shrubs and flowers are kept providing the ingredients for a large variety of small birds. Another potential site is a vacant lot that has been allowed to become overgrown with trees and bushes. One last possibility is to take walks in a neighborhood. However, they are not as productive and may create public relation problems, since the habitat for birds is better in backyards--fewer birds are seen along the streets. However, alleys sometimes give access to many good birdwatching places.

If time and resources are available for extended trips, visits to natural areas are extremely worthwhile since the opportunity for greater variety and more complete investigation of field biology can be attained. Whether it's a desert, mountain, forest or prairie setting, there are some basic things to look for. Accessability is probably the most important of these because if a place does not lend itself to easy access, the trip becomes more of an endurance test than a birdwatching trip. When looking at access, consider features such as roads, paths, trails, obstacles and seasonal limitations. Here are a few examples of generalized areas and what to look for. Shallow lakes and ponds with gentle sloping banks and plenty of aquatic plants growing along the edge or out into the water. Forests or wooded areas with established trails or paths. Also wooded areas with little underbrush and moderately spaced trees work if paths or trails are not already made. Open areas, either desert or prairie, generally have few problems in regard to access if roadways leading to them are in good condition.

If public access areas are not available and transportation can be obtained, simply driving back roads can be a good birdwatching experience. Most birds are accustomed to cars and do not consider them a threat. The car then, in essence, is a portable blind and by driving slowly and remaining inside the car, you can spot many varieties of birds along the road. Care must be taken when stopping not to block traffic and to stop well off the road.

When to go

Actually, anytime is a good time to go birdwatching because no matter where you are or the weather, there are birds to be watched. But there are times that are better than others. The best time of year for birdwatching is during spring and early summer when the birds are in their

breeding plummage. It's far easier to identify a bird in its breeding colors than in its drab winter coat. There is an exception to this rule, however. Waterfowl are generally in breeding plummage all year except for a few weeks in late summer. Time of day is not extremely important when considering when to go. Birds tend to be active during most of the day with a slight increase at sunrise and sunset. The time of day has more bearing on where they will be found than if they will be seen. At sunrise and before sunset most birds will be headed out to food and water. Smaller birds are more active all day and alternate short periods of rest and feeding.

What to take

What to take will depend on what you want to do and the availability of equipment. In some cases it wouldn't be necessary to take anything. You can just go and count the different birds seen and make general observations. But on an ideal field trip, everyone should have a pair of binoculars, a field guide and a note pad with pen. Also be aware of the weather and dress accordingly. If it's cool, a person can sometimes get cold standing and watching birds.

Selection and use of equipment

In general the amount of equipment needed by an amateur birdwatcher is minimal and inexpensive and once the basic equipment is obtained, a person is set for a lifetime of birding. The most expensive piece of equipment is a pair of binoculars. Models cover a wide price range but no matter the cost, select a pair that suits you. A primary consideration when buying binoculars is clarity of image. A simple test is to pick them up as you normally would, then hold them at arms length directed at a bright light and look at the pattern of light on the eyepiece. If it's circular, those binoculars are all right, but if it's elliptical, they are of poor quality. A final check is to select several pair in your price range and look at a distant object. The pair with the clearest image is the pair to buy. On the average, 8 of 10 cheap binoculars are out of alignment, double image, and can cause headaches with use. Normally the magnification for most birdwatching is 7X with a 35mm lens.

When selecting a bird book, look for a general purpose guide that is illustrated and provides a brief description of each bird. Three of the best field guides on birds are listed here.

A Field Guide to the Birds
Eastern land and water birds
by Roger Tory Peterson
Houghton Mifflin Company $5.95

The Audubon Society Field Guide to North American Birds
Eastern region, by Bull and Farrand
Canticleer Press
Alfred A. Knopf, Inc. New York, N.Y. $9.95

Birds of North America
by Robbins, Bruun, Zim, Singer
Golden Press - New York
Western Publishing Co., Inc.
Racine, Wisconsin $7.95

There are other guides, but no matter which one it is, select one with good illustrations or photos, descriptive information, geographic range and is for your area.

When using a guide, no previous knowledge of birds is necessary since most keys have color pictures. One only needs to leaf through the key and match the bird in the bush with the bird in the book. However, it's much easier to locate the identity of a bird if one is familiar with the major families. Keys usually group birds by family and members of a family are generally similar. Therefore, if a person can identify a specific bird and become familiar with its family characteristics, then when you see another bird exhibiting those features, you can assume it at least belongs to the same family. It's a bit tricky at first, but with practice, it becomes much easier.

On most birdwatching trips the only information to be recorded is the different birds sighted. In that case information can be recorded on a notepad or the birds checked on a list provided by the Kansas Ornithological Society. A copy of a checklist is in the appendix. When recording more detailed information, there is a standard procedure established by the American Ornithologist Union and is recorded in a formal log. Some birders make entries in the field and others take notes making entries later. A log is composed of two parts, one part titled Trip Log should contain a brief description of the field trip, including the date, who went, where the trip took place, a description of the weather and the names of birds sighted (usually common names). A second part is for recording information about the birds seen. As birds are identified at the top of a page, place the scientific name with the common name underneath. Then just below, enter the date and follow that with information concerning the number seen, unusual behavior, habitat, food or anything that seems important. On subsequent trips just enter the date that bird is seen and pertinent data.

Guiding the Field Trip

When it comes time to lead a field trip, don't worry about being an expert. Field trips make each member an instructor to the group, for each member has the responsibility of observing and making conclusions on his own. It's helpful if the leader or one member is more knowledgeable, but not necessary. A leader's main purpose is to organize the group and lead them to their own discoveries. To do this there are 5 steps to follow on the way to being a good leader.

1. Survey the area - investigate the area a few days in advance to get the feel of it. When reviewing an area, locate places that provide the most interest and have the greatest variety of birds so you can plan the

most interesting route. By surveying the area in advance, you will have some idea of the birds in the area. But don't limit the survey to birds--consider nesting and feeding sites, plants and other animals, even the geography. All these things will enhance a bird walk by developing ecological concepts. Once the area has been surveyed and you are thinking about the trip, there may be some things to research that will increase the value of the experience. In most cases a little time in the library will be sufficient.

2. Set the stage - just before beginning, organize the group and provide a little background information about the area and some idea of what they will see. Hopefully, this will develop some excitement or interest within the group and start them thinking about the trip. Also explain the objectives of the trip and specify any assignments the members are to complete. Ask questions about birds and the area for students to think about on the trip. Encourage students to ask questions about what they see on birds and other subjects. Always encourage questions because someone in the group has information they can share. No matter the age, if any one of them is interested in hunting, fishing, or camping, they have learned something that will benefit the walk.

3. Be alert - once the walk has started, next to keeping the pace slow and quiet, keep alert. Pay attention to what's going on around you. That doesn't mean watching the group, but watch for the many things going on in nature. Primarily watch for birds, but be sensitive to the effects plants, insects and mammals have on birds and vice versa. Look for tracks, droppings or other signs that shows an animal had been that way. Pay particular attention to the interactions between animals and their environment. Determine whether the terrain, climate, or vegetation affect the type of animal life you discover. This activity will add a comprehensive aspect to nature by bringing all the different observations together into ecological concepts.

4. Take notes - prepare a checklist as you go. The leader of any field trip has the responsibility of keeping track of what is seen. Other members will compare their list with yours, the official list. Write short notes about anything interesting that you encounter. By keeping an accurate record you will be more knowledgeable the next time you lead a group through that area. Plus you can compare changes that have occurred.

5. Summarize - at the end of any trip, call everyone together and discuss what occurred and what was seen on the trip. This is where your notes will come in handy. Compare notes with the group. Have the group share notes with each other and generally discuss the trip. Through summarizing and discussion, you can highlight important points and at the same time evaluate the trip by the group's response. If this has been a school field trip and you will be seeing the group later that day or even the next day, continue the discussion then.

Bird Study

Making behavioral observations:

One of the simplest methods of studying birds is by simply making and recording observations. For the person doing the study proper preparation is necessary. In general, observations should be made by one person, but two or three is possible. To record natural behavior it's essential that a person's presence does not interfere with the bird's normal routine. Construction of a blind is usually necessary for most behavioral studies. However, studies can be made without a blind. If the bird to be studied is located around someone's home or in a city or town, it is possible just to find a comfortable spot and sit down. Birds in some locations are accustomed to the presence of man and once you have settled in and manage to minimize your movements, most birds will return to their natural routine. If the birds to be studied are of a wilder kind, it becomes necessary to construct a blind. Building a blind is really a very simple matter for many blinds occur naturally in nature. Hiding behind thick bushes or behind logs or in some kind of depression works well. When natural blinds are not available, use vegetation from the study area to construct a blind. Cut a sufficient amount to hide yourself and build up some type of wall. One thing to remember is not to use material from around the blind site. Carry in the materials. If materials from around the blind are used, it becomes a sore thumb standing in the open. The key is to have a blind that blends into the bird's natural habitat.

Selection of a location for your blind depends a lot on the type of behavior you're concentrating on. Many birds cover a large range during their everyday activity, so it might be necessary to have more than one blind. Researching the bird in question is a good way of deciding where to place the blind. Some characteristic sites are on feeding areas, nesting sites and mating grounds. It will largely depend on the species as to which site to use. Waterfowl for instance will require blinds to be built on or near some type of water body. A simple study area with blind is to start a feeding station either on a window sill or in a back yard. In this case you can select the food and feeder that will attract the birds to be studied, so that all you have to do is look out the window.

Recording data is basically describing the behavior in written form. Maps of nesting sites, breeding areas or feeding areas should be made. Weather conditions, location dates and habitat are also important. There is no formal method of recording, but information should be clear enough to prepare a formal paper.

Collecting Specimens for Study

For amateur collectors there are a number of restrictions and rules to follow. If an instructor wishes to make a serious collection of bird species or conduct a study that requires the killing of any non or game birds, he must submit a formal application to the Federal Fish and Game Department plus to the state Fish and Game Division involved. Once the application has been accepted, you will be issued a permit with instruc-

tions as to acceptable collecting methods. It's not necessary to go to that much trouble to make a collection of bird skins. Many collections have been made from road kills and other accidentally killed birds. But, before collecting any specimens, it's best to notify the local police, wildlife officials, and conservation departments to be certain there will be no legal complications because it is illegal to have in your possession a dead or injured bird without permission. A salvage permit can be obtained from the state fish and game commission. To collect birds for inspection and permanent collections, there are some tips to follow to find a reliable source of accidentally killed birds. As difficult as it seems to find dead birds, there are some places to look that make it much easier. By looking along the edges of most roads a person can find many road kills, though some are in poor condition. Two good places to find dead birds that are ideal for collections are under TV and radio towers. This is because many birds migrate at night and the guy wires used to stabilize the large towers are not detected by birds. Many of the smaller birds hit the wires in the dark and either die outright or break a wing. So if a person can manage to get out to look under these towers early enough in the morning before predators get these birds, many different species can be found on the ground. Another place to check is around buildings with large windows. Occasionally a bird will fly into a window killing itself. Especially those birds that prey on insects will, while in pursuit of insects, fly into a window because they can't tell whether it's open or closed.

Once the bird has been collected, a note should be attached with the location (city and state), scientific name, date and the collectors name. If the skin is not to be prepared immediately, it can be frozen for preparation later.

The Permanent Collection

Preparation of Study Skins

The procedure described here is for use on small birds only, such as starlings, sparrows, robins, etc. These directions for preparing bird skins weretaken from Wallace and Mahon "An Introduction to Ornithology".

1. Relax the bird, flexing the legs, wings and head. Sponge off any dirt or blood stains on the feathers and dry with cornmeal. Use cornmeal (or other absorbent) liberally through the whole skinning process.
2. Part the abdominal feathers and make an incision through the skin, being careful not to cut through the body wall to the viscera. Extend the cut from the posterior end of the sternum into the anus or around one side of it (Fig. II.3 a).
3. Loosen the skin from the abdominal wall with fingers or scalpel until the knee joint is exposed. Cut the leg at this joint, cleaning the flesh from the tibia. Rub borax over the tibia, especially at the tarsal end, wrap it tightly with cotton until it simulates the size of the original limb. Push back into natural position. Repeat with the other leg.
4. Make an incision across the base of the tail, being careful not to cut too close to the base of the tail feathers which might then be lost.

5. Invert the skin carefully, using fingers and scalpel, over the back and breast until it reaches the wings (Fig. II.3b).
6. Sever each wing at the shoulder joint (proximal end of humerus) and continue pushing the skin up over the head (Fig. II.3c). In most birds the skin will slip over the head easily, but in some largeheaded birds (woodpeckers and ducks) it may be necessary to make a slit through the skin along the nape (or throat, if preferred) to free the head.
7. Pull the skin of the ear out of its socket with finger and thumb. Slip the skin over the eyes and remove them (Fig. II.3c).
8. Make an incision across the palate between the mandibles; extend the cut along the inner margin of each mandible and across the base of the skull. Then the body and most of the contents of the skull (brain) can be removed from the skin (Fig. II.4a).
9. Clean out any remaining portions of the brain and flesh from the skull, sprinkle the interior of the skull liberally with borax, and turn the skin back carefully over the skull.
10. Clean the wing bones (humeri) of flesh and remove as much as possible of the flesh from the radius and ulna, without loosening the secondaries from the ulna. In large birds it is better to remove flesh and tendons from the forearm by making an incision along the underside of the wing, cleaning the bones, then sewing the slit together with a few stitches.
11. The wings can be made to lie in a natural position in the final bird skin by (1) tying the two radii together in a parallel position about one-half inch apart (in medium-sized birds), (2) tying the humeri in a similar manner, or (3) bringing the skin between the wings closer together (taking up the slack) by a stitch in the skin.
12. Remove the oil gland, or at least its contents, from the base of the tail. Remove any fat, flesh, or blood stains still adhering to the skin or feathers. Skins with excess fat (e.g. ducks) may have to be degreased by immersing them in benzene or carbon tetrachloride for several hours or more, then drying them with cornmeal and/or compressed air.
13. Put a small tight wad of cotton in each eye, inserting it up through the neck with forceps.
14. Prepare a pointed stick (medical applicators are ideal for small birds) and wrap it tightly with cotton to form a body roughly comparable to the size of the body removed (use excelsior or other material for large birds).
15. Insert the body into the skin, with the point of the stick pushed into the skull, or protruding into the mouth cavity.
16. Arrange the skin carefully around the cotton body and sew up the abdominal incision (Fig. II.4b).
17. Tie the crossed legs together and tie on a correctly prepared label with locality, date, sex, weight, collector, and any other pertinent data on the tag. Be sure to sex the specimen by internal examination of the gonads, recording the data (a sketch to size is useful on the label) (Fig. II.4c).
18. Wrap the completed specimen in strips of cotton, or pin it out on a pinning board, and allow it to dry for several days before putting it in storage.

Rrprinted from Wallace and Mahon "An Introduction to Ornithology"

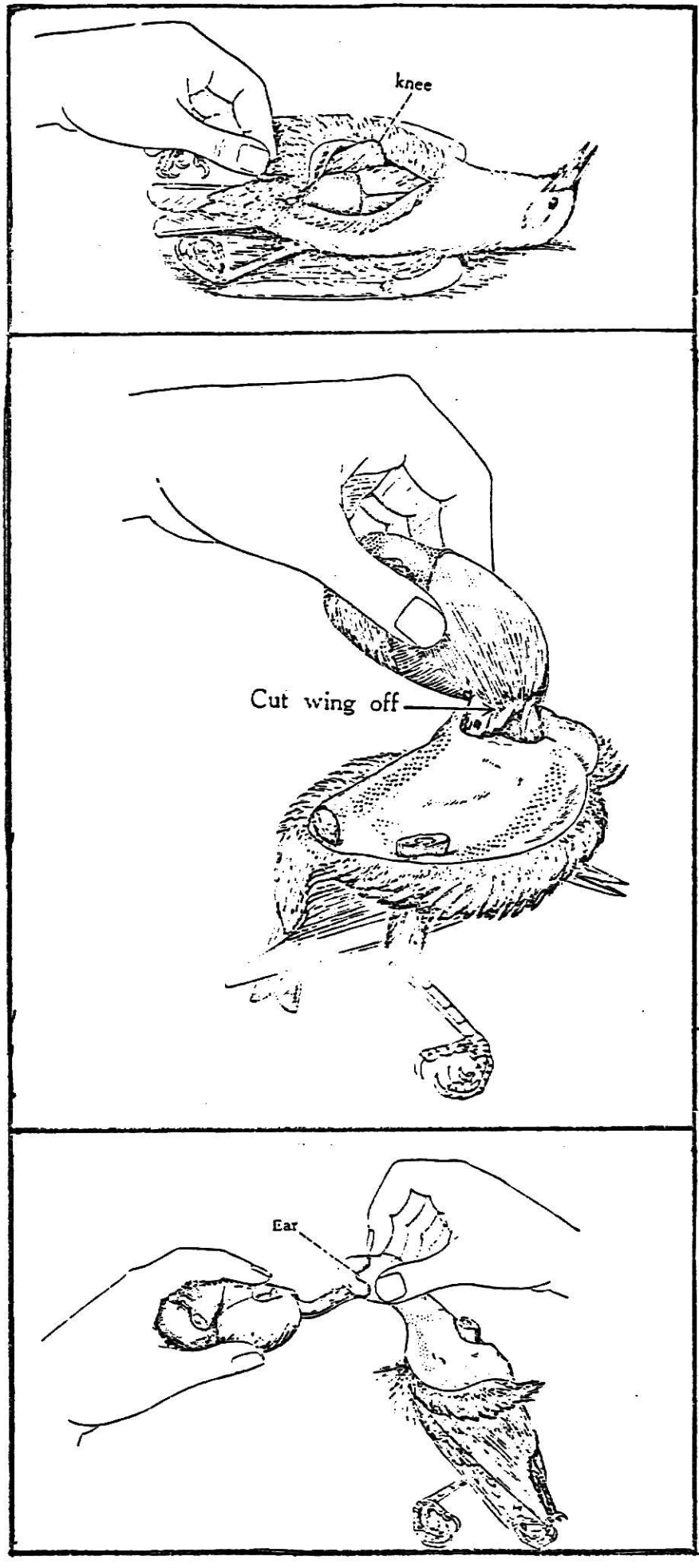
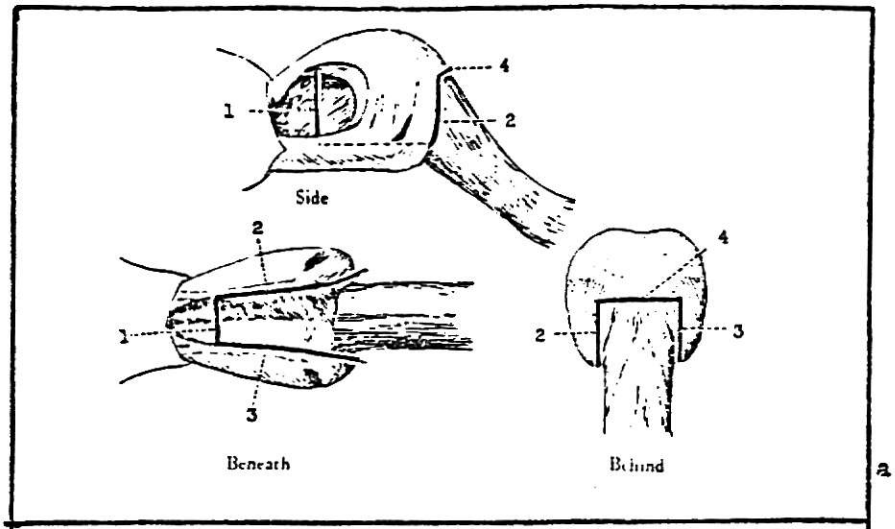


Figure II.3

Reprinted from Chapin "The Preparation of Birds for Study"



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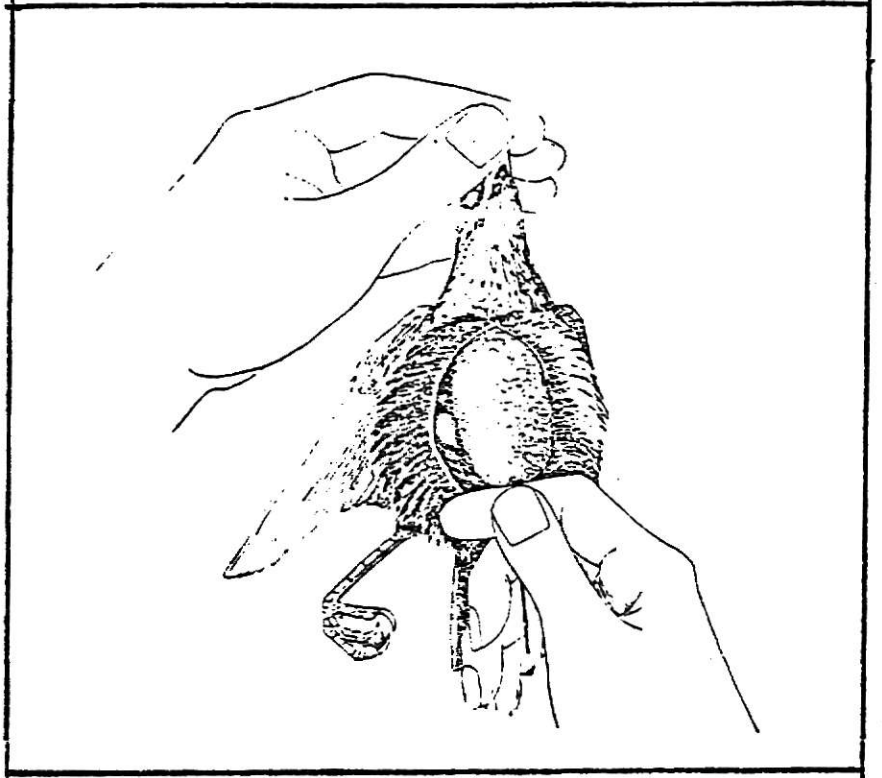

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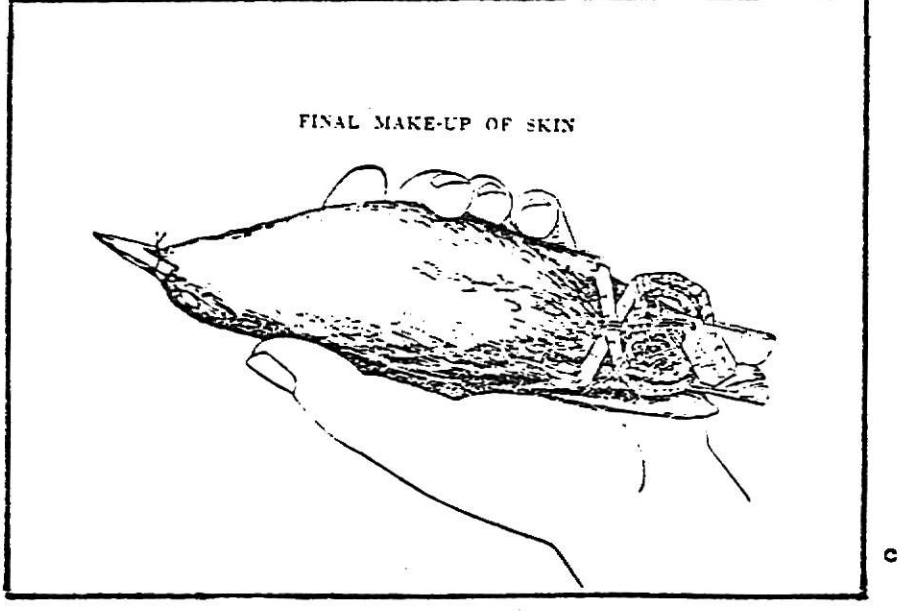

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Figure II,4

Reprinted from Chapin "The Preparation of Birds for Study"

When storing specimens of a collection, it's best to place them in a metal storage cabinet that has shallow removable trays or drawers. It's also wise to place some moth balls in a tray at the bottom of the cabinet. With any collection, it's a good idea to have a record book of all the specimens. Most collections number each bird in succession as they are collected. This is also the way they should be recorded in a book. As each specimen is added, assign it a number then make entries by number and include all information from the tag in the book. Some school collections have omitted the bird's name on the tag to force students to use a key to identify each bird. The record book is used mainly as a reference.

Field Trip Guide Sheet

Class:

Date of Trip: No. in group:

Purpose:

Objectives:

Background Information

Geographic Features: (geology, terrain, etc.)

Dominant Vegetation: (prairie, forest, marsh, etc.)

Birds Present:

Major Bird Foods:

Other Comments:

	No.
SPARROW	
House	
BLACKBIRDS, ORIOLES	
Bobolink	
E. Meadowlark	
W. Meadowlark	
Yellow headed	
Red winged	
Orchard Oriole	
Hooded Oriole	
Scott's Oriole	
Northern Oriole	
Baltimore	
Bullock's	
Rusty	
Brewer's	
Great tail. Grackle	
Common Grackle	
Br.-headed Cowbird	
TANAGERS	
Western	
Scarlet	
Summer	
GROSBEAKS, FINCHES	
Cardinal	
Rose-br. Grosbeak	
Bk. hd. Grosbeak	
Blue Grosbeak	

	No.
Indigo Bunting	
Lazuli Bunting	
Painted Bunting	
Dickcissel	
Evening Grosbeak	
Purple Finch	
Cassin's Finch	
House Finch	
Pine Grosbeak	
Common Redpoll	
Pine Siskin	
Am. Goldfinch	
Lesser Goldfinch*	
Red Crossbill	
Wh.-wg. Crossbill	
Gr.-tailed Towhee	
Rufous sid. Towhee	
Brown Towhee	
Lark Bunting	
SPARROWS	
Savannah	
Grasshopper	
Baird's	
LeConte's	
Henslow's	
Sharp-tailed	
Vesper	
Lark	

	No.
Rufous crowned*	
Bachman's*	
Cassin's	
Black throated*	
Sage	
Dark eyed Junco	
White-wing	
Slate colored	
Oregon	
Gray-headed Junco	
Tree	
Chipping	
Clay colored	
Brewer's	
Field	
Harris'	
White crowned	
Golden-crowned*	
White throated	
Fox	
Lincoln's	
Swamp	
Song	
McCown's	
Lapland	
Smith's	
Chestnut collared	
Snow Bunting	

NOTES

Use this space for on the-spot recording of details of rarities seen (size, shape, plumage, activity, habitat, location, voice), or nests found (location, habitat, contents), etc.

This checklist includes 414 species and 12 forms that have occurred in Kansas as of January 1, 1979.

If you are interested in birds, you are invited to join the Kansas Ornithological Society and one of the local groups in the state. K.O.S. holds spring and fall meetings and publishes a quarterly Bulletin and frequent Newsletters. Regular membership in the Society is $3.00 annually. Student membership (grade through high school) is $1.00. Contact Ruth Broderson, Membership Secretary, 2262 N. Richmond, Wichita, KS 67204, for further information.

Additional copies of this list may be obtained from: Eugene R. Lewis, Treasurer, 1285 MacVicar, Topeka, KS 66605. Price by mail: each 25c; 10/$1.00; 25/$2.00; 50/$3.50; 100/$5.00. Special prices on larger quantities.

Fourth Edition 01-79-10M

KANSAS ORNITHOLOGICAL SOCIETY
FIELD CHECK LIST
BIRDS OF KANSAS

Date _____ **Time** _____

Locality _____

Sky _____ **Wind** _____ **Temp.** _____ **Ground** _____

Observers _____

Total Species _____ **Total Individuals** _____

* Less than five records † Extinct x Extirpated

	No.
LOONS, GREBES	
Common Loon	
Arctic Loon*	
Red throat. Loon*	
Red neck. Grebe*	
Horned Grebe	
Eared Grebe	
Western Grebe	
Pied billed Grebe	
PELICAN, White	
Brown*	
CORMORANTS, ANHINGA	
Double crested	
Olivaceous	
Anhinga	
FRIGATE-BIRD	
Magnificent*	
HERONS	
Great Blue	
Green	
Little Blue	
Cattle Egret	
Great Egret	
Snowy Egret	
Louisiana	
Blk crnd. Night	
Yel crnd. Night	
Least Bittern	
American Bittern	
IBIS	
Wood Stork*	
White-faced	
White	
Roseate Spoon-bill*	
FLAMINGO, Am.*	
SWAN, Whistling	
Trumpeter	

	No.
GEESE	
Canada	
Brant	
Black Brant*	
White-fronted	
Snow	
Blue	
Ross'	
DUCKS	
Fulvous Whistling	
Mallard	
Black	
Mottled	
Gadwall	
Pintail	
Am. Green-winged Teal	
Blue-winged Teal	
Cinnamon Teal	
European Wigeon*	
American Wigeon	
N. Shoveler	
Wood	
Redhead	
Ring-necked	
Canvasback	
Greater Scaup	
Lesser Scaup	
Common Goldeneye	
Bufflehead	
Oldsquaw	
Common Elder*	
King Eider*	
White-winged Scoter	

	No.
Surf Scoter	
Black Scoter	
Ruddy Duck	
MERGANSER	
Hooded	
Common	
Red-breasted	
VULTURE	
Turkey	
Black*	
KITE	
Swallow-tailed	
Mississippi	
HAWKS	
Goshawk	
Sharp-shinned	
Cooper's	
Red-tailed	
Harlan's	
Red-shouldered	
Broad-winged	
Swainson's	
Rough-legged	
Ferruginous	
Harris'	
Golden Eagle	
Bald Eagle	
Marsh	
Osprey	
Gyrfalcon*	
Prairie Falcon	
Peregrine Falcon	
Merlin	
Am. Kestrel	

No.

PRAIRIE CHICKENS, GROUSE
- Ruffed Grouse x
- Greater
- Lesser
- Sharp-tail. Grouse

QUAIL
- Bobwhite
- Scaled

PHEASANT
- Ring necked

TURKEY

CRANES
- Whooping
- Sandhill

RAILS
- King
- Virginia
- Sora
- Yellow
- Black

GALLINULES
- Purple
- Common
- American Coot

PLOVERS
- Semipalmated
- Piping
- Snowy
- Killdeer
- Mountain
- American Golden
- Black bellied

SANDPIPERS
- Am. Woodcock
- Common Snipe
- Lg.-billed Curlew
- Whimbrel
- Eskimo Curlew
- Upland
- Spotted
- Solitary
- Willet
- Greater Yellowlegs
- Lesser Yellowlegs
- Red Knot
- Pectoral
- White rumped
- Baird's

No.

- Least
- Curlew*
- Dunlin
- Semipalmated
- Western
- Sanderling
- Short billed Dowitcher
- Long billed Dowitcher
- Stilt
- Buff breasted
- Marbled Godwit
- Hudsonian Godwit
- Ruddy Turnstone

AVOCET
- American

STILT
- Black necked

PHALAROPES
- Red
- Wilson's
- Northern

JAEGERS
- Pomarine*
- Parasitic
- Long tailed*

GULLS
- Glaucous
- Herring
- California*
- Ring billed
- Laughing
- Franklin's
- Bonaparte's
- Little*
- Bk.lg. Kittiwake
- Sabine's

TERNS
- Forster's
- Common
- Least
- Caspian
- Black

SKIMMER
- Black*

PIGEON
- Band tailed*

DOVES
- Rock

No.

- Mourning
- Passenger Pigeon†
- Ground
- Inca

PARAKEET
- Carolina†

CUCKOOS
- Yellow billed
- Black billed
- Roadrunner
- Groove billed Ani

OWLS
- Barn
- Screech
- Great Horned
- Snowy
- Burrowing
- Barred
- Long eared
- Short eared
- Saw-whet

GOATSUCKERS
- Ch. will's widow
- Whip poor will
- Poor will
- Com. Nighthawk

SWIFT
- Chimney

HUMMINGBIRD
- Ruby throated
- Broad tailed*
- Rufous
- Calliope*
- Rivoli's*

KINGFISHER
- Belted

WOODPECKERS
- Common Flicker
  - Yellow-shafted
  - Red-shafted
- Pileated
- Red-bellied
- Red-headed
- Lewis'
- Yel.-bel. Sapsucker
- Williamson's Sapsucker
- Hairy
- Downy
- Ladder-backed

No.

FLYCATCHERS
- Eastern Kingbird
- Western Kingbird
- Cassin's Kingbird
- Scissor-tailed
- Great Crested
- Ash-throated
- Eastern Phoebe
- Say's Phoebe
- Yellow bellied
- Acadian
- Willow
- Alder
- Least
- Hammond's
- Dusky
- Gray*
- Western*
- E. Wood Pewee
- W. Wood Pewee
- Olive-sided
- Vermilion*

LARK
- Horned

SWALLOWS
- Violet green
- Tree
- Bank
- Rough winged
- Barn
- Cliff
- Purple Martin

JAY, MAGPIE, CROW
- Blue Jay
- Steller's Jay
- Scrub Jay
- Mexican Jay*
- Black-billed Magpie
- Common Raven
- Wh.-necked Raven
- Common Crow
- Pinon Jay
- Clark's Nutcracker

CHICKADEES
- Black capped
- Carolina
- Mountain

TITMOUSE
- Tufted
- Bushtit*

No.

NUTHATCHES
- White breasted
- Red-breasted
- Pygmy

CREEPER
- Brown

WRENS
- House
- Winter
- Bewick's
- Carolina
- Lg. billed Marsh
- Sh. billed Marsh
- Rock

THRASHERS
- N. Mockingbird
- Gray Catbird
- Brown
- Curve-billed
- Sage

THRUSHES
- Am. Robin
- Varied*
- Wood
- Hermit
- Swainson's
- Gray cheeked
- Veery
- Eastern Bluebird
- Mountain Bluebird
- Town. Solitaire

GNATCATCHER
- Blue gray

KINGLETS
- Golden crowned
- Ruby crowned

PIPITS
- Water
- Sprague's

WAXWINGS
- Bohemian
- Cedar

SHRIKES
- Northern
- Loggerhead

STARLING

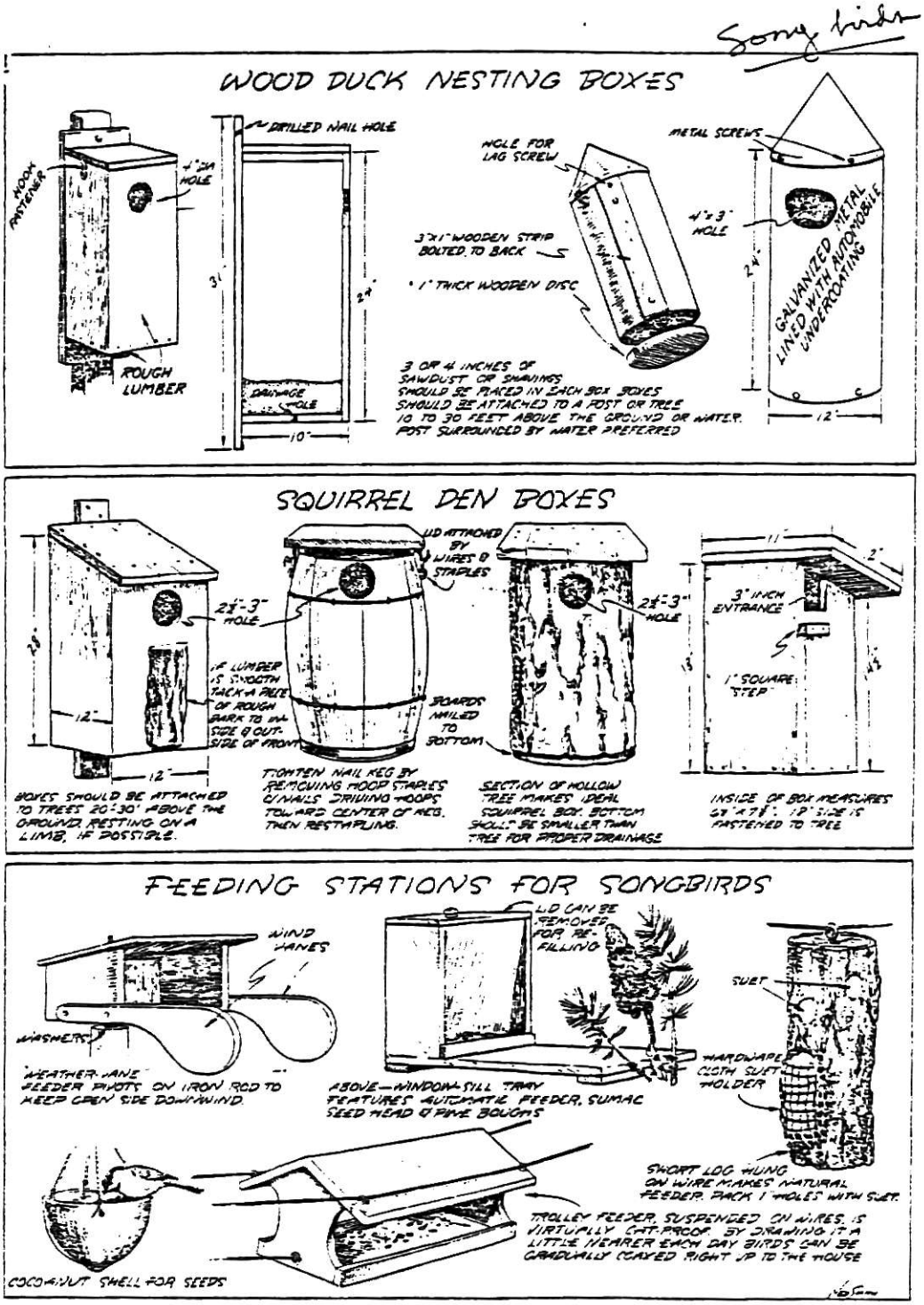
VIREOS
- Black capped
- White eyed
- Bell's
- Yellow throated

No.

- Solitary
- Red-eyed
- Philadelphia
- Warbling

WARBLERS
- Black & White
- Prothonotary
- Swainson's*
- Worm eating
- Golden winged
- Blue winged
- Tennessee
- Orange crowned
- Nashville
- Virginia's*
- Northern Parula
- Yellow
- Magnolia
- Cape May
- Black thr. Blue
- Yellow rumped Myrtle
- Audubon's
- Black thr. Gray
- Townsend's
- Black thr. Green
- Hermit*
- Cerulean
- Blackburnian
- Yellow throated
- Chestnut sided
- Bay breasted
- Blackpoll
- Pine
- Prairie
- Palm
- Ovenbird
- N. Waterthrush
- La. Waterthrush
- Kentucky
- Connecticut*
- Mourning
- MacGillivray's
- Com. Yellowthroat
- Yellow-breast. Chat
- Hooded
- Wilson's
- Canada
- Am. Redstart

Reprinted from the Kansas Ornithological Society Field Check List



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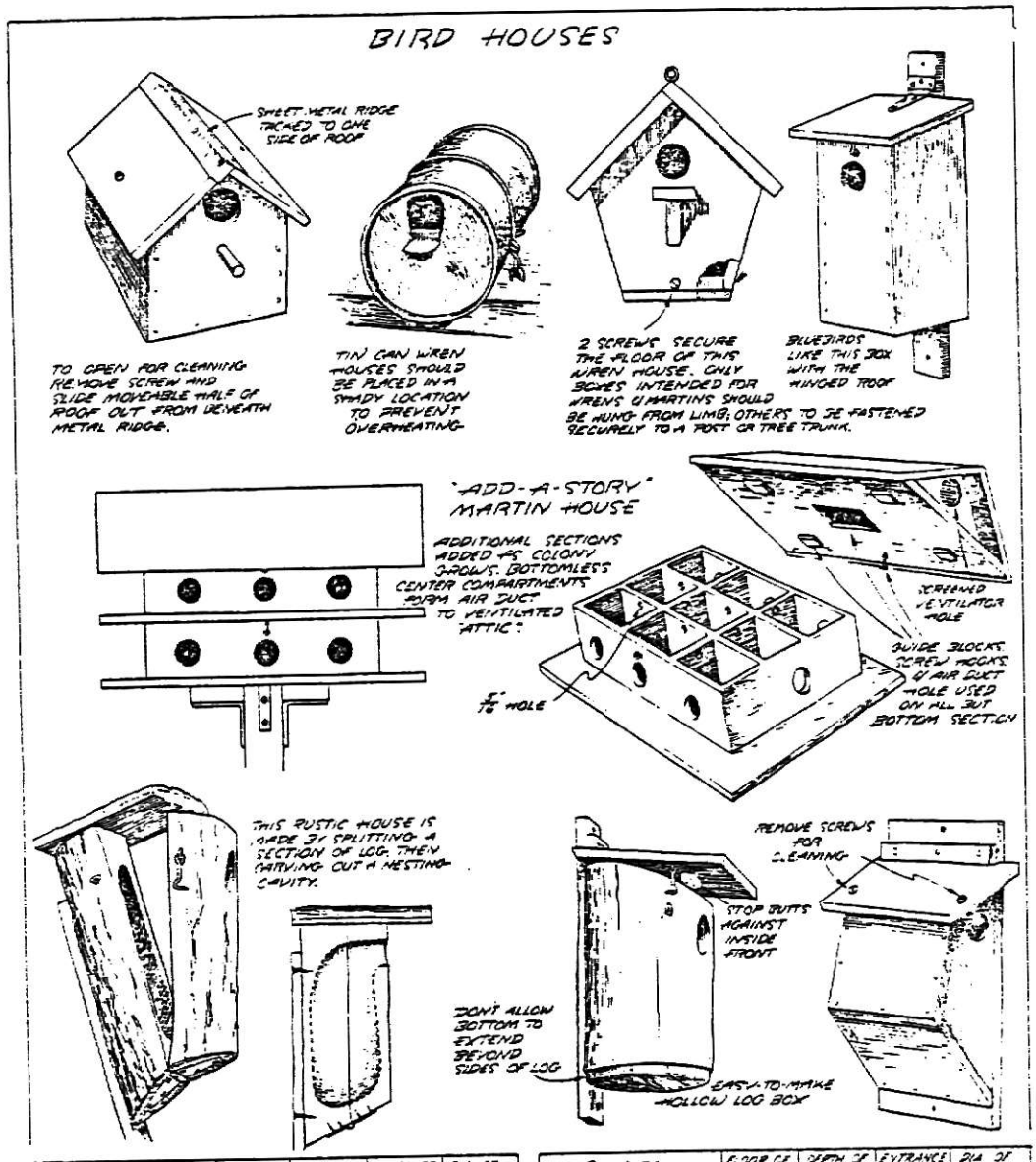

SPECIES	FLOOR OF CAVITY	DEPTH OF CAVITY	ENTRANCE ABOVE FLOOR	DIA. OF ENTRANCE
BLUEBIRD	5"x5"	8"	6"	1½"
CHICKADEE	4"x4"	8-10"	6-8"	1⅛"
TITMOUSE	4"x4"	8-10"	6-8"	1¼"
NUTHATCHES	4"x4"	8-10	6-8"	1¼"
HOUSE WREN	4"x4"	6-8"	1-6"	⅞"
CAROLINA WREN	4"x4"	6-8"	1-6"	1⅛"
CRESTED FLYCATCHER	6"x6"	8-10"	6-8"	2"

SPECIES	FLOOR OF CAVITY	DEPTH OF CAVITY	ENTRANCE ABOVE FLOOR	DIA. OF ENTRANCE
FLICKER	7"x7"	16-18	14-16	2½
RED-HEADED WOODPECKER	6"x6"	12-15	9-12	2"
DOWNY WOODPECKER	4"x4"	8-10	6-8"	1¼"
PURPLE MARTIN	6"x6"	6"	1"	2½"
TREE SWALLOW	5"x5"	6"	1-5"	1½"
BARN OWL	10"x18"	15-18"	4"	6"
SPARROW HAWK	8"x8"	12-15	9-12	3"

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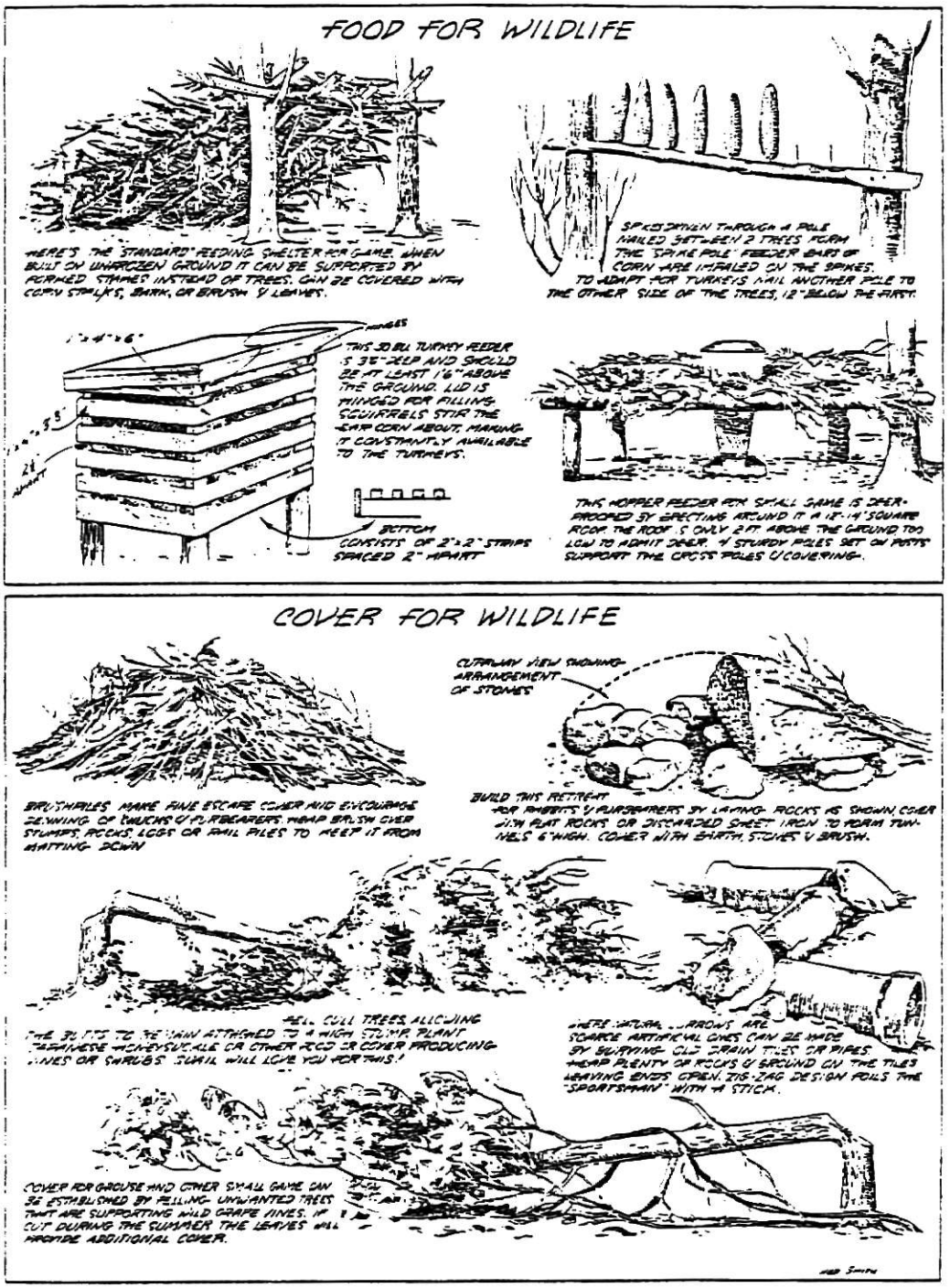

Reprint D-1

Reprinted from *Virginia Wildlife*, January, 1955
Virginia Commission of Game and Inland Fisheries
Richmond 13, Virginia

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National Wildlife Federation

COMMON BIRDS OF MANHATTAN, KANSAS

THE BIRD POPULATIONS INSTITUTE

COMMON BIRDS
OF
MANHATTAN, KANSAS

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THE BIRD POPULATIONS INSTITUTE

It is time for birders to acknowledge the fact that if they want to preserve the pleasure of watching birds, they must take the responsibility of watching over them. The protection of bird populations, however, depends on a deep understanding of their regulation, which for the most part, we lack. The BPI is committed to developing this understanding, and to communicating it to the people who care. When the impact of man's activities on bird numbers can be accurately assessed, we shall be better able to defend our conservation efforts.

INTRODUCTION

We at the Bird Populations Institute are excited about life. We believe that just being able to identify the common birds in our backyards can add very much to any person's life. Yet, we see that many people are *unfamiliar* with the common birds around them.

So, we have written this short guide to the 30 most common birds in Manhattan. We have purposefully kept it short and simple so it will be easy for anyone inexperienced in birdwatching to use. The illustrations are grouped together so it is easy to quickly identify a particular bird. Following the name of each bird is its approximate length. The 30 birds included are by no means all the birds which might be seen around Manhattan, but the majority of birds seen in town are among these thirty. We hope this guide will help you enjoy one of the most beautiful parts of all creation.

PRACTICAL HINTS FOR BETTER BIRDWATCHING

If you are new to birdwatching, here is some basic information which can help you get the most from it.

- —Birds are out all day, but are most active in early morning and late afternoon. These times are the best for seeing the most birds.
- —Small groups generally see more birds than do large groups, since small groups are less conspicuous.
- —Move slowly and quietly. If you walk fast and make a lot of noise, you'll miss seeing a lot and scare a lot away.
- —Although not a necessity, binoculars make identification easier. Since they make things look closer, you can see a lot of detail that you would miss without them. If you're serious about birdwatching as a lifelong pursuit, a good quality pair of 7 × 35 binoculars is one of the best investments you can make.
- —Your own backyard is an excellent place to start birdwatching; eventually you can see over 30 species. Other nearby places include Sunset Cemetery, Tuttle Creek reservoir and Pottawatomie County State Lake no. 2. If you go onto private land, remember to ask permission first.
- —Remember that it is illegal to kill or keep as pets native wild birds.
- —Get involved with others interested in birdwatching. Watching birds is fun, but sharing your interest is even more rewarding.
- —Bird feeding can add a whole new dimension to birdwatching. Having a feeding program in your backyard attracts many species and brings birds close to your house. If you are interested in bird feeding, write to BPI for more information.

WESTERN MEADOWLARK (L 8")

1 This is the state bird of Kansas. It is streaked light brown above and yellow underneath with a crescent-shaped breast patch. The Western Meadowlark is almost identical to the Eastern Meadowlark and can be separated in the field only by song; the Western's song is longer than the Eastern's. Meadowlarks are seen in grassy fields and perched on wires and fences. Their main food is seeds and insects. The Western Meadowlark is one of the true symbols of the prairie and can be seen here all year round.

MOURNING DOVE (L 10")

2 Mourning Doves are our only native doves. This medium-sized bird is fairly uniformly brownish-grey in color with slightly darker wings. The long pointed tail separates the Mourning Dove from the similar domestic pigeon, which has a shorter rounded tail. Mourning Doves are abundant outside of town, but less common in town. They can be seen perched on wires and in trees. Their main food is grain and other seeds. Mourning Doves can be seen in our area all year long.

BROWN CREEPER (L 5")

3 Brown Creepers resemble Nuthatches in their habits, but are different in color and have a curved bill. They are brown above with broken white lines running from the middle of their back to their bill. They are all white underneath. Like Nuthatches, they are very good at climbing around on trees, eating insects from the bark. Creepers often go unnoticed, even though they are fairly common. This is because their color blends in so well with the trees they are on. And, they generally stay by themselves, seldom making any sound. But, with a sharp eye and a little patience, you are likely to see these handsome little birds. Brown Creepers are year-round residents of our area.

CHICKADEE (L 4")

4 Chickadees are small sparrow-sized birds. They are greyish brown above and slightly lighter underneath. They are easily recognized by the striking contrast of the black cap and throat patch surrounding a white patch below the eye. Chickadees can be seen hanging upside down from plants from which they eat seeds. They are very energetic, quickly flying and hopping from one twig to another, frequently giving their enthusiastic "chick-a-dee-dee-dee" call. Chickadees are year-round residents of our area.

TUFTED TITMOUSE (L 6")

5 This crested bird acts like a Chickadee, but can be told from them by the Titmouse's crest, larger size and lack of the black bib of the Chickadee. This largest North American titmouse is common in deciduous woodlands, especially along streams. The sexes are similar in appearance and are found nesting in cavities. Their whistled song is two notes which are repeated two to four times. The Tufted Titmouse is a common sight throughout this area all year round.

NUTHATCH (L 5")

6 Nuthatches are stout tree-climbing birds. They have bluish-grey backs with white undersides and a slender black bill. Adult males have a black cap, while females and immatures have a cap about the same color as their back. Nuthatches are generally found in large trees where they eat insects living in the bark. Their short legs and powerful feet and toes make them very good at climbing up, down and around tree trunks and limbs. Their legs are so short that they almost seem to move along by gliding. They are beneficial to trees since they eat insects which can be harmful to these trees. Nuthatches are as easily identified by sound as by sight; their nasal "yank-yank" call is hard to forget. Nuthatches are year-round residents of our area.

HOUSE SPARROW (L 5")

7 House Sparrows are not actually sparrows, but are members of a European Finch family. Like the starling, the House Sparrow was introduced to this country. The House Sparrow has been a dramatic success in terms of survival in the United States. House Sparrows are small brownish-grey birds with a lighter breast and two white bars on the wings. The male has a black bib and beak, a grey cap and white cheeks. The females and immatures are rather plain looking. These birds will nest anywhere there is a protective hole or crevasse. House Sparrows feed on seeds and insects and are year-round visitors at backyard feeding stations. They are quick to notice a new feeder setup and by frequenting the feeder, they lead other birds to find food.

JUNCO (L 5")

8 Juncos are one of the most common sparrows at feeders in the winter. They are about the size of House Sparrows and are uniformly dark grey-brown above with no wing bars. Their head is slightly darker than the rest of their body and their belly is white. The white edges on their tail are seen best when the Junco is in flight, a very good identification feature. Juncos are common in brushy areas where they eat seeds. Their call is a single sharp "chip." Juncos can be seen in our area from late fall until early spring.

GOLDFINCH (L 4")

9 Goldfinches are one of the most brightly colored species in adult male plumage. The adult male is bright yellow with a black tail and black wings with white wing bars. The adult male also has a black forehead. Females and immatures are less brightly colored. Goldfinches are found in flocks in trees and brush and at feeding stations where they eat seeds. They can be identified in flight by their roller coaster flight pattern. Goldfinches are year-round residents of our area.

HOUSE WREN (L 4")

10 This small bird is nearly all brown. Its back has a checked pattern and its tail is barred. Wrens are told by their tail which is often pointed in the air. They nervously fly from one place to another searching for insects which they catch with their slender bill. They nest in cavities in trees or in boxes provided for them. Wrens probably use more energy than any other bird their size; they seem to never stay still. They fly from one place to another, frequently giving their loud, bubbling song. These summer residents more than any other bird demonstrate enthusiasm.

CATBIRD (L 8")

11 This is the only plain, dark slaty-grey bird that has rusty undertail coverts. Catbirds have a distinct black cap, short wings, and a slender bill. Named for its mewing call, it often flicks its long blackish tail. This bird likes to skulk in the undergrowth and prefers bushy habitats, wood margins or residential areas. Catbirds are seen commonly from spring until fall in this area.

BROWN THRASHER (L 10")

12 This slim bird is a rich rufous brown with a heavily streaked belly. It has a long rufous tail, is short-winged and has a slender, curved bill. The phrases of the Thrasher's song are repeated twice, rather than once like the Catbird or numerous times as the Mockingbird does. This bird prefers to nest in brushy or thorny areas and is common throughout the year in Manhattan.

RED-HEADED WOODPECKER (L 7")

13 This black-backed woodpecker is the only woodpecker with an entirely red head. It can be told from other species by the large white wing patches on the rear edge of the wings. The wing patches and the white rump are conspicuous in flight. This bird is often seen in scattered trees and in groves, on farms or in town. They nest in a hole in trees and give a raucous "kwrrk" call. This woodpecker is commonly found in Manhattan year round.

DOWNY WOODPECKER (L 5")

14 Downy Woodpeckers are seen often in the suburbs in shade trees and in the woods. This miniature woodpecker has a vertical white stripe on the back, barred outer tail feathers and a short, slender bill. The males have a red patch on the back of their heads, but the females lack this patch. Like most woodpeckers, they eat insects and nest in holes in trees. The call is soft, sounding similar to "pik." Downy Woodpeckers are common around this area all year.

COMMON FLICKER (L 11")

15 This is a large woodpecker with a brown back, no white on the wings, and a black breast band. In flight, the white rump is visible. Flickers like to nest in excavations in trees, posts or in buildings. The more common Yellow-shafted Flicker has a brown face, a grey crown and the nape of its neck is always red. Adult males have a black "mustache." The Red-shafted Flicker has a grey face, brown crown and red "mustache." They also lack the red nape of the Yellow-shafted Flicker. The Yellow-shafted Flicker is abundant in the Manhattan area all year long.

CHIMNEY SWIFT (L 5")

16 These are small, dark swifts, with long and slender wings that are built for speed. The tail is stiff and slightly rounded, but never forked or fanned. Chimney Swifts are often detected by the noisy chatter they make while flying rapidly overhead. Swifts are commonly seen in flocks, flying almost continuously all day long, feeding on flying insects that they catch in their wide mouths while in flight. At night they a e found nesting in chimneys or in hollow trees. Chimney Swifts are a undant in Riley County from spring through fall.

PURPLE MARTIN (L 7")

17 These large swallows are abundant in the summer when they commonly nest in apartment-type bird houses put up in yards. The adult males are solid bluish-purple in color while the females and first year males are dark above with patches of purple and a light colored belly. These birds feed exclusively on insects which they catch in flight. They are often seen in large numbers soaring and darting in the sky. Purple Martins are very sociable birds; several pairs will nest together in the same apartment complex where their constant social chattering continues from dawn to dusk. Purple Martins arrive in Manhattan in late March to early April and migrate south again in late summer. During a summer these birds will usually raise two broods. The nests are made almost exclusively of mud which is collected around ponds, streams and even puddles in yards.

BARN SWALLOW (L 6")

18 This is one of the most common swallows in our area. Barn Swallows are bluish purple above. Adults have orange bellies, while immatures are white underneath with a light orange throat patch. Barn Swallows are the only swallow with a deeply forked tail. This, along with their orange underparts separates them from the somewhat similar Purple Martin. Barn Swallows are often seen darting through the air hunting insects, which they catch in their wide mouth. They are also frequently seen perched on wires. They build mud nests on rafters in barns and old sheds. Barn Swallows are summer residents of our area.

EASTERN KINGBIRD (L 7")

19 The Eastern Kingbird is a common bird that prefers the open areas, but is occasionally found in town. They have a black head, back, wings and tail with a white band at the end of it. They are all white underneath. There is a small red patch on top of the head that is hard to see in the field. The Eastern Kingbird is a member of the flycatcher family, a group of birds that usually perch on branches and wait for insects to fly by. Upon spotting one, they will dart off the perch, catch it and return to a perch to feed. Eastern Kingbirds are often seen perched on barbed-wire fences or powerlines where they wait for their prey. These birds are very aggressive toward intruders and don't hesitate to drive off birds larger than themselves that have entered their territory. Because they do feed exclusively on insects, Eastern Kingbirds are in Manhattan only in the summer, arriving in late March and departing in late September.

WESTERN KINGBIRD (L 7")

20 Western Kingbirds, like the Eastern Kingbirds are flycatchers. They have similar feeding habits, although the Western Kingbird seems to prefer higher hunting perches. These birds prefer open areas with scattered trees as nesting sites, but they are also very common in town. The Western Kingbird has an olive-grey colored head and back with a white throat, yellow breast and a black tail with white outer tail feathers. The Western Kingbird, like the Eastern Kingbird is quick to chase off large intruders from its territory. It is not uncommon to see a crow or hawk being chased by several Kingbirds of both species. Western Kingbirds arrive in Manhattan during the last of April to the first of May and remain until late August.

COMMON NIGHTHAWK (L 9")

21 This grey or grey-brown bird lives up to its name by being most commonly seen at dusk, flying above treetops and houses eating insects. They have long pointed wings with white wing patches. The head is large and flat with a small bill and enormous mouth. While the eyes appear huge and round at night, in daylight they seem to be only slits. The eggs are speckled and are laid on the bare ground or on flat-topped buildings. Nighthawks are common from the spring through the fall in Manhattan.

ROBIN (L 8")

22 Robins are common, well known birds that are often seen feeding on lawns. The characteristic orange breast is only on adult birds, while the juvenile birds have a whitish breast with black spots. The head and back are greyish in color and there is a white splash on the tips of the outer tail feathers. Robins make their nests out of mud and grass, usually in the crotch of a tree or shrub. In the summer, Robins feed on insects and earthworms, but in the winter, they feed on fruits and berries. Robins are very fond of bird baths, and even in winter once your bath has been discovered, Robins will come frequently to drink and bathe.

KESTREL (L 9")

23 The Kestrel is a small falcon that is ommon in open areas that are bordered by woods or powerlines. The mal can be recognized by blue on the back of the wings and an unbarred r isty tail. The female has a solid rusty-brown back and a horizontally barred rusty tail. These are very beneficial birds since they prefer to eat insects and rodents. They will also eat smaller birds and have been known to catch House Sparrows at bird feeders. These birds are often observed perched on powerlines or open branches where they search for their prey. They will also hover over a field while searching for food. The Kestrel nests in hollow cavities of trees or even in bird houses. They are year-round residents of our area.

RED-TAILED HAWK (L 18")

24 The Red-tailed Hawk is a common large soaring hawk often seen perched on power poles or soaring gracefully overhead. The adult birds have a brick-red tail, while the immature birds have a brown tail with black horizontal bars. They will hunt from perches or while soaring. Rodents, especially field mice are the preferred food of these hawks. They have tremendous patience as they sit on a perch waiting for their prey to expose itself. Red-tailed Hawks are often incorrectly called chicken hawks, but it is very rare for any hawk to feed on domestic birds. The nest of these hawks is a large platform of sticks usually high up in a tree. Red-tailed Hawks are year-round residents of our area.

BALTIMORE ORIOLE (L 6")

25 This is one of our brightly colored birds. Adult males are bright orange with a black head and throat. Part of their back and tail are also black. Immatures and females are less brightly colored. Told from somewhat similar Robins by slimmer build and by white wingbars and long, sharp bill. Baltimore Orioles are usually seen in large shade trees both outside of and in town. Their main food is insects and fruits. Their song is a series of musical whistles. Baltimore Orioles can be seen here in the summer.

CARDINAL (L 8")

26 This member of the finch family is a common sight to all. The male is bright red with a black patch on the throat while his mate is more of a buffy brown with just a touch of red. Both sexes have a pointed crest and a heavy, red bill. This bill is ideal for cracking seeds. Besides seeds, Cardinals also like to eat insects and small fruits. You may often see them hunting for food in river thickets, along woodland edges, or in shrubs and bushes in your backyard. Their song is a slurred whistle, diminishing in pitch, with several variations: "What-cheer, cheer, cheer" or "Whoit, whoit, whoit." Cardinals are common in the Manhattan area all year long.

BLUE JAY (L 10")

27 This is a large, bright blue bird with a black "necklace" and a predominant crest. The wings are short and rounded, and one can observe white spots in the wings and tail. Both sexes are alike in appearance, with long, powerful bills adapted to their omnivorous diet. The jay's call is common to many. Its harsh slurring "jeeah" is often heard in backyards nearly everywhere. Blue Jays make their nest in trees out of twigs and lay from three to seven spotted eggs. They can be seen here all year long.

CROW (L 17")

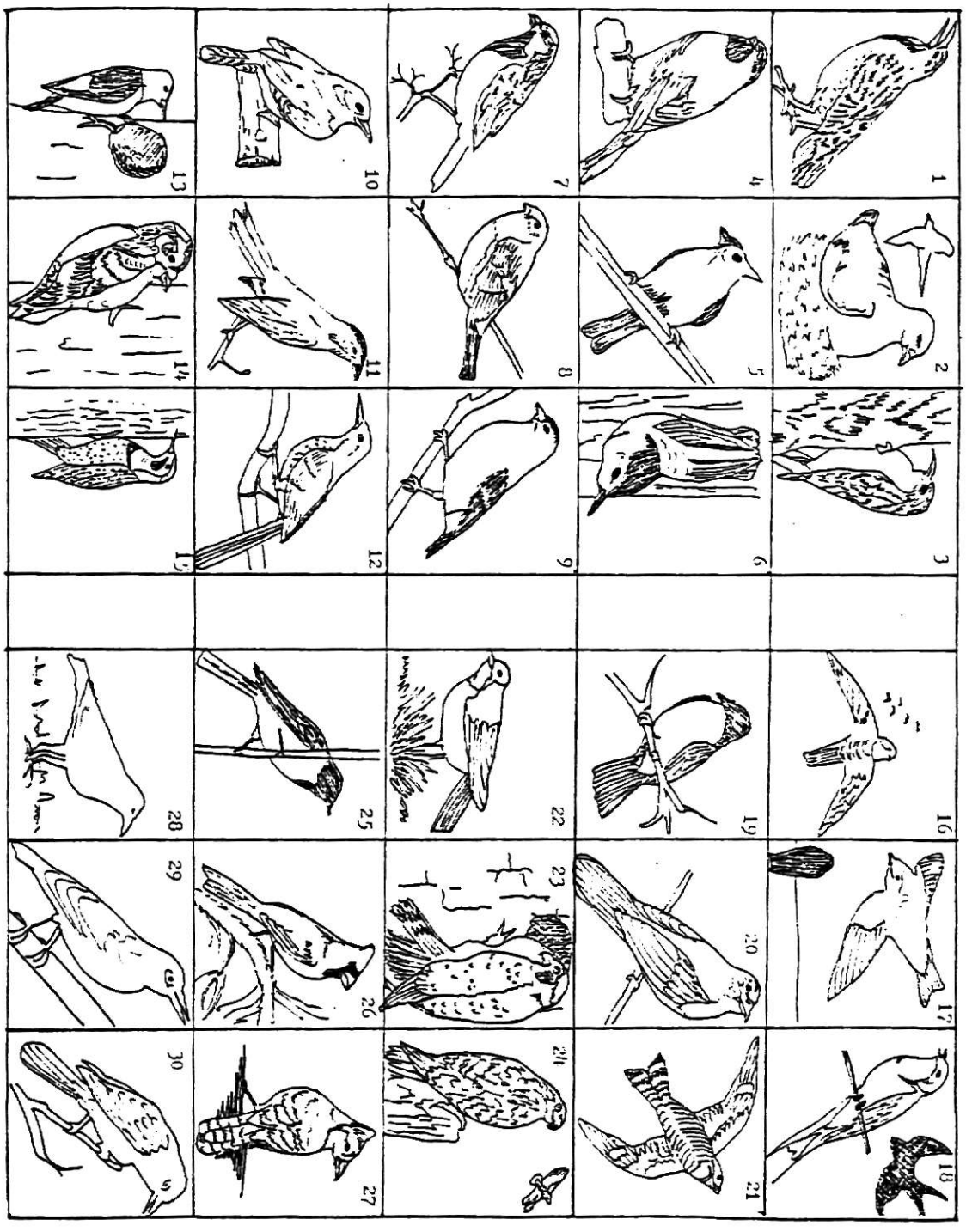
28 This is the largest of the black birds found in our area. Crows are much larger than Starlings and Grackles, measuring well over a foot from the end of the beak to the tip of the tail, and are solid black, even down to their toes. Crows travel in close-knit groups and will constantly keep in communication with their cawing calls. Crows will eat just about anything, from road kills and insects to seeds. They will occasionally come to bird feeders to feed on corn. Crows nest secretly in thick stands of trees; they will even nest in Manhattan. An ideal place to observe these birds nesting is the Manhattan Cemetery, where the dense trees and undisturbed setting is ideal for them. Crows are year-round residents.

STARLING (L 6")

29 Starlings are plump black birds with a purple iridescence to their feathers in the summer. They have a short tail and a medium-long yellow bill. These birds like to associate in flocks and are often seen feeding, flying and roosting in this manner. The song of the Starling is a squeaky whistle and they will often imitate the calls and songs of other birds. These birds are not at all picky about what they eat, as they will eat anything from seeds to insects to bread. Starlings often become pests at bird feeders because they feed in such large numbers and will chase off other birds. Starlings were originally brought to the United States from Europe and they have become well established year-round residents of our area.

GRACKLE (L 11")

30 Grackles are common black birds in our area that are often confused with Starlings. Grackles, though have long wedge-shaped tails, light eyes, a black bill and a call that resembles the sound of a squeaky swingset. Grackles like to nest in colonies, preferably in evergreen trees. Their main diet in the summer is insects and seeds and they will come to bird feeders year-round, where they prefer milo. These birds are very common in the summer, but the majority migrate in late summer and return again in late winter.



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FIELD EXPERIENCES

THE STUDY

OF

FISHES

RATIONALE

The study of fish life and ecology is one field of biology that can be done indoors and outdoors. These animals can be studied in their own environments of streams and lakes with guaranteed results for nearly every body of water will contain fish. Several areas of animal ecology can be demonstrated with fish, including adaptation, habitat, food chains and behavior. With the use of a large aquarium it is possible to create one of the best mini-environments known. Observation and experimentation can be conducted over a long period of time by bringing ecology into the classroom with an aquarium. This way most of the principles of field biology can be taught without leaving the school.

INSTRUCTIONAL OBJECTIVE

On the completion of this module the student will be able to:

1. Plan a fish collecting trip.
2. Collect some fish.
3. List the steps to preserve fish.
4. Start an aquarium mini-environment.
5. Identify a fish to family with the use of a key.
6. Outline a fish study for a student project.

INSTRUCTIONAL ACTIVITIES

Introductory Activities

1. Read the information in this module.

Application Activities

2. Obtain a fish collecting permit from your state fish and game.
3. Catch some fish by trap, seine, or hook and identify them to family.

Alternative Activities

4. Contact local fish and game office for information on fish in your area.

INTRODUCTION

This module is proposed as an aid for teachers to introduce their students to fish. The planning and preparation of field trips being of major consideration. Also various field studies will be outlined with ideas on setting up an aquarium to bring fishes into the classroom. Information on where to go, equipment, collecting and preservation will be discussed.

PLANNING A FIELD TRIP

The key to success is careful planning. There are many things to consider when organizing a field trip. Some are school policy permission from supervisors, teacher liability, acquiring transportation, class time trips or extended trips, safety precautions and cost. These have little to do with fish but are an important part of any field trip. When it is time to plan a trip to study fish there are several questions that need to be answered.

1. What are the objectives of this trip?
2. How much time is available or needed?
3. Will transportation be necessary?
4. Where should this trip be taken?
5. When is the best time to go?
6. What kind of equipment will be necessary?

The answers to these questions will determine the type of field trip and establish an outline for the purposes of the trip. From this you will be able to evaluate the benefits the students will receive from this type of experience.

FISH STUDIES

Studies of fish in the field are mostly limited to the collection an identification of fish with some discussion of adaptation and habitat. On streams different species of fish will be caught in different parts of the stream. Some will favor the faster moving sections, others the deeper slow moving sections and the adaptations and habitats of each species will reflect in their design. Characteristics of fish will be discussed further in the section on identification.

Comparisons of fish characteristics identify the habitat or niche that fish occupies. Darker colored fish with barbels (whiskers), mostly catfish, are generally bottom feeders adapted to slower murky waters. Other bottom feeders have mouths that are on the lower side of the head allowing them to work around rocks and gravel on the floor, these include suckers, drum and carp. More preditory fish such as sunfish and bass are flatter laterally and green in color to reflect the vegetation where they where they feed.

Population diversity or the number of different species found is an indication of the habitats and food sources available. Healthy ponds, lakes or streams should have several different species including several different

kinds of bottom feeders, preditory or game fish and forage fish such as minnows. The smaller the number of species can indicate the condition of that stream or lake as it is affected by natural process or pollution.

Along with population diversity examine energy flow by developing food chains for those fish identified. For each fish list the possible foods they might need. Some generalizations are that bottom feeders eat snails, insect larvae, crayfish, worms, and other organisms that dwell on the bottom. The preditory fishes like bass, walleye, pike, and sunfish feed mainly on other fish including minnows, chad and smaller members of their own kind. Fish are extremely cannibalistic especially in ponds or lakes with only a few species. Surface feeders prey largely on insects, snakes, and even small mammals. These include many minnows and game fish such as bass, trout and sunfish. It must be remembered that depending on the season, availability and other similar factors, these types of food can be interchanged.

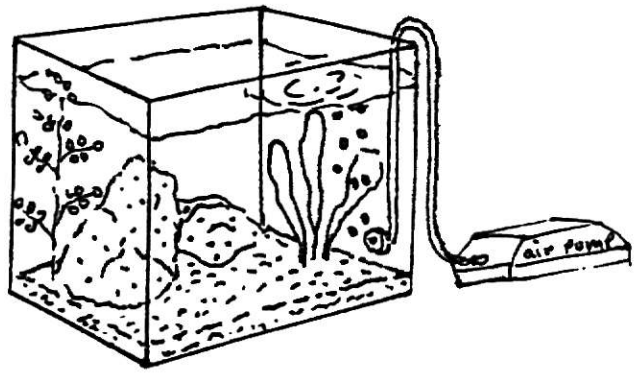
Another consideration is nesting activity and possible hybridization between two similar species. Most fish of inland waters of North America spawn (breed) during the spring and early summer. They construct nests by forming depressions in gravel or mud bottoms either making their own or working out a natural crevice or depression. Variations occur with each species and some do not make nests or have even more elaborate ones. Nests that are likely to be seen from shore in ponds and lakes are those made by members of the sunfish family which nest in shallow areas along the shore. By cautiously walking the shoreline during May and June its possible to spot one or more fish hovering over a small depression on the bottom. These fish are guarding their nests and will be reluctant to leave. In lakes and ponds that have shorelines without abundant nesting sites will create crowding on nesting sites. Since fish release their egg and sperm over the nest for fertilization in the water, the close proximity of nests will result in hybridization of eggs due to sperm of one species fertilizing the eggs of another. Most hybridization occurs in coal strip pits and rock or sand quarries that have steep sides and little sloping shore line.

AQUARIUMS

An excellent way to observe fish and examine various principles of ecology is to establish an aquarium. It is possible to use tropical fish but I recommend collecting fish from your area. The thing to remember is to save only small fish of roughly the same size. One good size fish could eliminate the whole collection.

To set up an aquarium for class use, try to get at least a 10 gallon tank. Overcrowding will make observation difficult and the situation is harmful to the fish also. Any book on tropical fish and aquariums will provide ample information on taking care of aquariums. The basic setup requires an air pump to aerate the water. Also tap water should be aerated for at least 2 days before fish are added to drive out the chlorine and other gases found in the tap water. It is usually recommended to have a filter but it is not really necessary. Waste and debris will settle to the bottom and can be removed every other week by stirring up the bottom and removing about half the water and replacing it. This procedure should be done whether there is a filter or not.

What to include in an aquarium is entirely up to you, but to provide the largest number of habitats include vegetation and rock ledges. On the floor of the aquarium place 1 to 1 1/2 inches of gravel that has been thoroughly washed. In one corner or along the back, stack some moderate sized rocks about halfway up the side. Then either purchase some plastic or real plants to place around the aquarium. Water plants from the same location as the fish collected can be used if they are washed thoroughly. An example of an aquarium setup is shown in the drawing.



Many native fish, like tropical fish, are interesting pets. Most of the minnows, madtoms and topminnows readily accept the same dry fish food sold commercially for goldfish and tropical fish. Other native fish, especially the colorful darters and sunfish, may not thrive on dry fish food, but can be kept healthy on frozen brine shrimp sold in pet stores. Native fish tolerate a wider range of temperature than do most tropical fish, but some of the most colorful Kansas (darters and certain minnows) will retain their bright colors only at temperatures below 70oF. Some native species are aggressive and should not be kept in the same aquarium with expensive tropicals. Basically the rules of aquarium management for tropical fishes apply to native species, including those of water conditioning, sanitation and disease treatment.

COLLECTING FISH

When selecting a location for a place to take a class or group to collect fish, visit several locations. The site should be open and easily accessible by car or within easy walking distance. Ideally the water should not be over 2 or 3 feet deep. For safety sake it is better to have two adults working the net or at least older high school students.

Small streams and shallow shorelines of ponds and lakes are good for collecting. Ideally for group activities the water should not be over 2 or 3 feet deep. But before collecting, a permit is required from most State Fish and Game Offices along with permission from the land owner.

When it comes to capturing fish, there are three basic ways to do it. It is possible to use a dip net by walking the shoreline and using a long handle to reach out and pull it through the water. The drawback to this method is the small size of the net plus the limited area a person can cover even by wading.

Another method is to seine in much the same way fishermen seine for bait. Figure 1 shows a typical method of working a lake or pond. One worker pulls his end of the net far out into the water while the second collector remains close to shore. The end of the net is brought around in a wide arc and, finally, both ends are brought up on the beach. As the net moves into shallow water, it tends to bag out to trap the small fishes. Much the same method is used in streams. Here the worker moving into the water is down stream from the stationary worker. The net is then moved in an arc out into the water moving upstream as illustrated in Figure 2. It is sometimes helpful if a person is upstream from the net overturning rocks or beating the water to scare fish into the net. Care must be taken in this method for water rushing into the net will create considerable force. Some icthyologists recommend the reverse of this procedure, thus moving one end downstream, it supposedly places the fisn in an awkward escape posture. In any case, the net should be worked around until both ends of the net can be brought on shore at the same time.

Lake

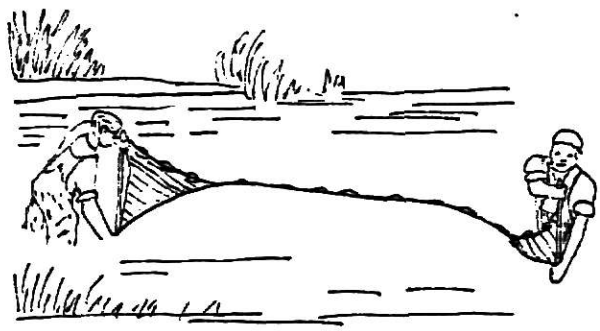


Figure 1

Stream

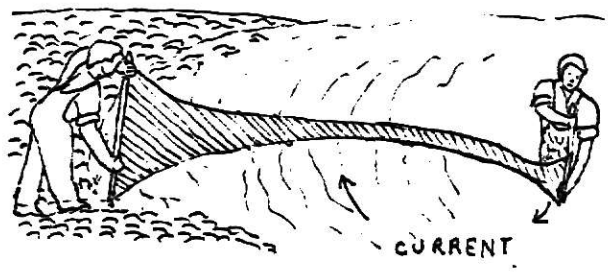
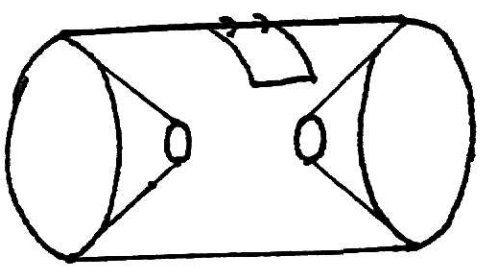


Figure 2

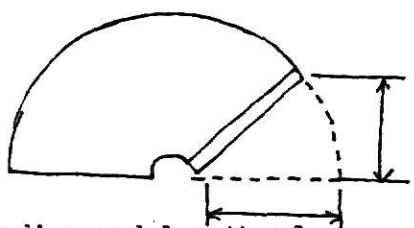
The third method is to use a fish trap. Figure 3 illustrates a funnel trap which is appropriate for both crustaceans and fish. The basic principle of the minnow trap is the funnel which leads toward a bait. The trap may be square or round or any form one chooses. One funnel is often sufficient but two or more may increase the catch. For operation a trap is baited and lowered into a stream or pond by means of an anchor string. The bait generally consists of chopped fish tied in cheesecloth and suspended between the two funnels.

A



B

made from $\frac{1}{4}$ inch hail screen



The radius and length of of cut are equal.

Figure 3

Nets and traps can be purchased at any sporting goods store that carries fishing supplies. The nets especially are priced so that it is better to buy than construct your own. Nets should be washed in fresh water then dried before storing. Fish traps in these stores are regulated for bait fish only, so they are usually small. Larger traps are best constructed for your own needs and purposes but require trapping permits to use if the opening is bigger than one inch.

FISH IDENTIFICATION

This section is adapted from "Fishes in Kansas," by Cross and Collins, University of Kansas Museum of Natural History, Public Education Series No. 3, July 3, 1975. Most fish have one or two dorsal (upper) fins on the back, a tail fin, and a single anal (lower) fin beneath the body near the tail fin. In addition, most fish have two sets of paired fins--the pectoral behind the head, and the pelvic fins behind or below the pectoral fins. Each fin on a fish can be spread or folded by means of thin rods, called rays if they bend easily, and called spines if they are stiff with tips sharp enough to prick your finger. Most Kansas fish have scales, but some do not, and others have scales so small they may not be noticed. Some fish have limp "whiskers" called barbels around the mouth. These are used in finding food. Differences in the position and shape of fins and presence or absence of barbels and scales are important in identifying the fishes. Differences in color also help to identify fish, but fish can change colors, so color is not always a safe way to learn to recognize fish.

In most cases the common name of a family will be relevant identification for all species of that family. The only possible exception is the sunfish family which has three distinct types. Black basses grow larger than other sunfish, are more slender than the other members of the family and are the most prized as game fish. Second are crappies either white or black species that are slab-sided fishes that are easily recognized by having about as many bony spines in their anal fin as in the dorsal fin; crappie abound in most lakes, but are caught less often in streams. The third group consists of several small, compact, often colorful fishes variously called panfish, perch as well as sunfish. For more exact identification use a key, a few are listed in the appendix.

PRESERVING FISH

Those fish to b kept for a collection should be killed in a 5-10% formalin solution. Any fish not for collection should be returned to the water. Some fish will die from handling no matter how careful a person is. These should be collected. Smaller specimens (less than 5"-6") are better for collections, they are easier to handle and take up less space. The killing container should be large enough so that the fish die in a straight position, large mouth gallon jars are excellent. A different killing jar should be used for each collecting site and a take (or note) attached attached to it with information on the date, location, habitat, and collector.

To make a collection, members of a species should be placed in an individual container with pertinent information. Smaller fishes are stored in a 5% formalin. Larger fishes need to be placed in 10% formaline. Long fish can be folded in half and tied to fit in a jar. This has been a fixative process, for long term storage change the solution after a week and rinse to remove slime from the body. For examination specimens can be removed then returned to their containers.

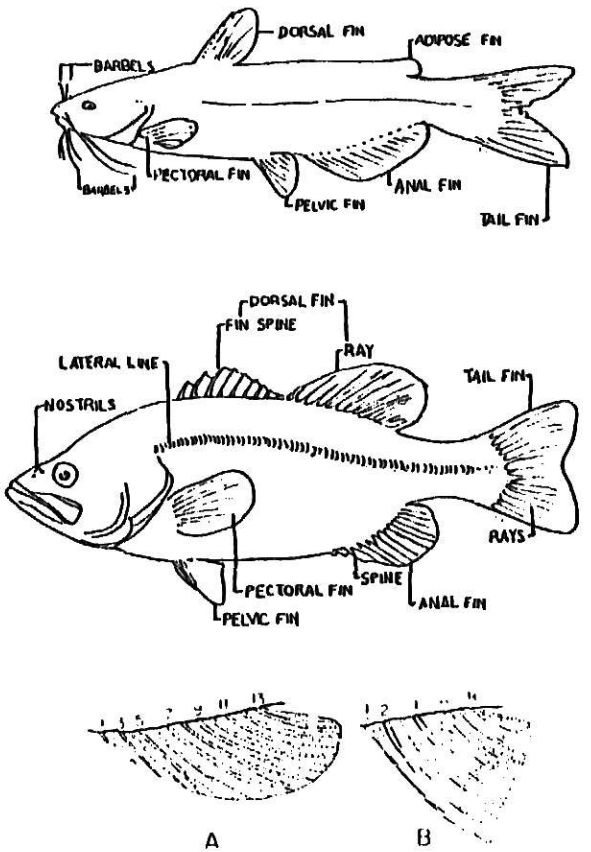


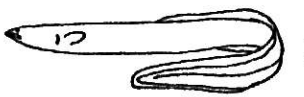
Fig. 5. Channel catfish (top) and largemouth bass (center) with names of fins and other structures mentioned in key to families of fishes and most descriptive accounts. Fins at bottom (*A* and *B*) show *how rays are counted*: A—total count used for fins that slope gradually away from the body, as in topminnows and the anal fin of catfishes, or the dorsal fin of perches; B - principal ray count used for fins that have a straight "leading edge," as in the fins of minnows and suckers

KEY TO THE FAMILIES OF FISHES IN KANSAS

PART A

Worm-like with 7 pits behind eye.

Lamprey Family, see page 23.



Worm-like with small pectoral fin behind head.

Eel Family, see page 33.

Eight whiskers (barbels) around mouth.

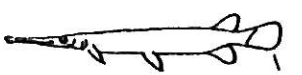
Catfish Family, see page 102.

Snout like canoe paddle. No scales.

Paddlefish Family, see page 20.

Shovel-like snout. Five rows of large, hooked scales.

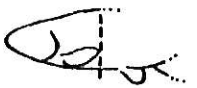
Sturgeon Family, see page 21.



Long jaws with needle-like teeth. Thick bony scales and rounded tail.

Gar Family, see page 27.

If your fish does not resemble any of those above, turn the page and continue



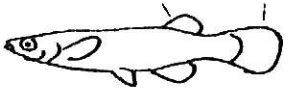
Pelvic fins behind pectoral fins. Go to PART B.

Pelvic fins below pectoral fins. Go to PART C.

PART B

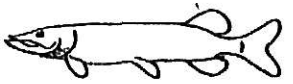
Tail fin rounded. Long dorsal fin.

Bowfin Family, see page 32.



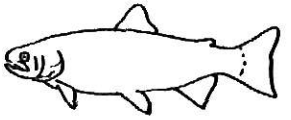
Tail fin rounded. Short dorsal fin.

Topminnow and Mosquitofish families, see page 117.



Tail fin forked. Short dorsal fin near tail.

Pike Family, see page 30.

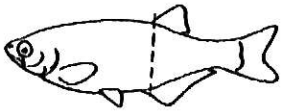


Flap-like adipose fin on back between dorsal fin and tail fin.

Trout Family, see page 38.

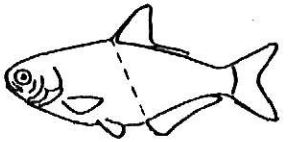
Two separate dorsal fins (the first is very small—look carefully). Pectoral fin high on side of body.

Silverside Family, see page 123.



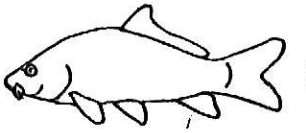
Dorsal fin above anal fin. Jaws strongly toothed. Belly scales do not form sharp edge.

Mooneye Family, see page 37.



Dorsal fin in front of anal fin. Jaws without strong teeth. Belly scales form sharp edge (run finger *forward* along belly).

Herring Family, see page 35.

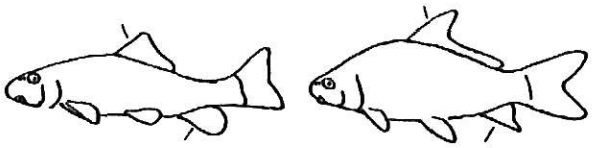


Saw-edged bony spine at front of dorsal and anal fins.

Minnow Family (Carp and Goldfish), see page 41.

Generally small (less than 8 inches long) and thin-lipped. No spines in dorsal and anal fins—note their shape and position.

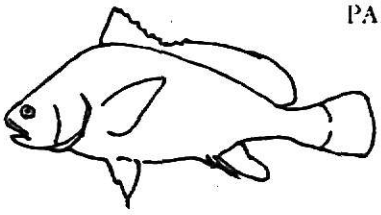
Minnow Family (native minnows), see page 41.



Sucker Family, see page 80.

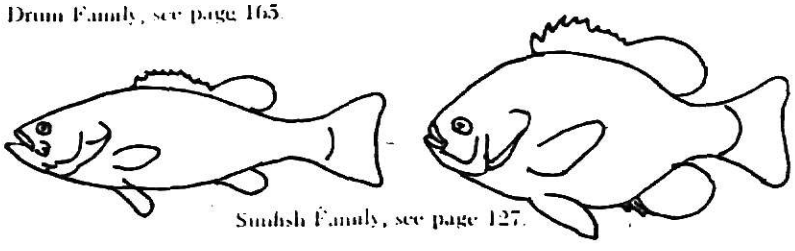
Generally large and thick-lipped. No spines in dorsal and anal fins—note their shape and position.

PART C



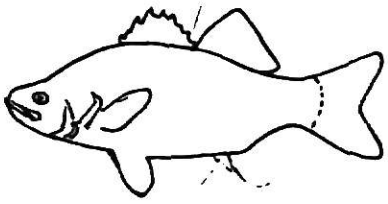
One dorsal fin. Tail fin rounded. Two stout spines in anal fin.

Drum Family, see page 165.



Sunfish Family, see page 127.

One dorsal fin. Tail fin notched. Three spines in anal fin.

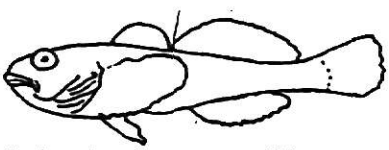


Two dorsal fins. Three spines in anal fin. Sides flattened.

Temperate Bass Family (White and Striped basses), see page 125.

Two dorsal fins. Two or less spines in anal fin. Sides rounded.

Perch Family (includes walleyes and darters), see page 112.



Two dorsal fins. Body naked (without scales). No spines in anal fin

Sculpin Family, see page 124.

Two dorsal fins (first one is small). One chin whisker. Tail fin rounded.

Codfish Family, see page 116.

Reprinted from Cross and Collins "Illustrated Guide to Fishes in Kansas".

Cross, F. B. & J. T. Collins
1975. Fishes in Kansas, Univ. of Kansas Mus. Nat. Hist., Pub. Ed. Ser. 3: 1-189. Available for $6.50 postpaid from Publications Secretary, Museum of Natural History, University of Kansas, Lawrence, Kansas 66045.

Cross, F. B. & J. T. Collins
1976. Illustrated Guide to Fishes in Kansas, Univ. Kansas Mus. Nat. Hist., Pub. Ed. Ser. 4: 1-24.

Eddy, S. & J. C. Underhill
1978. How to Know the Freshwater Fishes, Wm. C. Brown Co. Publishers, Dubuque, Iowa.

McClane
1970. McClanes Field Guide to Freshwater Fishes of North America, Holt, Rinehart and Winston; New York, N.Y.

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Knudsen, J. W., 1966, "Collecting and Preserving Plants and Animals," Harper & Row Publishers, New York, Evanston, San Francisco, London, pp 210-222.

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FIELD EXPERIENCES

THE STUDY

OF

HERPS

RATIONALE

Amphibians and reptiles are two of the most misunderstood groups of animals in the world. Tradition has endowed these creatures with evil and mysterious powers that have generated many fears and superstitions which are unfounded. Amphibians and reptiles are important parts of nature's scheme and deserve respect and understanding. Education and knowledge are the only means of teaching people the value of amphibians and reptiles or other less loved creatures.

INSTRUCTIONAL OBJECTIVES

On completion of this module the student will be able to:

1. Identify at least 3 places to locate amphibians.
2. Identify at least 2 places to locate reptiles.
3. Name one method of trapping amphibians.
4. Describe the proper method of holding snakes.
5. Outline ways of maintaining aquarium pets.
6. Use a key to identify amphibians and reptiles.

LEARNING ACTIVITIES

Introductory Activity

1. Read and study the information in this module.

Application Activity

2. Locate and catch a reptile or amphibian.
3. Use a key to identify the specimen to genus.

Alternate Activity

4. Locate a field guide for amphibians and reptiles of North America.

INTRODUCTION

In recent years increasing emphasis has been placed on outdoor education and investigation of plants and animals. One area of outdoor education that receives little interest is the study of amphibians and reptiles because of traditional fears held by many people. As a result, harmless and beneficial amphibians and reptiles are often destroyed through ignorance. The purpose of this module is to show ways to find, study and enjoy amphibians and reptiles. Instructions for the identification of Kansas specimens are also included.

PLANNING FIELD TRIPS

The key to success is careful planning. There are many things to consider when organizing a field trip. Some are school policy, permission of supervisiors, teacher liability, transportation, length of trip, safety precautions and cost. They have little to do with amphibians and reptiles but are an important part of any field trip. Here are some questions that should be answered before going on a field trip.

1. What are the objectives of this trip?
2. How much time is available or needed?
3. Will transportation be necessary?
4. Where should this trip be taken?
5. When is the best time to go?
6. What kind of equipment will be necessary?

The answer to these questions will determine the type of field trip and establish an outline for the purposes of the field trip. From this you will be able to evaluate the benefits the students will receive from this type of service.

LOCATING AMPHIBIANS AND REPTILES

In spring, following the choruses of frogs and toads will lead to their discovery; at such time it is profitable to look about until voices of interest are heard. At other times any pond, marsh or other body of water may be expected to contain individuals. Most species of salamanders breed early in the spring. All caves, especially those containing water, are likely places for amphibians and, to a lesser extent, for reptiles. In caves care should be taken to observe streams or pools closely for any sign of small salamanders and salamander larvae.

Seiving of marshes, ponds and streams is a productive method. Turtles and occasionally snakes or salamanders are to be found by this means. Any closely packed debris or vegetation present near the borders of bodies of water should be hauled onto the shore and carefully inspected for salamanders, frogs, snakes or turtles.

The most effective field technique is to keep a sharp eye on the entire surroundings and turn every conceivable type of cover. Stones, logs, cardboard, junk, tin and any other moveable surface cover may conceal some seldom seen reptile and amphibian. Objects can be turned with a stick or hoe in case a poisonous snake should be there. An alert observer never leaves a stone unturned, but always replaces the stone or log to its original position. Failure to relace stones and logs to their original position will result in destruction of the habitat. In early spring and to a lesser extent in the fall, one may expect good results from this effort. In the summer the ground under such cover is often too dry, and little will be seen. At such times of the year it is by far the best practice to be about early in the morning, before the heat of the sun has penetrated through cover to the ground. Often much more will be present under such cover early in the morning than at any other time.

In certain areas removal of debris from the ground reveals many specimens. Accumulations of leaves, twigs and even flood deposits often conceal reptiles or amphibians. Rotten logs and loose bark on logs or trees are also a favorite haunt; different species often prefer different types of logs. As logs are turned and broken up one should always remember to lift the bark that may remain on the ground and under which animals often seek protection. Bales of hay drying in fields may conceal snakes and make it profitable for the observer to be present when the hay is being removed.

Inspecting the edges of streams or pools may reveal small holes in the mud or sand where the heads of turtles have been protruding. Feeling with the hands or feet about such spots often yields turtles that would otherwise be difficult to find.

COLLECTING AND HANDLING AMPHIBIANS AND REPTILES

Once discovered, all frogs and salamanders occurring in Kansas may be captured and handled with safety. Catching them by hand, dip net or sieve. Care should be taken, however, to avoid any possible contact of the skin mucus with a person's eyes, nose or mouth, because the skin secretions of certain salamanders, some frogs and all toads are poisonous if ingested and irritate any mucus membranes. These amphibians are best handled by taking the hand and grasping the animal arount its waist.

If one is fast enough, lizards can be caught with bare hands or a net. A lizard noose is the best method for catching lizards for lizards have a lot of tolerance for the noose and will not go far if missed. The noose should be slowly brought over the head then quickly pulled toward the tail to tighten the noose. Hold lizards to secure the legs and to prevent sudden lunges by holding the neck between thumb and forefinger. Caution needs to be taken not to grab or hold a lizard by the tail for it can break off.

Land turtles can generally be caught by hand with little difficulty but water turtles require special handling. Aquatic turtles can sometimes be spotted in shallow water and chased down. More success will be had by trapping water turtles. Snapping turtles are very dangerous to handle, they can cause severe injury by biting. For small snappers using the tail for a handle is a good way. Large snappers should be held in the same fashion as softshell turtles. This is done by taking one hand on the upper shell and applying enough pressure on the neck so the head cannot reach around and bite. The other hand is used to grasp the tail or shell just above it.

Snakes, however, include a number of dangerous, venomous species. Unless these can be recognized positively in advance, the amateur should treat all snakes as if venomous and avoid them in the safest possible manner. For any type of field trip it is wise to become familiar with the identity of poisonous snakes of that region. Harmless snakes can be temporarily captured for closer examination by picking them up quickly by any part of the body. However, any snake more than sixteen inches long may be capable of giving a painful bite and some precaution may be desired. Gloves can be worn or a stick or other object used to firmly hold the snake's head, while the other hand grasps it on the neck. The proper method for holding snakes is to place the thumb and middle fingers on either side of the head and place the index finger on top. Grasp firm enough to control but not to harm the snake. Use the free hand to hold the body near the middle. It is possible to use only one hand for very small snakes under twelve inches. Very large snakes may require the aid of an assistant.

Amphibians and reptiles are facing problems created by man's activity. Because of this they should not be collected but captured, examined and released. Ignorance has brought about the wanton destruction of snakes (poisonous or nonpoisonous) or other reptiles. Reptiles especially are of very considerable value in the balance of nature and to man in controlling his really important enemies and pests among the insects and small mammals. Amphibians also contribute to our needs by consuming large numbers of insects and their larva. But amphibians are threatened by the filling in or pollution of their watery homes.

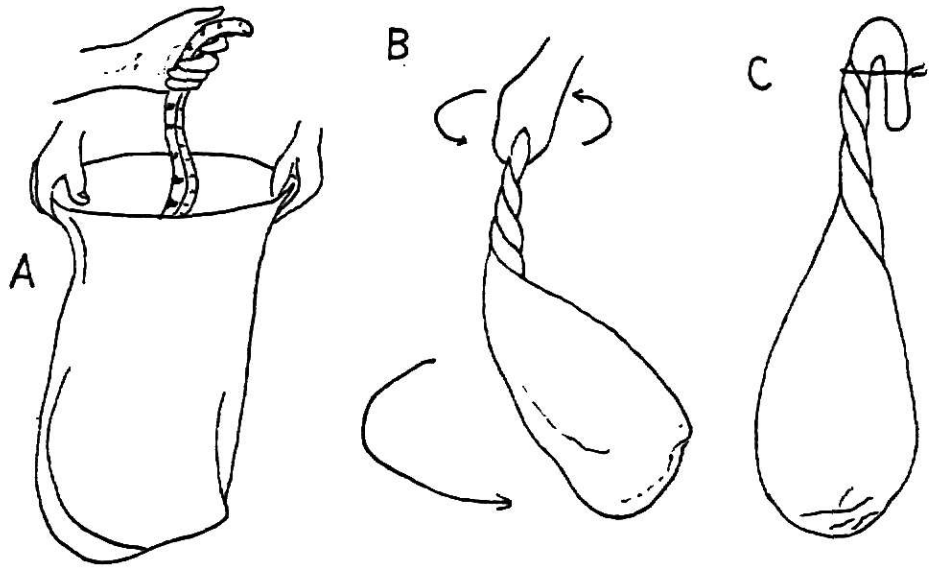
TRANSPORTATING AND PRESERVATION OF AMPHIBIANS AND REPTILES

For reference collections, it is best to use only the most abundant and easily identifiable forms. Generally a few each of frogs, toads, salamanders, turtles or snakes is sufficient.

Amphibians will need to be separated into separate containers with only those of one kind in each container. Each genera secretes a specific mucus poison on the skin that can be fatal to other genera. Collecting containers should not be overcrowded and must be kept moist and cool. Quart jars with a little water and paper toweling are best if holes are punched in the lid.

Reptiles are placed in cloth bags when captured. Use bags made of stout canvas for poisonous snakes or large nonpoisonous ones. Snakes are especially adept at working through weak spots in the seam of a bag or through the neck of the bag, unless it is properly tied. Figure 18-1 shows one method of bagging a specimen. The specimen is dropped into the bag, where upon the mouth of the bag is closed and the sack is spun around to twist the neck. This prevents the specimen from escaping while the neck of the bag is being tied. Note the neck of the bag is doubled over and double tied.

Large lizards and nonpoisonous snakes are placed in bags as follows: While holding the specimen in your right hand reach all the way to the bottom of the bag. Grip the specimen with your hand through the bag, release your right hand while still holding the specimen with your left hand, and twist the neck of the bag closed. Professional rattlesnake collectors attach a collecting sack to a stout hoop and handle. The bag then resembles a butterfly net. Specimens are transferred to the bag by means of a snake stick or hooked stick.



Preservation of specimens for a reference collection is accomplished through several stages or steps. Amphibians can be killed by placing them directly in a 10% formalin solution. To fix amphibians inject body cavity with formalin then position the specimen as desired and place in a jar filled with 10% formalin for about a week. Next the specimen is transferred to a solution of 5% formalin, 70% ethyl alcohol or 40-50% isopropyl alcohol. It is sometimes a good idea to soak the specimen in water a day or two before transferring and washing off any remaining mucus.

Reptiles can be killed most effectively and cheaply by freezing them. It is not the least inhumane for the reptile goes to sleep before it freezes. Chloroton, clove oil in their water, or chloroform can be used also. To fix reptiles, formalin has to be injected throughout the body then the specimen is placed in a 10% formalin for a few days. After fixing, follow the same steps as for the amphibians only using 6% formalin for small ones and 10% formalin for the larger ones.

After preservation the jars should be labeled with the date, location, collector, preparer, field notes and colors. Storage in a cool dark place with little temperature change is essential.

Additional parts of collections include dried specimens (mostly turtles) which are injected with formalin then dried in position. Skulls can be added by soaking in Clorox.

Diagrams on the following pages were taken from Peterson's Field Guide to Reptiles and Amphibians of the Eastern and Central U. S. by Conant.

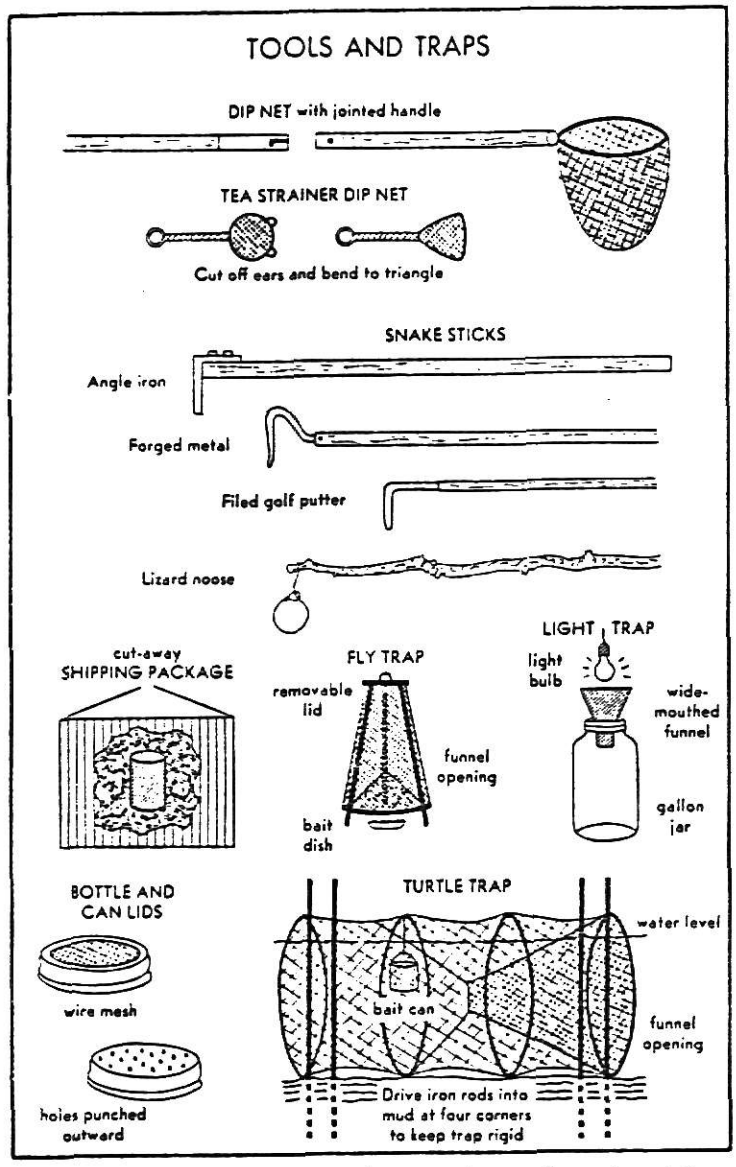


Fig. 1. Tools used in catching and transporting reptiles and amphibians. (See also Plate 1.) Fly and light traps are useful for gathering live insects to feed captive lizards, toads, treefrogs, etc.

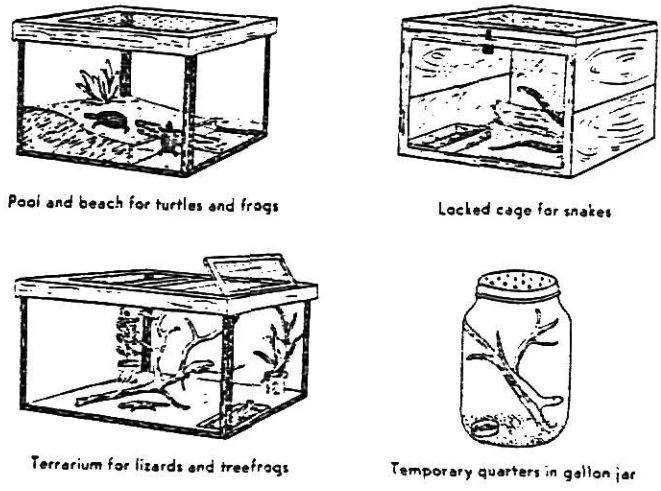
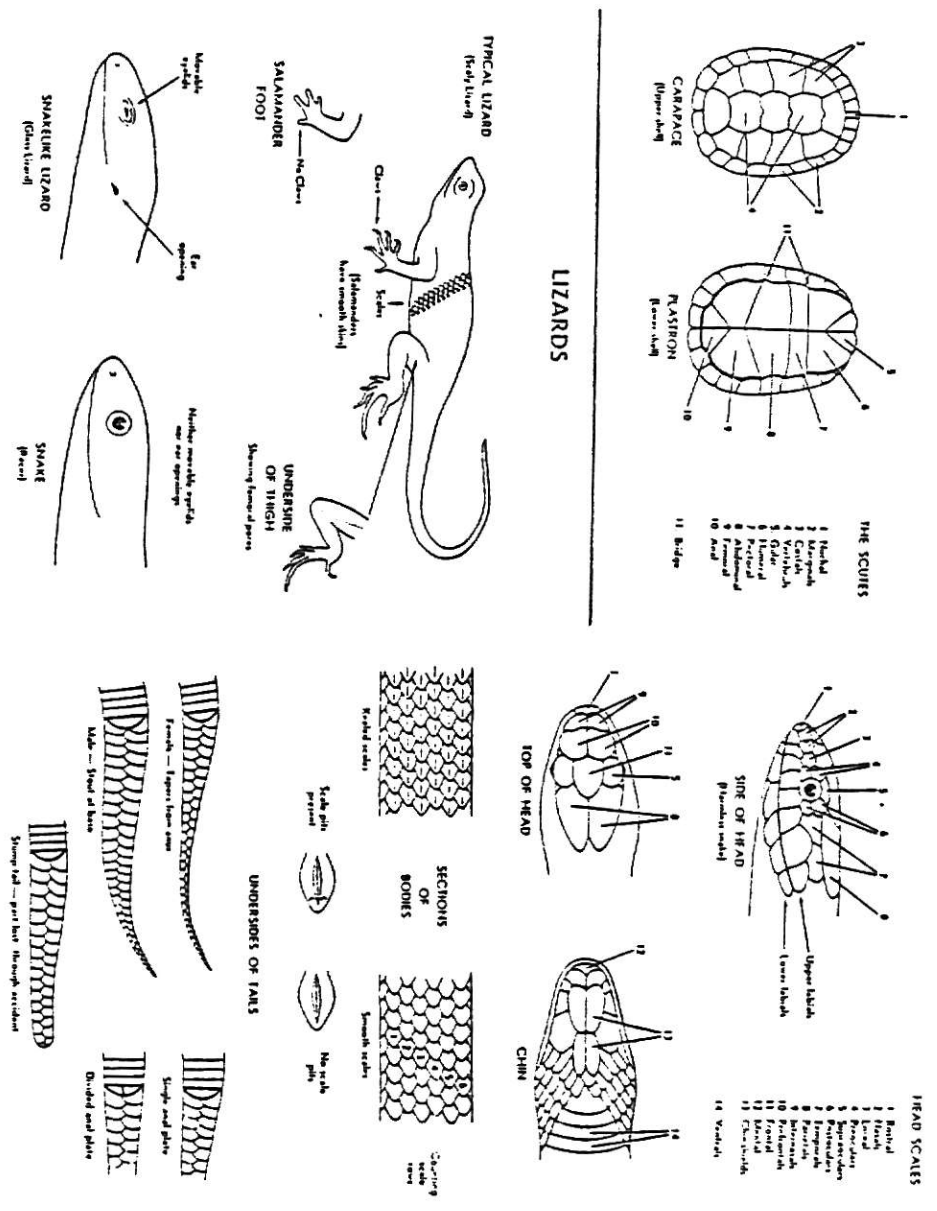


Fig. 2. Living quarters for the smaller kinds of reptiles and amphibians are easily made from old aquariums, wooden boxes, and glass gallon pickle, mustard, and mayonnaise jars.

Reprinted from Conant, "A Field Guide to Reptiles and Amphians of Eastern and Central North America ".



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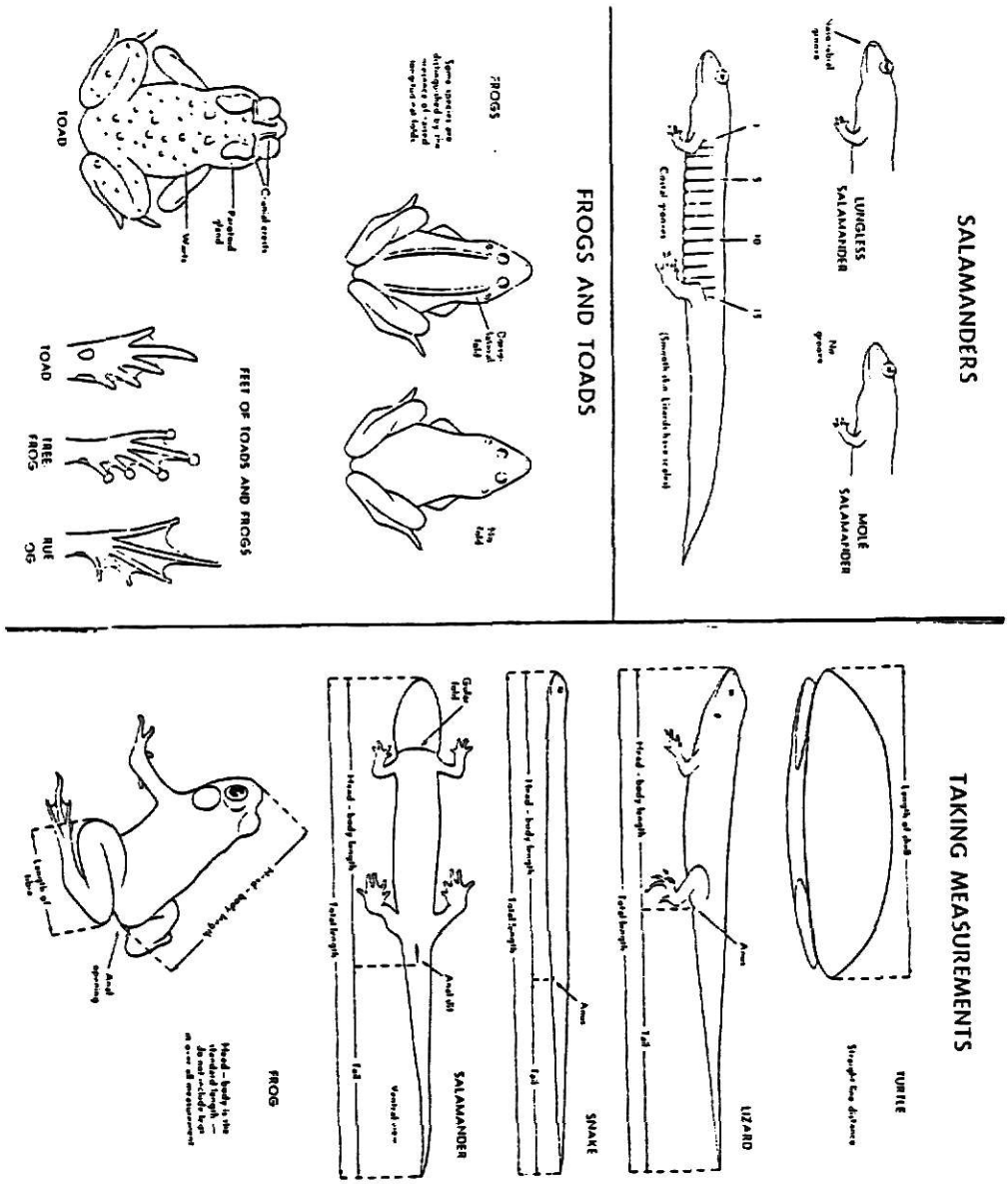
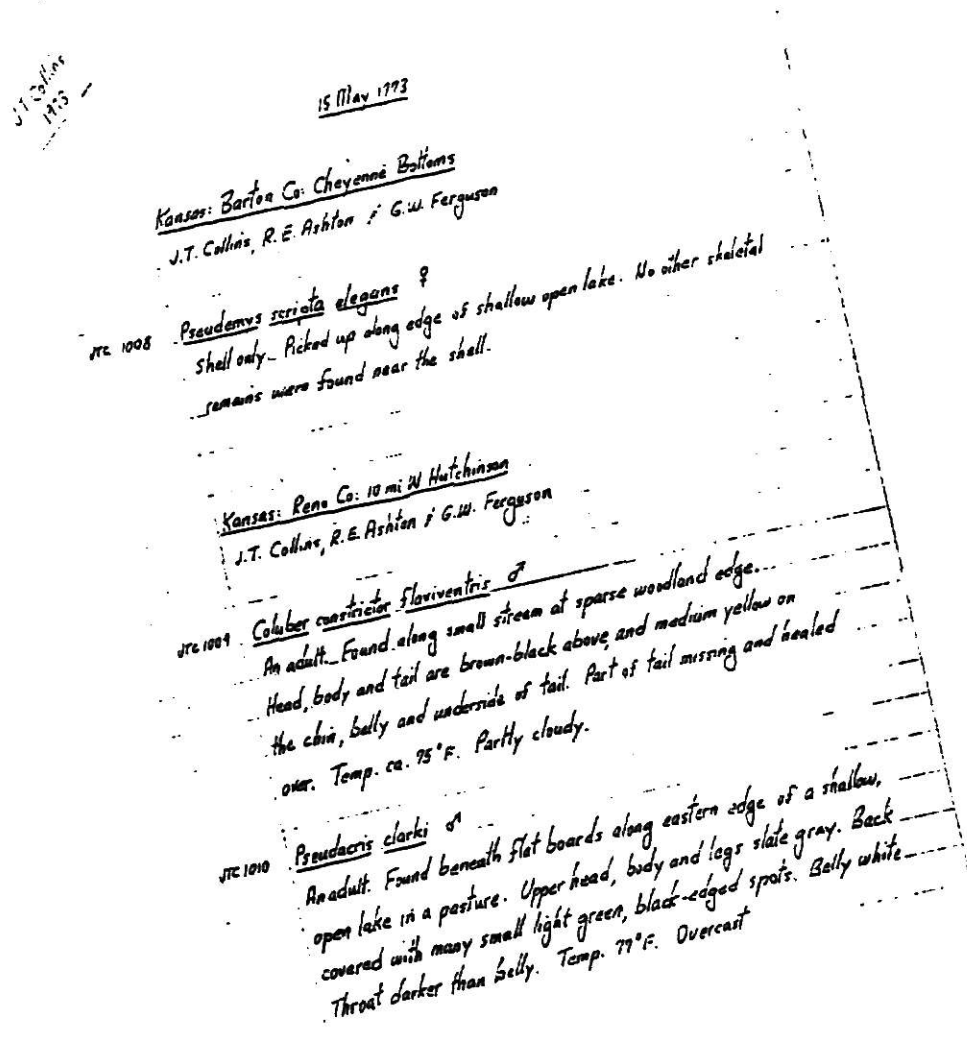


Reprinted from Conant, "A Field Guide to Reptiles and Amphibians of Eastern and Central North American".

Maintaining Records

All field scientists maintain a field notebook which contains accurate records of field trips. Such records include date, location, weather, habitat, collectors, observations, and a list of what is collected. See the copy of a page from a field notebook (below). It is a good habit to maintain field notes if one is planning to continue studies in biology.



15 May 1993

Kansas: Barton Co: Cheyenne Bottoms
J.T. Collins, R.E. Ashton & G.W. Ferguson

JTC 1008 Pseudemys scripta elegans ♀
Shell only - Picked up along edge of shallow open lake. No other skeletal remains were found near the shell.

Kansas: Reno Co: 10 mi N Hutchinson
J.T. Collins, R.E. Ashton & G.W. Ferguson

JTC 1009 Coluber constrictor flaviventris ♂
An adult. Found along small stream at sparse woodland edge. Head, body and tail are brown-black above, and medium yellow on the chin, belly and underside of tail. Part of tail missing and healed over. Temp. ca. 95°F. Partly cloudy.

JTC 1010 Pseudacris clarki ♂
An adult. Found beneath flat boards along eastern edge of a shallow, open lake in a pasture. Upper head, body and legs slate gray. Back covered with many small light green, black-edged spots. Belly white. Throat darker than belly. Temp. 77°F. Overcast

Reprinted from Ashton "Reptiles and Amphibians".

A Key to Kansas Amphibians and Reptiles

A key consists of a series of couplets. Each couplet offers a choice of contrasting characters or identification marks. To use this key, start with the first couplet and choose the statement (A or B) which most nearly fits the reptile or amphibian you are trying to identify. Then proceed to the next couplet as indicated, until you reach the name of the animal.

KEY TO THE SPECIES OF ADULT FROGS AND TOADS IN KANSAS

1A. Enlarged, raised, round or kidney-shaped or elongate glands on neck behind eyes; skin dry; bony crests between and/or behind eyes may or may not be present 2

1B. No enlarged glands on neck behind eyes; skin moist; no bony crests on head 6

2A. Enlarged gland on neck is round; small reddish warts on brown or grey back; no bony crests on head ..... Red-spotted Toad

2B. Enlarged gland on neck is kidney-shaped or elongate; bony crests may or may not be present 3

3A. Color green or yellow-green with small black spots and/or bars which sometimes unite on back to form network pattern; belly white; no bony crests on head ..... Western Green Toad

3B. Bony crests present between and behind eyes 4

4A. Pairs of large dark blotches outlined with light borders on back and sides; bony crests between eyes come together on snout to form large, flat, raised knob or boss ..... Great Plains Toad

4B. No large dark blotches on back; bony crests between eyes do not meet to form a knob or boss 5

5A. Belly covered with dark spots; enlarged gland behind eye separated from bony crest behind eye or connected only by a short spur from the bony crest ..... American Toad

5B. Belly white or with only one dark breast spot; enlarged gland behind eye in contact with the bony crest behind eye ..... Rock Mountain Toad

6A. Skin folded once across back of head behind eyes; snout very pointed 7

6B. Skin not folded across back of head behind eyes; snout round 8

7A. Color uniform grey or light tan; belly uniform white or yellowish ..... Plains Narrow-mouthed Toad

7B. Color uniform brown or reddish brown; belly darkly spotted or mottled; a light stripe may or may not be present down the back ..... Eastern Narrow-mouthed Toad

Reprinted from Ashton "Reptiles and Amphibians".

8A. Eye slit vertically when exposed to strong light; black spur at base of each hind foot ..... Plains Spadefoot

8B. Eye not slit vertically when exposed to strong light; no black spur at base of each hind foot 9

9A. Enlarged pads on each toe 10

9B. No enlarged pads on each toe 11

10A. Color grey, tan or brown with darker X-shaped mark on back ..... Northern Spring Peeper

10B. Color variable (grey, tan or green); white patch under each eye; underside of thighs bright yellow or orange ..... Southern Gray Treefrog

11A. Triangular mark between eyes followed by single stripe down back; ragged black length-wise stripe on each inner thigh; *alternating light* and dark bars on upper lips ..... *Blanchard's Cricket Frog*

11B. No triangular marks between eyes or, if present, with spots or three stripes; no ragged black stripe on thighs; no alternating light and dark bars on upper lips 12

12A. A raised fold or ridge of skin on each side of back running from behind eye down back to thigh 13

12B. No raised fold or ridge of skin on back between eye and thigh 16

13A. No spots on back ..... Green Frog

13B. Pattern of distinct spots on back 14

14A. *Spots between* folds of skin on back arranged roughly in two rows down back; underside of thighs yellow-orange ..... Pickerel Frog

14B. Spots between folds of skin on back scattered irregularly; underside of thighs white 15

15A. Few or no dark marks or fleckings between spots on back ..... Leopard Frog

15B. Numerous dark flecks present between spots on back and sides, creating network pattern ..... Northern Crawfish Frog

16A. Light line on upper lips 17

16B. No light line on upper lips ..... Bullfrog

Reprinted from Ashton "Reptiles and Amphibians".

17A. Length of back darkly striped or with stripes broken into rows of spots ..... Western Chorus Frog

17B. Back covered with light pale green spots darkly bordered ..... Spotted Chorus Frog

KEY TO THE SPECIES OF ADULT SALAMANDERS IN KANSAS

1A. Presence of bushy gills or gill-slit (opening on side of neck) 2

1B. Gills and/or gill slits absent 3

2A. Four toes on each hind foot; reddish, bushy gills extend out from each side of neck ..... Waterdog

2B. Five toes on each hind foot; one gill-slit opening on either side of neck ..... Hellbender

3A. No vertical grooves on sides of body; body color olive-green to brown; belly distinctly yellowish ..... Central Newt

3B. Distinct vertical grooves on sides of body between front and hind limbs 4

4A. Sixteen or more body grooves between front and hind limbs 5

4B. Fourteen or less body grooves between front and hind limbs 6

5A. Sixteen to eighteen vertical body grooves between front and hind limbs; color grayish-pink ..... Crotto Salamander

5B. Nineteen or twenty vertical body grooves between front and hind limbs; color tan or gray ..... Gray-bellied Salamander

6A. Body slender and yellow or orange with black streaks, flecks and/or spots 7

6B. Body robust and dark colored; with or without light colored spots, bars and/or mottling 8

7A. Continuous dark streak from snout to tail ..... Dark-sided Salamander

7B. No dark streak from eye to tail; body and tail covered with small distinct black spots ..... Cave Salamander

8A. Body darkly mottled; no light spots or bars on body; belly dark ..... Small-mouthed Salamander

8B. Body dark with distinct light spots, bars and/or mottling on back and sides; belly yellow or yellow and black ..... Tiger Salamander

Reprinted from Ashton "Reptiles and Amphibians".

KEY TO THE SPECIES OF ADULT TURTLES IN KANSAS

1A. Tail longer than half the length of the upper shell; tail covered with raised, saw-toothed projections 2

1B. Tail shorter than half the length of the upper shell; tail not covered with raised projections 3

2A. Upper jaw strongly hooked; three rows of large raised keels running from front to back of upper shell; large scales on top of head ..... Alligator Snapping Turtle

2B. Upper jaw not strongly hooked; upper shell has few keels, if any, and none in rows running from front to back; no large scales on top of head ..... Common Snapping Turtle

3A. Edges of upper shell soft and flexible 4

3B. Entire upper shell hard and rigid 5

4A. Front margin of upper shell with small bumps or tubercles; front and rear feet and legs covered with dark streaks and/or spots ..... Western Spiny Softshell

4B. Front margin of upper shell smooth; front and rear feet and legs uniform color—no streaks or spots ..... Midland Smooth Softshell

5A. Lower shell has two distinct movable hinges at front and back 6

5B. Lower shell without distinct movable hinges 8

6A. Feet are webbed; tail has horny, claw-like tip ..... Yellow Mud Turtle

6B. Feet are not webbed; tail without horny, claw-like tip 7

7A. Usually three claws on rear feet; lower shell uniform color with no markings ..... Three-toed Box Turtle

7B. Usually four claws on rear feet; lower shell with distinct radiating yellow lines ..... Ornate Box Turtle

8A. Two small fleshy projections or barbels on chin ..... Stinkpot

8B. No small fleshy projections or barbels on chin 9

9A. Rear edge of upper shell smooth and without jagged projections; lower shell patterned with bright red ..... Western Painted Turtle

Reprinted from Ashton "Reptiles and Amphibians".

9B. Rear edge of upper shell roughly notched with jagged projections; lower shell not patterned with bright red 10

10A. Distinct raised dark-tipped keel running down middle of upper shell 11

10B. No keel running down middle of upper shell, or, if present, low and not dark-tipped 12

11A. Long crescent-shaped, white or yellow mark behind eye which prevents all small head stripes from reaching the eye; no yellow spot on upper jaw beneath eye ..... Mississippi Map Turtle

11B. Short crescent-shaped mark behind eye, but small head stripes pass below it and reach to the eye; yellow spot present on upper jaw beneath eye ..... False Map Turtle

12A. Small yellow spot behind eye and separated from eye by a short vertical yellow line; dark-colored seams between large scales (plates) on belly ..... Map Turtle

12B. No small yellow spot behind eye; lower shell with or without pattern 13

13A. Lower shell unmarked; head dark with yellow stripes ..... Missouri Slider

13B. Lower shell with pattern of dark spots; large red stripe behind each eye (old adults may be completely black) ..... Red-eared Turtle

KEY TO THE SPECIES OF ADULT LIZARDS IN KANSAS

1A. No ear openings on head behind each eye ..... Lesser Earless Lizard

1B. Ear openings on head behind each eye 2

2A. No front and rear legs present ..... *Western Slender* Glass Lizard

2B. Front and rear legs present 3

3A. Back covered with rough, raised scales; spines on back of head may or may not be present 4

3B. Back covered with flat or granular scales which are smooth 5

4A. Large spines on back of head ..... Texas Horned Lizard

4B. No large spines on back of head ..... Eastern Fence Lizard

Reprinted from Ashton "Reptiles and Amphibians".

5A. Two black bands on neck ..... Eastern Collared Lizard
5B. No black bands on neck 6

6A. Seven light stripes present, one down middle and three on each side of back; belly scales much larger than tiny scales on back ..... Prairie Lined Racerunner
6B. Four to seven light stripes on back; belly scales same size as scales on back; scales on entire body appear shiny or glossy and feel very smooth 7

7A. No light stripes on back or sides; back brown; dark stripe on each side running from eye onto tail ..... Ground Skink
7B. Light stripes on back and/or sides 8

8A. Scale rows on sides of body between front and hind legs slant upwards from front to back ..... Great Plains Skink
8B. Scale rows on sides of body between front and hind legs are parallel with ground and do not slant upwards 9

9A. No light stripes on top of head; a broad dark stripe on each side of body bordered above and below by light stripe and extending from eye onto tail ..... Southern Coal Skink
9B. Light stripes on head may or may not be present; usually alternating dark and light stripes on back and sides 10

10A. Seven light stripes on back and sides alternating with six or eight dark stripes; light stripes on back are less distinct than on sides; the dark stripe on the side which runs from the eye onto the tail always bordered above and below by distinct light stripes ..... Prairie Skink
10B. Five light stripes on back and sides and two light stripes on head in young adult males, females, and young; old males without stripes and have a bright orange-red head 11

11A. Fifth scale (counting from nose back) on upper lip touches the lower edge of eye ..... Five-lined Skink
11B. Sixth scale (counting from nose back) on upper lip touches the lower edge of eye ..... Broad-headed Skink

Reprinted from Ashton "Reptiles and Amphibians".

A KEY TO THE SPECIES OF ADULT SNAKES IN KANSAS

1A. Scales on belly much wider than those on upper part of body 2

1B. Scales on belly same size as those on upper part of body; pinkish-brown color ..... New Mexico Blind Snake

2A. Pit or depression on each side of head between eye and nostril; with or without rattle (POISONOUS) 3

2B. No pit or depression on each side of head between eye and nostril; no rattle 6

3A. With rattle on tail 4

3B. Without rattle on tail ..... Copperhead

4A. Nine large scales on top of head between and in front of eyes ..... Massasauga

4B. Small scales on top of head except one large scale above each eye 5

5A. Bands or blotches on tail; upper body patterned with dark blotches ..... Prairie Rattlesnake

5B. Tail usually uniform black; rusty, reddish stripe down middle of back; upper body patterned with dark bands or chevrons ..... Timber Rattlesnake

6A. Nose turned sharply upward 7

6B. Nose not turned sharply upward 8

7A. Underside of tail lighter than color of belly ..... Eastern Hognose Snake

7B. Underside of tail and belly black ..... Western Hognose Snake

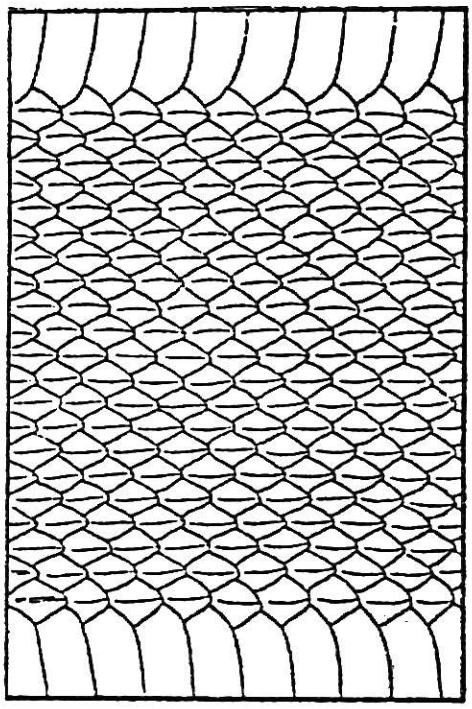
8A. All or some scales on upper part of body keeled (see Fig. 1A) 9

8B. All scales on upper part of body smooth (see Fig. 1B) 25

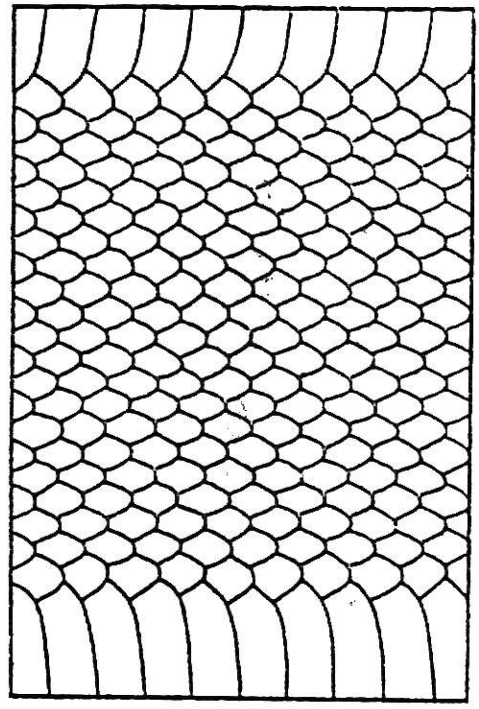
9A. All scales on upper part of body keeled 11

Repinted from Ashton "Reptiles and Amphibians".

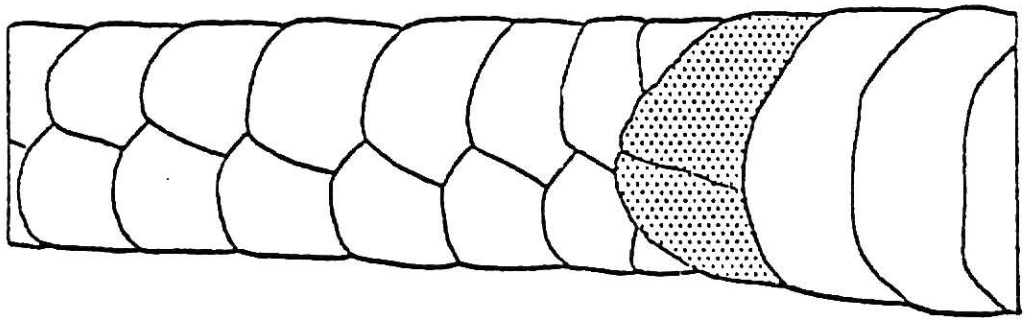
1A

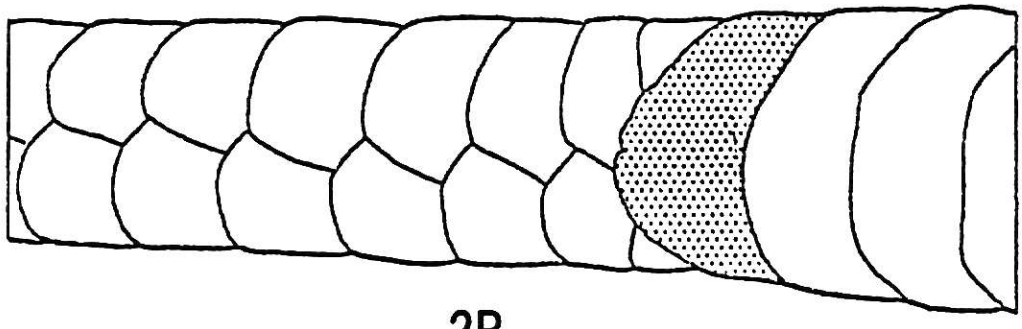


1B



2A





2B

Reprinted from Ashton "Reptiles and Amphibians".

9B. Only scales on rear portion of upper body weakly keeled; color of upper part of body light brown with no pattern 10

10A. Five scales on upper lip; one scale directly behind each eye ..... Rough Earth Snake

10B. Six scales on upper lip; two or more scales directly behind each eye ..... Western Earth Snake

11A. Anal scale divided into two parts (see Fig. 2A) 12

11B. Anal scale not divided into two parts (see Fig. 2B) 20

12A. Body, head and tail uniform green color ..... Rough Green Snake

12B. Body, head and tail not uniform green color 13

13A. Upper body uniform grey or brown with wide light tan or cream stripe on lower sides running from head onto tail ..... Graham's Water Snake

13B. Upper body not colored and patterned as in 13A 14

14A. Upper body uniform dark color or with dark bands or blotches on a lighter background 16

14B. Upper body not banded or blotched; either light brown with two rows of dark spots down back or reddish with light spot on each side of neck behind head 15

15A. Seven scales on upper lip; belly color cream or greyish; two rows of dark spots down back ..... Texas Brown Snake

15B. Five or six scales on upper lip; belly bright orange-red or jet black; light spot on each side of neck behind head ..... Northern Red-bellied Snake

16A. Belly uniform cream or yellowish with some dark shading on edges of scales; underside of tail cream or yellowish with no pattern ..... *Blotched Water Snake*

16B. Belly and tail not colored or patterned as in 16A 17

Reprinted from Ashton "Rentiles and Amphibians".

17A. Upper body uniform shiny dark brown or black ..... Black Rat Snake

17B. Upper body with pattern of bands or blotches 18

18A. Upper body with brownish blotches on lighter background; belly with dark and light checkerboard pattern ..... Great Plains Rat Snake

18B. Upper body either with bands only or with bands on front of body and blotches on rear; belly with half-moon shaped spots of variable color 19

19A. Upper body patterned with dark bands on drab olive or yellowish background; belly yellow with dark half-moon shaped spots irregularly scattered ..... Diamond-backed Water Snake

19B. Front of upper body with dark bands and rear of upper body with dark blotches; belly with brownish half-moon shaped spots, sometimes in two rows ..... Northern Water Snake

20A. Middle of upper body with length-wise yellow, greenish or orange stripe from head onto tail 21

20B. Upper body with large dark blotches on yellow background ..... Bullsnake

21A. Two rows of black spots down middle of belly; six or less scales on upper lip ..... Lined Snake

21B. No rows of black spots down middle of belly; seven or more scales on upper lip 22

22A. Stripe on each side of body covers third and fourth scale rows (counting upward from first row next to belly) 23

22B. Stripe on each side of body covers second and third scale rows (counting upward from first row next to belly) 24

23A. Upper lips with dark vertical bars; dark spots between stripes on back and sides ..... Western Plains Garter Snake

23B. Upper lips without dark vertical bars; area between stripes on back and sides uniform dark color ..... Western Ribbon Snake

Reprinted from Ashton "Reptiles and Amphibians".

24A. Large, light-colored, crescent-shaped mark on neck behind angle of jaws ..... Checkered Garter Snake

24B. No large, light-colored, crescent-shaped mark on neck behind angle of jaws; area between stripes on back and sides reddish ..... Red-sided Garter Snake

25A. Anal scale divided into two parts (see Fig. 2A) 26

25B. Anal scale not divided into two parts (see Fig. 2B) 34

26A. Upper body, head and tail uniform green color ..... Western Smooth Green Snake

26B. Upper body, head and tail not uniform green color 27

27A. Yellow or orange ring on neck behind head ..... Prairie Ringneck Snake

27B. No yellow or orange ring on neck behind head 28

28A. Eye slit vertically when exposed to strong light ..... Texas Night Snake

28B. Eye not slit vertically when exposed to strong light 29

29A. Upper body dark grey or black; belly pink ..... Western Worm Snake

29B. Upper body and belly not colored as in 29A 30

30A. Upper body light brown with darker head 31

30B. Upper body and head not colored as in 30A 32

31A. Rear of upper body light brown and gradually darkening toward front of body; head dark; one scale behind each eye; six scales on upper lip ..... Flat-headed Snake

31B. All of upper body uniform light brown with abrupt dark head; two scales behind each eye; seven scales on upper lip ..... Plains Black-headed Snake

32A. Upper body dark brown or bluish; belly cream or yellow ..... Eastern Yellow-bellied Racer

Reprinted from Ashton "Reptiles and Amphibians".

32B. Upper body and belly not colored as above 33

33A. Two scales in front of each eye; ten or more scales on lower lip; rear part of body always tan; scales on upper body appear braided ..... Coachwhip

33B. One scale in front of each eye; seven scales on lower lip; upper body tan or reddish-brown, sometimes with one or more dark bands ..... Great Plains Ground Snake

34A. Scales directly behind anal scale on underside of tail are not divided into two rows ..... Texas Long-nosed Snake

34B. Scales directly behind anal scale on underside of tail are divided into two rows 35

35A. Belly white with no pattern ..... Texas Glossy Snake

35B. Belly with light and dark pattern 36

36A. Upper body with bands of red or orange, black and yellow ..... Milk Snake

36B. Upper body with brown blotches or black with yellow speckling 37

37A. Upper body with brown blotches ..... Prairie Kingsnake

37B. Upper body black with yellow speckling ..... Speckled Kingsnake

A Checklist of Amphibians and Reptiles in Kansas

This checklist has been prepared due to the numerous changes in the Kansas herpetofauna which have occurred since the second edition (1956) of Smith's "Handbook of amphibians and reptiles of Kansas," which is out-of-print. Accurate ranges for amphibians and reptiles in Kansas are best obtained from Conant (1958).

Common names used in this list are those standardized for North American amphibians and reptiles by the ASIH Common Names Committee (1956).

We record a total of 91 species and 98 subspecies of naturally occurring amphibians and reptiles in Kansas.

Salamanders

1. Hellbender (*Cryptobranchus a. alleganiensis*)
2. Mudpuppy (*Necturus m. maculosus*)
3. Red River Waterdog (*Necturus maculosus louisianensis*)
4. Central Newt (*Notophthalmus viridescens louisianensis*)
5. Small-mouthed Salamander (*Ambystoma texanum*)
6. Eastern Tiger Salamander (*Ambystoma t. tigrinum*)
7. Barred Tiger Salamander (*Ambystoma tigrinum mavortium*)
8. Dark-sided Salamander (*Eurycea longicauda melanopleura*)
9. Cave Salamander (*Eurycea lucifuga*)
10. Gray-bellied Salamander (*Eurycea multiplicata griseogaster*)
11. Grotto Salamander (*Typhlotriton spelaeus*)

Frogs and Toads

12. Plains Spadefoot (*Scaphiopus bombifrons*)
13. Great Plains Toad (*Bufo cognatus*)
14. Western Green Toad (*Bufo debilis insidior*)
15. Red-spotted Toad (*Bufo punctatus*)
16. American Toad (*Bufo g. americanus*)
17. Rock Mountain Toad (*Bufo w. woodhousei*)
18. Blanchard's Cricket Frog (*Acris crepitans blanchardi*)

Reprinted from Ashton "Reptiles and Amphibians".

19. Western Chorus Frog (*Pseudacris t. triseriata*)
20. Spotted Chorus Frog (*Pseudacris clarki*)
21. Northern Spring Peeper (*Hyla c. crucifer*)
22. Gray Treefrog (*Hyla chrysoscelis*)
23. Eastern Narrow-mouthed Toad (*Gastrophryne carolinensis*)
24. Western Narrow-mouthed Toad (Gastrophyne *olivacea*)
25. Northern Crawfish Frog (*Rana areolata circulosa*)
26. Bullfrog (*Rana catesbeiana*)
27. Green Frog (*Rana clamitans melonata*)
28. Pickerel Frog (*Rana palustris*)
29. Leopard Frog (*Rana pipiens*)

Reptiles

Turtles

30. Alligator Snapping Turtle (*Macroclemys temmincki*)
31. Common Snapping Turtle (*Chelydra s. serpentina*)
32. Stinkpot (*Sternotherus odoratus*)
33. Yellow Mud Turtle (*Kinosternon f. flavescens*)
34. False Map Turtle (*Graptemys pseudo geographica*)
35. Map Turtle (*Graptemys geographica*)
36. Mississippi Map Turtle (*Graptemys kohni*)
37. Western Painted Turtle (*Chrysemys picta belli*)
38. Missouri Slider (*Chrysemys floridana hoyi*)
39. Red-eared Turtle (*Chrysemys scripta elegans*)
40. Three-toed Box Turtle (*Terrapene carolina triunguis*)
41. Ornate Box Turtle (*Terrapene o. ornata*)
42. Smooth Softshell (*Trionyx m. muticus*)
43. Western Spiny Softshell (*Trionyx spinifer hartwegi*)

Lizards

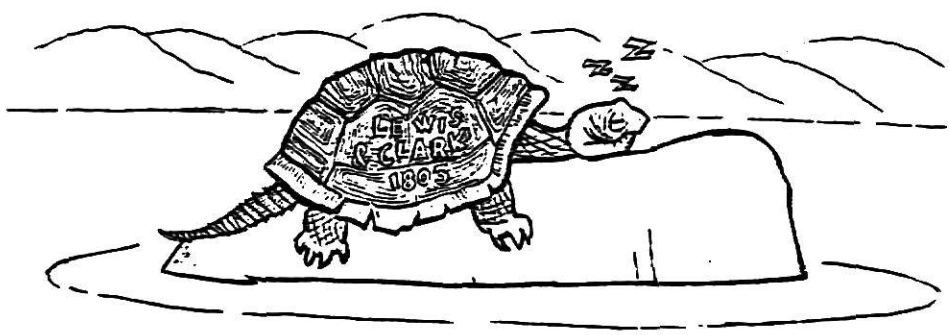
44. Northern Earless Lizard (*Holbrookia m. maculata*)
45. Eastern Earless Lizard (*Holbrookia maculata perspicua*)
46. Eastern Collared Lizard (*Crotaphytus c. collaris*)
47. Northern Fence Lizard (*Sceloporus undulatus hyacinthinus*)
48. Northern Prairie Lizard (*Sceloporus undulatus garmani*)
49. Texas Horned Lizard (*Phrynosoma cornutum*)
50. Ground Skink (*Leiolopisma laterale*)
51. Southern Coal Skink (*Eumeces anthracinus pluvialis*)
52. Five-lined Skink (*Eumeces fasciatus*)
53. Broad-headed Skink (*Eumeces laticeps*)
54. Great Plains Skink (*Eumeces obsoletus*)
55. Northern Prairie Skink (*Eumeces s. septentrionalis*)
56. Southern Prairie Skink (*Eumeces septentrionalis obtusirostris*)
57. Six-lined Racerunner (*Cnemidophorus sexlineatus*)
58. Western Slender Glass Lizard (*Ophisaurus a. attenuatus*)

Snakes

65. New Mexico Blind Snake (*Leptotyphlops dulcis dissecta*)
66. Western Worm Snake (*Carphophis vermis*)
67. Prairie Ringneck Snake (*Diadophis punctatus arnyi*)
68. Eastern Hognose Snake (*Heterodon platyrhinos*)
69. Plains Hognose Snake (*Heterodon n. nasicus*)
70. Dusty Hognose Snake (*Heterodon nasicus gloydi*)
71. Rough Green Snake (*Opheodrys aestivus*)
72. Western Smooth Green Snake (*Opheodrys vernalis blanchardi*)
73. Eastern Yellow-bellied Racer (*Coluber constrictor flaviventris*)
74. Eastern Coachwhip (*Masticophi f. flagellum*)
75. Western Coachwhip (*Masticophis flagellum testaceus*)
76. Great Plains Rat Snake (*Elaphe guttata emoryi*)
77. Black Rat Snake (*Elaphe o. obsoleta*)
78. Texas Glossy Snake (*Arizona elegans elegans*)
79. Bullsnake (*Pituophis melanoleucus sayi*)
80. Prairie Kingsnake (*Lampropeltis c. calligaster*)
81. Speckled Kingsnake (*Lampropeltis getulus holbrooki*)
82. Red Milk Snake (*Lampropeltis triangulum syspila*)
83. Western Milk Snake (*Lampropeltis triangulum gentilis*)
84. Texas Long-nosed Snake (*Rhinocheilus lecontei tessellatus*)
85. Great Plains Ground Snake (*Sonora e. episcopa*)
86. Plains Black-headed Snake (*Tantilla n. nigriceps*)
87. Flat-headed Snake (*Tantilla gracilis*)
88. Texas Night Snake (*Hypsiglena ochrorhyncha texana*)

Reprinted Ashton "Reptiles and Amphibians".

89. Graham's Water Snake (*Regina grahami*)
90. Blotched Water Snake (*Natrix erythrogaster transvesa*)
91. Diamond-backed Water Snake (*Natrix r. rhombifera*)
92. Northern Water Snake (*Natrix s. sipedon*)
93. Texas Brown Snake (*Storeria dekayi texana*)
94. Northern Red-bellied Snake (Storeria o. occipitomaculata)
95. Rough Earth Snake (*Virginia striatula*)
96. Western Earth Snake (*Virginia valeriae elegans*)
97. Checkered Garter Snake (*Thamnophis m. marcianus*)
98. Red-sided Garter Snake (*Thamnophis sirtalis parietalis*)
99. Western Plains Garter Snake (*Thamnophis radix haydeni*)
100. Western Ribbon Snake (*Thamnophis p. proximus*)
101. Northern Lined Snake (*Tropidoclonion l. lineatum*)
102. Central Lined Snake (*Tropidoclonion lineatum annectans*)
103. Texas Lined Snake (*Tropidoclonion lineatum texanum*)
104. Osage Copperhead (*Agkistrodon contortrix phaeogaster*)
105. Broad-banded Copperhead (*Agkistrodon contortrix laticinctus*)
106. Western Massasauga (*Sistrurus catenatus tergeminus*)
107. Timber Rattlesnake (*Crotalus horridus*)
108. Prairie Rattlesnake (*Crotalus v. viridis*)



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For further information on the Reptiles and Amphibians project write to either of the specialists listed below at Kansas State University, Manhattan, Kansas 66506.

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The Cooperative Extension Service wishes to thank the Museum of Natural History, University of Kansas at Lawrence for their contribution to and support of this 4-H project.

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Photos courtesy Ray E. Ashton, Jr., Joseph T. Collins, Karl H. Maslowski.
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FIELD EXPERIENCES

THE STUDY

OF

INSECTS

RATIONALE

Outdoor education is an essential part of any biology class and an important part of field study is identifying insects. Relationships between organisms is the fabric that supports mankind and a major thread is the world of insects. Insects, in carrying out their role in nature, have a direct effect on the quality of life we enjoy. For they can be helpful and harmful at the same time by contributing to food production and destroying much of the food we produce. They are also carriers of many major diseases such as malaria, bubonic plague, yellow fever and others. Damage to homes and clothes is done by insects as well. However, of all the insects, only 1% are harmful. The remainder contribute to food chains and the recycling of organic materials and minerals or are neutral. Let's also remember that many insects are truely beautiful. Because of the influecne insects have over our lives, it's essential that we understand them.

INSTRUCTIONAL OBJECTIVES

Upon the completion of this module the student should be able to:

1. Construct a net for collecting flying insects.
2. Mount and label insects for a collection.
3. Construct and set insect traps to collect insects.
4. Name 10 places to find insects and identify the type expected.
5. Describe the correct method of collecting flying insects with a net.
6. Make a spreading board and pinning block.

LEARNING ACTIVITIES

Introductory Activities

1. Read the information in this module and study it thoroughly.

Application Activities

2. Collect and mount 10 insects for a permanent collection.
3. Identify all 10 insects to order by using a key.

Alternative Activities

4. Read "How to Know the Insects" by Jaques or some other book on insects.

INTRODUCTION

Of all the living things on this planet over 75% belong the the Class Insecta. Along with being the most numerous they are also the most adaptable, eventually overcoming our attempts to control them. We must manage insects in some way, especially crop pests, because insects consume roughly 50% of all food produced for human consumption. They also damage timberland and undermine homes (termites). Because insects and humans compete for some of the same resources and the human population is growing while the amount of arable land is decreasing, it becomes increasingly important to study insects. This module is an attempt to provide an introduction to the study of insects. Included are simple instructions on the collection and preservation of insects.

PREPARING FOR FIELD TRIPS

The key to success is careful planning. There are many things to consider when organizing a field trip. Some are school policy, permission from supervisors, teacher liability, transportation, length of trip, safety precautions and cost. They have little to do with insects but are an important part of any field trip. Here are some questions that should be answered before going on a field trip.

1. What are the objectives of this trip?
2. How much time is available or needed?
3. Will transportation be necessary?
4. Where should this trip be taken?
5. When is the best time to go?
6. What kind of equipment will be necessary?

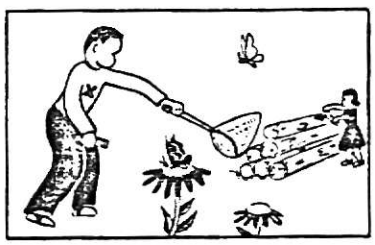
The answer to these questions will determine the type of field trip and establish an outline for the purposes of the trip. From this you will be able to evaluate the benefits the students will receive from this type of experience.

CONDUCTING THE FIELD TRIP

Insects have an advantage over other outdoor subjects by being found everywhere and during every season. Since insects are cold blooded, they do not become active unless they are warmed. Insects will become active any time of year when the temperature is above 60-65^{o}F (15^{o} C) for a few days. To find insects for field trips, any outdoor area will work. School yards, vacant lots, parks, woods, and prairies are just a few. Once a location has been selected and the group is on the site, it's usually best to turn them loose and let them explore and locate their own specimens for later identification. If it's a large area, it is good to have a route to follow to cover the area completely. H. E. Jaques in his book

"How to Know the Insects" nas developed a list of over 60 places to look for insects. Many of the places mentioned are not those found on field trips but are locations and ideas that the students can use to collect insects on their own. It's important that the students record the habitat where the insects are found. By learning the habitat students will discover the food and consequently their effect on us.

MORE THAN SIXTY PLACES TO LOOK FOR INSECTS



Wherever one turns, insect life is abundant. This list of collecting suggestions is not exhaustive. The ingenious student will find still other places and ways to add to his collection. He will get into new regions and try new ways if he wishes to get the largest number of species. Some good detective work will locate many insect culprits.

1. Look *EVERYWHERE.* Trained eyes can find some form of insect life almost anywhere.

2. Look under *STONES AND BOARDS.* (Turn them back to their original position when through, so they will be ready again.) This form of collecting is particularly good in the spring and early summer.

3. Many beetles and other insects may be found under loose *BARK* on logs and stumps. Do not neglect the small insects.

4. Tear up and carefully examine *SHELF FUNGI AND MUSHROOMS* for the insects that feed or hide in them.

5. Tear up *ROTTEN WOOD* and look for the insects living in it.

6. Sift *DRY LEAVES,* decayed wood and other debris through a collecting sieve on a white cloth or paper. Many small insects may be found in this way.

7. Slowly heating *FUNGI* or debris will drive out the insects.

8. On some warm days, particularly in early spring and late fall the *AIR* is fairly filled with flying insects. The wise collector gets his share of them.

9. Have a good insect net, keep it in good condition and use it for butterflies, and other flying forms. It is usually best to wait till they settle. To run them down "tells the world" what you are doing, but *NETS* fewer insects.

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Reprinted from Jaques, "How to Know the Insects".

10. You will find *SUGARING FOR MOTHS* at night exceedingly interesting as well as very fruitful. (See p. 16)

Figure 16. SNOWMAN? No,—p. 1 late with his required insect collection.

11. *PROWL AROUND AT NIGHT* with lantern or flashlight. You will be surprised at the numbers of insects prowling about too.

12. *STREET LIGHTS* attract many insects, particularly on sultry nights. You can often find rare ones there. Some lights are better than others; try a lot of them.

13. *A PORCH LIGHT*, especially on a white house, will attract many species.

14. If your landlady will permit it, open the screen of your window and bottle the insects that come to your *STUDY LIGHT*.

15. At night, suspend a lighted lantern over a *TUB OF WATER* containing a spoonful of kerosene and harvest your crop the next morning.

16. Cut *TWIGS FROM TREES*, tie into bundles and hang on the sides of trees; examine from time to time for wood borers.

17. Visit *WOOD PILES* in timber, wood lots or cellar and look for longhorns, clerids and other insects. This is best in spring and early summer.

18. Use the *BEATING UMBRELLA* or beating cloth vigorously. It often yields big results and many rare ones can be had this way. (See p. 17)

19. Shut up plant *GALLS* and infected pieces of wood in insect tight containers and examine from time to time for the insects that emerge.

20. Collect *PUPAE* from as wide a range as possible. Confine in roomy containers and watch for the adults to emerge. Winter is a particularly good time to collect many pupae.

21. Use the *SWEEPING NET* vigorously on a wide variety of vegetation both day and night. Don't pass up the little insects you catch this way.

22. Examine *FLOWERS* of every species for insects feeding or hiding in them. Be careful not to break the plants, then they may be profitably visited again and again.

Figure 17. Insects leave traces of their whereabouts in many ways.

23. Wherever you see *LEAVES* of plants with parts eaten away, look for the insect doing it.

24. Look in and under the *EXCREMENT* of domestic animals in pasture fields for dung beetles and other insects.

25. *DIG* still deeper *IN* the *GROUND* for more, and other species.

26. Look under *DEAD CHICKENS* and other animals for carrion beetles and other insects.

27. Make traps by *COVERING DEAD BIRDS*, fish or other animals with boards. The boards serve as a hiding place and when turned back reveal many carrion beetles, etc.

28. Make traps with *MOLASSES* smeared on the under side of boards laid on the ground.

29. *BURY JARS* or tin cans so that the top will be level with the ground and suspend a dead mouse or bird over each receptacle or partly fill with a molasses bait.

30. Look through *DECAYING FRUIT* or other garbage.

31. With a fine *WATER NET* catch the insects you can see swimming in water.

32. With rake or special net draw *DEBRIS* and *ALGAE* from bottom of water courses and catch the insects as they scramble back.

33. Pour water on the *ALONG-SHORE* land. This brings out the shore bugs and beetles.

34. Almost every species of *BIRD AND MAMMAL* has its own species of lice. When such animals are killed wrap the body at once in tough paper. When the lice leave their host they may be easily caught on the paper.

35. Wherever you see *PLANTS* harboring aphids or scale insects, that is a good place to look for lady beetles, syrphid flies, etc.

36. *DOMESTIC ANIMALS* in pastures attract several species of flies.

37. *LARVAE* of many insects, especially moths and butterflies, can be raised until the adults mature from them. This is the best way to get perfect specimens.

38. Examine the *WINDOWS* of buildings. Many insects may be found trying to get out, particularly in early spring. Stables and poultry houses are especially good.

39. Look through *FLOUR BINS*, granaries, and wherever cereals or meal is kept, for grain feeding insects.

40. Follow the *PLOW* when plowing is being done and cheat the blackbirds out of part of their dinner.

41. *CLOSETS* or boxes where clothing and old papers are stored yield paper and woolen insect pests.

42. *READ SUGGESTIONS* for collecting, in any good book on insects.

43. Lay chips, stones or boards on top of *STUMPS* where trees have been freshly cut. The sap attracts many interesting species and the chips keep them until the entomologist comes.

44. Wherever trees are shedding their *SAP* look for bees, flies, and other insects.

45. When the *WILLOWS* bloom, their catkins are fairly alive with bees and flies.

46. Split the *STEMS* of dry or green weeds and other plants for stem borers, as well as other insects hiding there.

47. Different species of plants are attacked by different insects. Know your plants and visit or sweep as many different species as possible. A record of the plant on which an insect was feeding is valuable.

48. *Examine the DEBRIS cast up by RISING STREAMS during a flood* or shortly thereafter. You can't beat it for quantity or number of species if you catch it right.

49. Look for insects floating in along the *WATER LINE* on the windward side of a water course after a warm night.

Figure 18. An occasional picnic and collecting trip can be combined

50. Many good ones may be found on the outside of brilliantly lighted *SHOW WINDOWS*. Look inside by day.

51. *MOSSES AND LICHENS* harbor many insects. They can be gotten out by the sieve, heat, by tearing up the plants or by using a separator.

52. After a rain look for insects where *LEAVES* unite with the twigs in clusters. They seek shelter in the whorl about the node.

53. To catch small insects in the *WATER* use a test tube or small bottle, hold it as nearly submerged as possible without letting the water enter; on nearing the insect lower the edge next to it and it will be washed into your bottle.

54. *A warm and dry sandy BANK* is an ideal place to find Tiger beetles.

55. When driving in an open *CAR* insects collide with the various parts of the interior and drop in the seats. They are often quiet for a time and may be bottled easily.

56. When dining out of doors leave an open *SANDWICH* on a stump or log and return an hour or two later and harvest your crop.

57. *LUMBER PILES* afford hiding places for many insects.

58. Watch for insects that are visiting mud puddles or the edges of bodies of water to drink.

59. Spread a large cloth under trees or shrubs and beat the trunks with a padded heavy club. Many specimens will drop on the cloth and may be easily taken.

60. Dig under trees or plants for pupae of moths and other insects. Perfect specimens will emerge from these if they are carefully cared for.

61. Separators (See Fig. 11) for extracting small insects from moss, soil debris, etc. get some valuable specimens and save much time.

62. A white sheet suspended in a strong light at night attracts many species. If the bottom of the sheet is turned up it will serve as a trough to catch those that fall.

63. In fast flowing streams hold a water net tightly against the bottom of the stream while stones just up stream are moved or the bed dug up so that hiding insects may swim or be washed into the net.

64. Low sheltered places will often yield some good specimens, in early spring before insects are out elsewhere.

65. An insect net attached to an automobile sometimes gets an amazing number of specimens. 25-30 m.p.h. seems to be right for speed. The net should be emptied every two or three miles.

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COLLECTING AND MOUNTING INSECTS

For collecting the minimum equipment necessary to collect insects is one's hands and some sort of container for the specimens collected. However, one can do much better with a net and killing jar. For general collecting it's best to have at least the following items: insect net, killing jar, forceps, trowel (or other digging tool) and white cloth.

A method of constructing an insect net is shown in Figure 1. The handle should be light and strong and about a yard (1m) long; the rim should be about 12 inches (0.3m) in diameter and made of fairly heavy wire (no.6 or no.8 gauge). Grooves and holes are cut in one end of the handle (Figure 1A); the wire for the rim is bent as shown in Figure 1B, fitted into these holes and grooves and fastened in place with heavy cord, fine wire or friction tape or a 50mm length of metal tubing may be slipped over it. The ideal shape for the bag is shown in Figure 1D. The material for the bag (excepting the rim) can be made from a single piece of cloth cut as shown in Figure 1E, and if the edges are sewn together with french seams, the net can be used with either side out. The

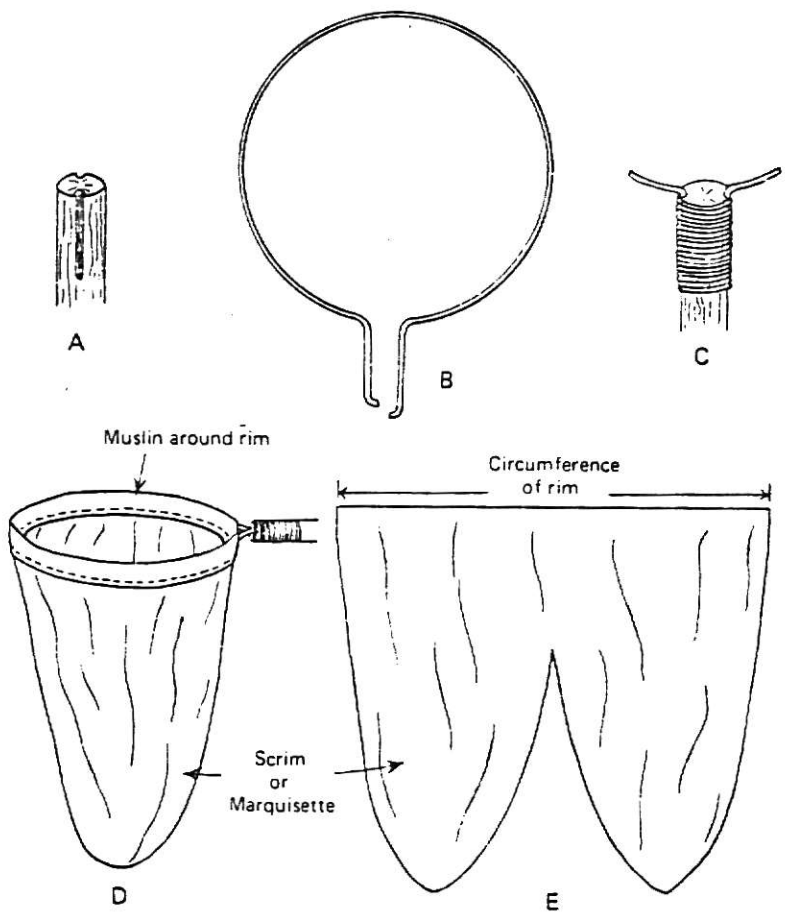


Figure 1 Homemade insect net. Grooves and holes are cut in the end of the handle, as in A; the wire for the rim is bent, as shown in B, fitted into the holes and grooves, and held there with heavy cord, wire, or friction tape. C. The material for the bag is cut as in E, and the finished net is shown in D.

Reprinted from Borror, "An Introduction to the Study of Insects",

bag should be made of two types of cloth, a heavy band (muslin or canvas) around the rim and a lighter material for the main part of the bag; the choice of the latter material will depend on the type of collecting for which the net will be used. A net for general collecting should have a sufficiently open mesh so that an insect can be seen through it; the best material is probably marquisette or scrim. A net used primarily for beating or sweeping should be made of muslin or fine mesh bolting cloth, through which even the smallest insects cannot escape. It may be possible to make arrangements for a shop class to make the net frames and trowels. A home economics sewing class could sew the nets. However, students can make their own crude nets by stretching a hanger into a circle and attaching it to a stout pole. The net can be made from an old pair of nylon hose with the legs sewn shut, or some type of cloth bag.

When collecting insects with a net, one may look for particular insects and then swing at them, or one may simply swing the net through vegetation (sweeping). When one catches a particularly active insect, he must use certain precautions to prevent the insect from escaping before it can be transferred to the killing jar. The safest method is to fold the net over with insect in the bottom of the net; the insect is then grasped through the net (provided it does not sting), and transferred to the killing jar. If the insect is one that stings (when in doubt it is better to assume it does sting), there are three methods of transferring it to the killing bottle. (1) The fold of the net containing the insect can be put into the killing bottle until the insect is stunned; then the insect can be picked out of the net and put into the bottle. (2) The insect can be grasped through the net with forceps, rather than with fingers, and transferred to the bottle. (3) The insect may be gotten into a fold of the net and stunned by pinching (pinching the thorax), and then transferred to the killing jar.

After sweeping, to make sure that no desired individuals escape, the insects can be shaken into the bottom of the net, and this part of the net placed in the killing jar, which is then covered until the insects are stunned. The specimens desired, or the entire catch, can then be transferred to the killing jar.

The killing jar and collecting jars can be provided by the student. Jars are made from clean wide mouth jars (pickle and peanut butter jars are excellent). The collecting jars are just wide mouth jars with a screw cap to keep dead insects in to bring them from the field to the classroom. The killing jar has blotting paper or cotton or plaster in the bottom that is saturated with carbon tetrachloride, alcohol, chloroform or ethyl acetate. Another method is to collect insects in a jar, then place the jar and insects in a freezer.

Mounting Insects

Insects should be mounted within 24 hours of killing or they will become hard and brittle. If mounting cannot be done in that time and hardening has already occurred, the insects can be softened by the use of a relaxing jar. A relaxing jar can be any wide mouth container that can be sealed nearly air tight. Place an inch (2.5 cm) of sand in the bottom and moisten with water. A few drops of carbolic acid is added to prevent mold. By placing an insect in an open box or on a piece of paper

and putting it in the jar and sealing, an insect will become pliable in 12-24 hours. However, specimens must be watched closely, for it ruins many insects if they get wet or too soft. Also, do not put more insects into the relaxer than can be mounted at one time.

Immature and soft bodied insects can be killed and stored in a solution of 70% alcohol, either methanol or isopropyl (rubbing alcohol). The best method of mounting hard bodied insects is by pinning, which allows specimens to retain their normal appearance and ease of handling. Common pins are undesirable for pinning insects; they are usually too thick and too short, and they rust. Specially designed insect pins are best, purchased from a science supply company, they are longer, come in various sizes, and they do not rust. However, for students making their own collections, common straight pins will do.

There are two methods of pinning insects. One involves inserting the pin through the insect and the other is called pointing. When pinning, it's important to pin the larger insects as illustrated in Figures 2 and 3. Moths and butterflies require additional preparation to fix the wings. Figures 4 and 5 illustrate the proper technique for spreading the wings. It's important that moths and butterflies are either freshly killed or relaxed before spreading the wings. Spreading boards are helpful, but a piece of cardboard works fine by placing the insect on its back. Steps for pinning minute insects on paper points is outlined in Figure 6.

A major tool used during the pinning process is pinning blocks (Figure 7). This tool is used to locate insects and labels on the pin in a uniform manner. The deepest hole is for the insect, the middle hole is for a label with locality and date (figure 8). The lowest or shortest hole is for another label with other information such as the collector's name or the scientific name.

Boxes to store the collection in can be expensive if purchased. Shop classes could be asked to construct some boxes, however, on the high school level, cigar boxes with a piece of cardboard in the bottom for pinning is sufficient. Arrangement in the boxes is usually grouping by order and family, but that is entirely up to the teacher.

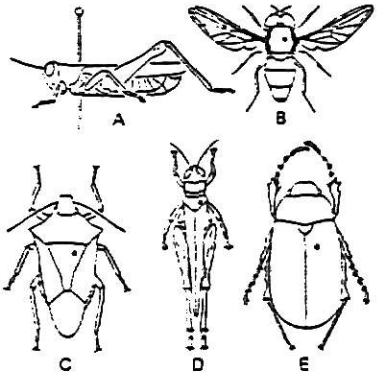


Figure 2 Methods of pinning insects. A, specimen in lateral view showing method of pinning grasshoppers; the black spots in the other figures show the location of the pin in the case of flies (B), bugs (C), grasshoppers (D), and beetles (E). (Courtesy of the Illinois Natural History Survey.)

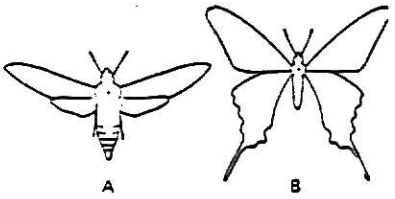


Figure 3 Method of pinning Lepidoptera. These insects are pinned through the center of the thorax in both moths (A) and butterflies (B). (Courtesy of the Illinois Natural History Survey.)

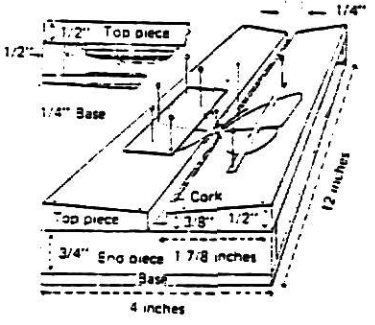
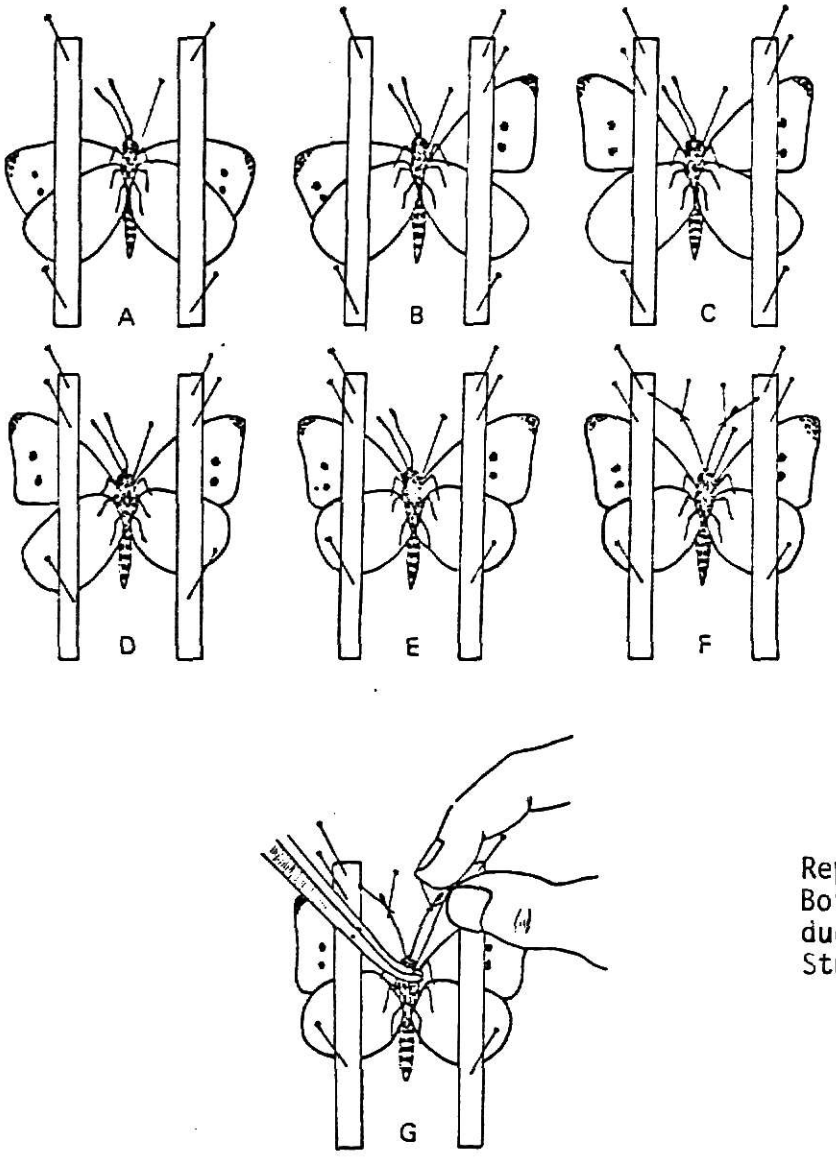


Figure 4 The spreading board, showing dimensions, details of construction (inset), and a spread specimen. The wings of the specimen may be held in place by a single broad strip of paper as shown on the left wings, or by a narrower strip and pins as shown on the right wings. Courtesy of the Illinois Natural History Survey.)

Illustrations from Borror, "An Introduction to the Study of Insect



Reprinted from Borror, "An Introduction to the Study of Insects".

Figure 5 Steps in spreading a butterfly upside down on a flat surface. A, position before starting to raise the wings; B, front wing on one side raised; C, front wing on the other side raised, with hind margin of front wings in a straight line; D, hind wing on one side raised; E, hind wing on the other side raised; F, antennae oriented and held in position by pins; G, removing the pin from the body of the butterfly.

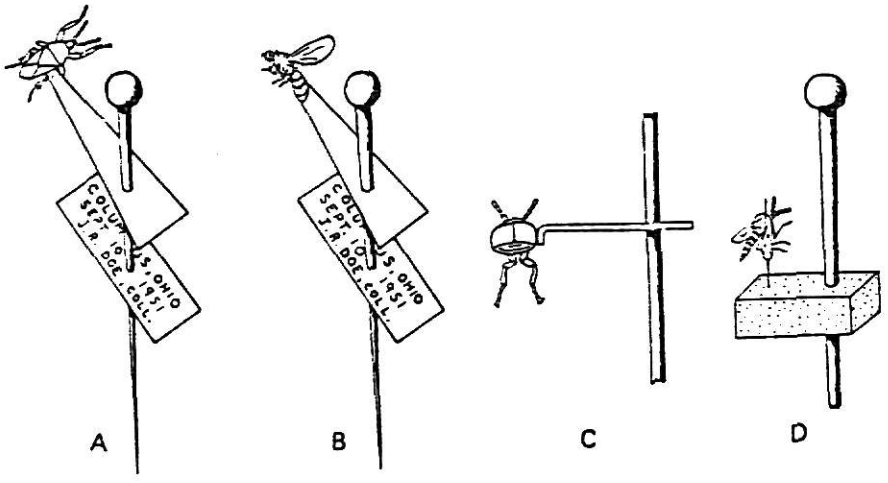


Figure 6 Methods of mounting minute insects. A, bug on point, dorsal side up; B, fly on point, left side up; C, beetle mounted dorsal side up, attached by its side to the bent-down tip of the point; D, mosquito mounted on a minuten pin.

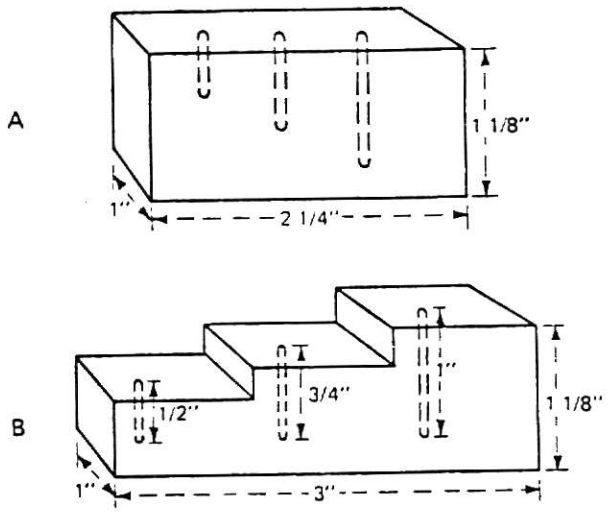


Figure 7 Pinning blocks. These may be a rectangular piece of wood containing holes drilled to different depths (A), or a block shaped like a stair step, with holes drilled to the bottom (B). The block of the type shown in A usually has the holes drilled to depths of 25, 16, and 9.5 mm. After a specimen or label is placed on the pin, the pin is inserted into the appropriate hole until it touches bottom – into the deepest hole for the specimen, the middle hole for the label bearing locality and date, and the last hole for any additional label. (From DeLong and Davidson. Courtesy of the Ohio State University Press.)

Reprinted from Borror, "An Introduction to the Study of Insects".

IDENTIFYING INSECTS

Since insects compose the largest and most diverse class of animals, it's only logical that the characteristics and language to describe them is also very complicated. For this reason most school collections only identify insects to a family. For more precise identification your state land grant university maintains an office with the U.S. Department of Agririculture that will identify insects for you. You can get the address of the nearest office from agriculture extension agents, fish and game officials or soil conservation agents.

For general classroom identification there are some small keys that can be obtained from most book stores. A list of a few are in the appendix. These keys have been simplified for the amateur and generally contain pictures for matching purposes. For school collections the accuracy of these keys is sufficient. If more accurate identification is desired, it will be necessary to send them to an expert. If any student wishes to do more detailed work, direct them to any text on entomology.

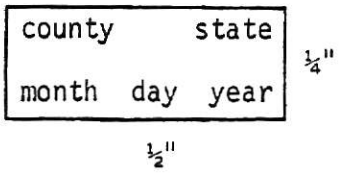


Figure 8. Label that is mounted on pins is made ¼" x ½" in size.

Identification Key to Order of Insects

Read the first two lines of the following key. There are two given choices or descriptions of parts of an insect.

Look at the insect for identification to order. If it has wings well developed, refer to step 2 as indicated in the second column. If the insect to be identified is wingless, or with small, undeveloped wings, refer to step 22, as indicated.

Continue through the key in this manner, reading the two descriptions opposite each number to which referred and compare them with the insect to be identified. Illustrations have been added to aid in identification.

When reading a description which fits the insect to be identified, it will be followed by a word printed in capital letters. This is the name of the order to which that insect belongs. For further information about the insect, turn to the page in the manual indicated by the number in the last column.

WORDS USED IN THE KEY

Abdomen - the third body region of insects.
Antenna (pl., antennae) - the horns or feelers located on the heads of insects.
Cells - the areas in the wings of insects which are between or bounded by veins.
Cerci (sing., cercus) - the threadlike or sometimes forcepslike tails near the tip of the insect abdomen (usually a pair).
Conspicuous - easy to see.
Constricted - thin or narrow.
Cornicles - short, blunt horns or tubes (sometimes buttonlike) on the top and near the end of the aphid abdomen. They give off a waxy liquid which helps protect against enemies.
Elytra - the leathery or hard front wings of beetles. They usually cover the hindwings when at rest and sometimes are called "wing covers."
Furcula - a forked "tail" on the underside of the abdomen of COLLEMBOLA (springtails), used for jumping.
Halteres - small knoblike organs (sometimes shaped like a baseball bat or bowling pin) located on the thorax of DIPTERA. They take the place of the hindwings and are used to help balance the insect in flight.
Mandibles - the first pair of jaws in insects; stout and toothlike in chewing insects, needle- or sword-shaped in sucking insects; the lateral upper jaws of biting insects.
Membranous - thin like a membrane. Clear or almost clear enough to see through - like cellophane or clear plastic sheeting.
Mesothorax - the second or middle thoracic ring which bears the middle pair of legs and the first pair of wings.
Metathorax - the third or last thoracic segment. Joins to the abdomen. Bears the hind pair of legs and second pair of wings or rudiments of these wings, such as the halteres found on flies (DIPTERA).
Palpi (sing., pulpus) - small "feelers" near the mouths of insects, probably used to help select food when eating.
Parasite - any animal that lives in or on another.
Pronotum - the top or upper side of the prothorax.
Prothorax - the first thoracic ring or segment; bears the first pair of legs but has no wings.
Scales - the powderlike covering which gives color to the wings of most butterflies and moths. Actually, very small scales which overlap like shingles on a roof.
Segments - joints or divisions of the insect body, leg or antenna.
Segmented - jointed or divided into sections.
Stylet - tubular, sucking mouthparts of sucking insects.
Tarsi - (sing., tarsus) - the "feet" of insects. The last small segments or joints near the end of the insect leg. The number may vary from one to five.
Thorax - the second or intermediate region of the insect body, found between the head and abdomen; bears the legs and wings when present; made up of three rings or segments; first, prothorax; second, mesothorax, and third, metathorax.
Veins - the rodlike or veinlike stiffening or supporting "frame" of the insect wing.

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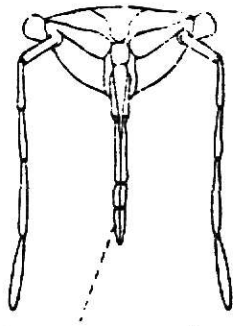
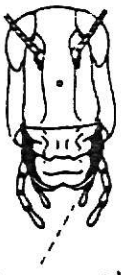


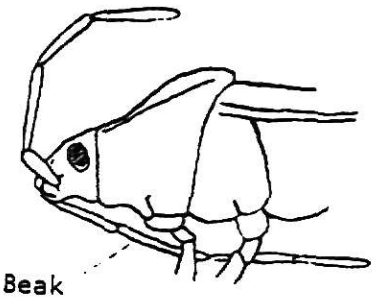
Sucking mouthparts

Figure 1



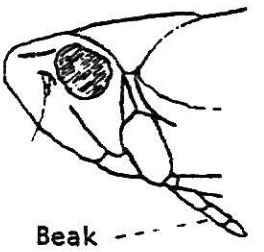
Chewing mouthparts

Figure 2



Beak

Figure 3



Beak

Figure 4

Steps		Refer to Step No.	Insect Order
1.	Wings well developed	2	
	Wingless, or with small undeveloped wings .	22	
2.	Front wings (elytra) hard, leathery, at least at base; hindwings, if present, membranous (skinlike)	3	
	Wings entirely membranous (skinlike)	7	
3.	Sucking mouthparts, with beak longer than wide, and usually jointed (figure 1).	4	
	Chewing mouthparts (figure 2)	5	
4.	Beak arising from front part of head (figure 3); front wings usually leathery at base and membranous (skinlike) at tip; tips generally overlapping when at rest (true bugs)		HEMPITERA
	Beak arising from rear underside part of head, often appearing to arise at base of front legs (figure 4); front wings of uniform texture throughout; tips not overlapping, or only slightly overlapping when at rest (leafhoppers, cicadas, aphids, treehoppers)		HOMOPTERA

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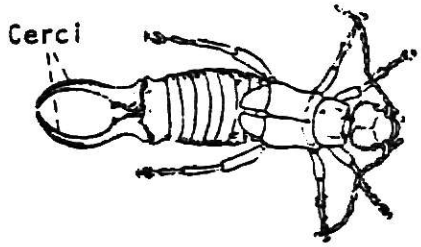

Figure 5

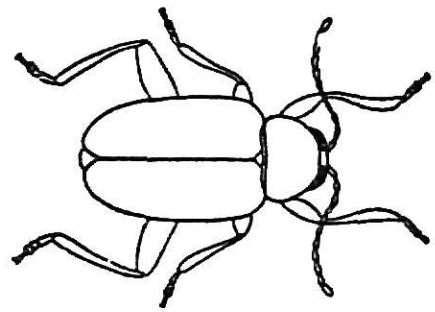

Figure 6

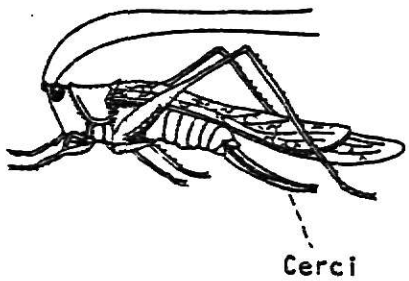

Figure 7

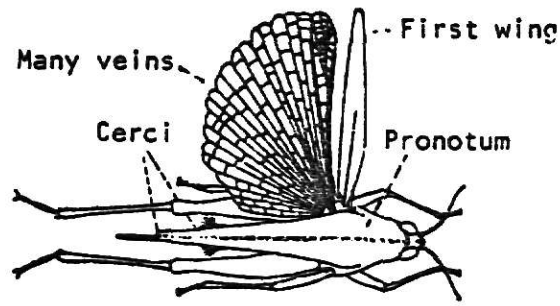

Figure 8

Steps		Refer to Step No.	Insect Order
5.	Abdomen with forcepslike cerci (appendages near tail) (figure 5); elytra (leathery front wings) short, leaving most of the abdomen exposed (earwigs)		DERMAPTERA
	Abdomen without forcepslike cerci, or if cerci appear forcepslike, then wings cover most of abdomen	6	
6.	Front wings without veins, usually meeting in a straight line down middle of back (figure 6); antennae (feelers on head) with 11 or fewer joints; hindwings narrow, usually longer than front wings when unfolded and with few veins (beetles)		COLEOPTERA
	Front wings with veins, either held rooflike over abdomen or overlapping over abdomen when at rest (figure 7); antennae usually with more than 12 joints; hindwings broad, usually shorter than front wings and with many veins (figure 8) (grasshoppers, crickets, roaches, mantids)		ORTHOPTERA
7.	With 2 wings	8	
	With 4 wings	11	

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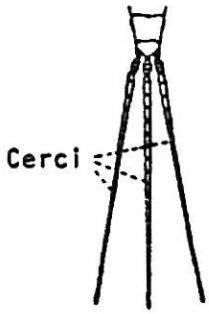

Figure 9

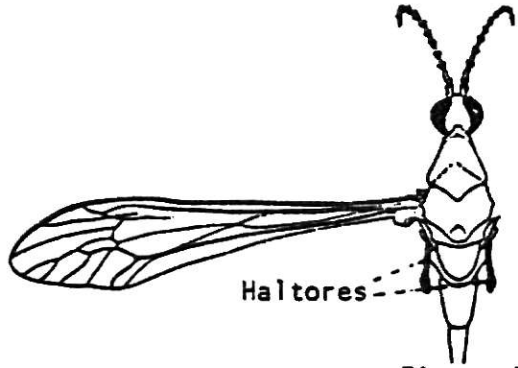

Figure 10

Figure 11

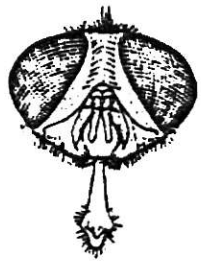

Figure 12

Figure 13

Steps		Refer to Step No.	Insect Order
8.	Body grasshopperlike; pronotum (top side of prothorax) extending back over abdomen, pointed at tip (figure 8); hindlegs enlarged (grouse or pigmy locusts, family *Tetrigidae*)		ORTHOPTERA
	Body not grasshopperlike; pronotum not as above; hindlegs not so enlarged	9	
9.	Abdomen with threadlike or spinelike tails (figure 9); mouthparts small or undeveloped; halteres (knoblike organs, taking place of hindwings) (figure 10) present or absent . . .	10	
	Abdomen without threadlike or spinelike tails; mouthparts usually well developed, forming a sucking beak (figure 11) or tongue (figure 12); halteres present (true flies, mosquitoes, gnats, midges)		DIPTERA
10.	Halteres (figure 10) present and hooklike; wings with only one forked vein (figure 13); antennae (feelers on head) long and conspicuous; very small insects, usually less than 1/8 inch long (male scale insects, family *Coccidae*)		HOMOPTERA
	Halteres absent; wings with many veins and crossveins; antennae short, bristlelike, small; usually over 1/4 inch long (mayflies) . .		EPHEMERIDA

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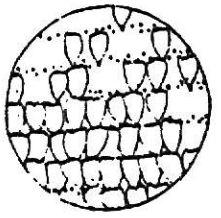
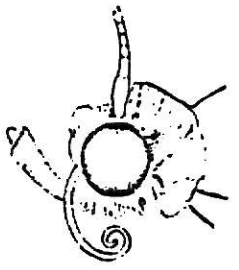


Figure 14



Coiled mouthparts
Figure 15

Figure 16

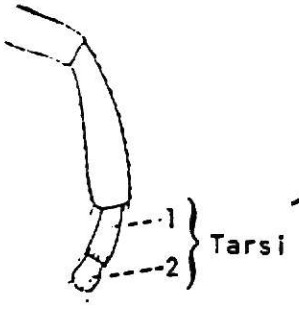


Figure 17

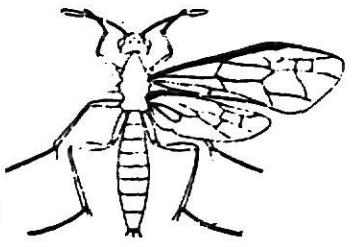


Figure 18

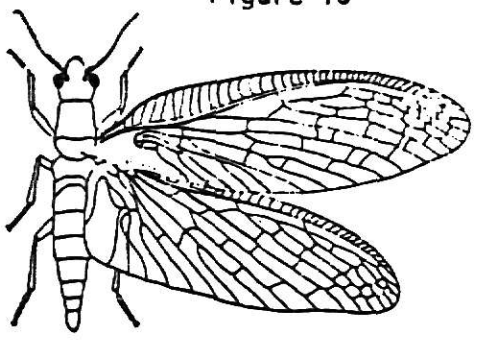


Figure 19

Steps		Refer to Step No.	Insect Order
11.	Wings completely or almost completely covered with microscopic, powderlike scales (figure 14); mouthparts usually in the form of a long, coiled tubelike beak or tongue (figure 15); antennae (feelers on head) many-jointed (butterflies and moths)		LEPIDOPTERA
	Wings not covered with scales, though they may be hairy (figure 16); mouthparts not in form of a coiled tubelike tongue; antennae of various kinds	12	
12.	Wings long and narrow, veinless or with only 1 or 2 veins, fringed with long hairs (figure 16); tarsi (feet) (figure 17) with only 1 or 2 joints, the last segment swollen; very small insects, usually less than $\frac{1}{8}$ inch long (thrips)		THYSANOPTERA
	Wings not as above; if wings are somewhat long and narrow, then the tarsi have more than two segments	13	
13.	Hindwings smaller than front wings (figure 18), usually with fewer veins	14	
	Hindwings as large or larger than front wings, with as many or more veins (figure 19) . . .	18	

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Figure 20

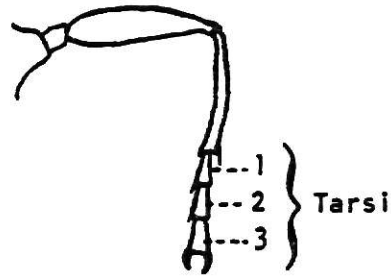

Figure 21

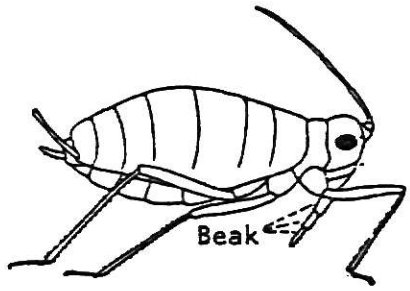

Figure 22

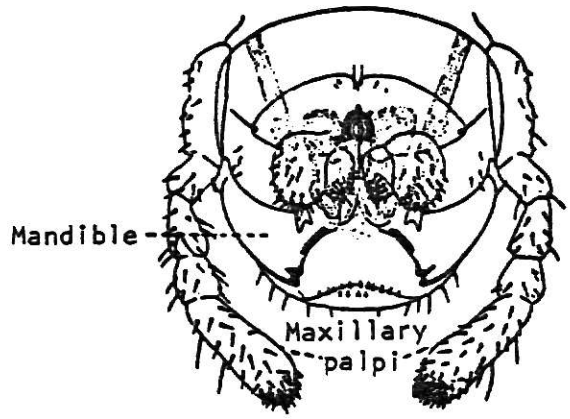

Figure 23

Steps		Refer to Step No.	Insect Order
14.	Front wings with many crossveins and cells (areas between veins); antennae (feelers on head) short, bristlelike, small; abdomen with two or three long threadlike tails (figure 9); delicate, soft-bodied insects (mayflies)		EPHEMERIDA
	Front wings with few crossveins and cells (figure 20); antennae fairly long, or if short and bristlelike, then there are no threadlike tails	15	
15.	Tarsi (feet) two- or three-jointed (figure 21)	16	
	Tarsi (feet) four- or five-jointed	17	
16.	Mouthparts sucking, the beak arising at rear of head (figures 4 and 22) (leafhoppers, cicadas, aphids, treehoppers)		HOMOPTERA
	Mouthparts chewing (figure 23), very small insects (booklice, barklice, psocids)		CORRODENTIA

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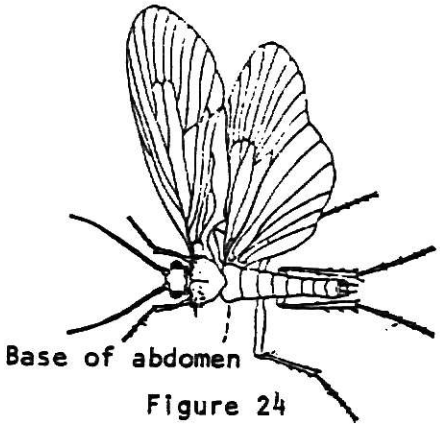

Figure 24

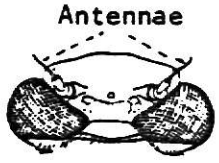

Figure 26

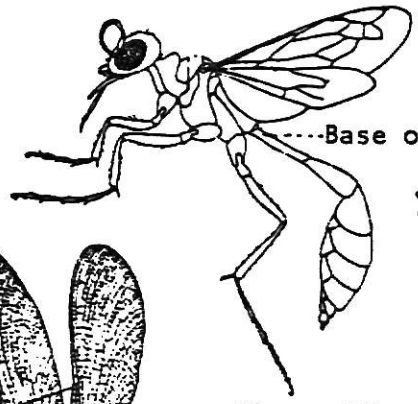

Figure 25

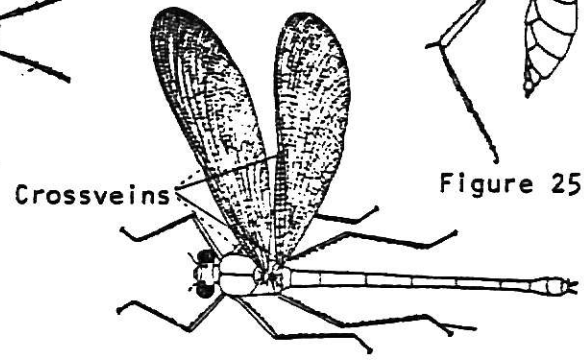

Figure 27

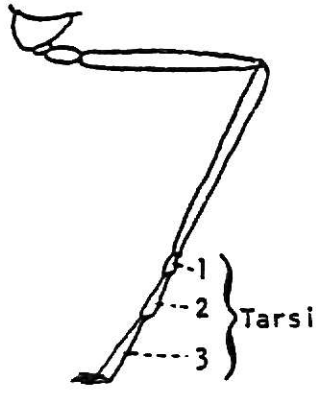

Figure 28

Steps		Refer to Step No.	Insect Order
17.	Wings noticeably hairy; mouthparts usually very small except for the palpi (feelers near mouth); antennae (feelers on head) usually as long as the body or longer; veins in front and hindwings similar; abdomen not narrow at the base; rather soft-bodied insects, not wasplike (figure 24) (caddisflies)		TRICHOPTERA
	Wings apparently not hairy; mandibles (chewing mouthparts) well developed; antennae shorter than the body; fewer veins in hindwings than in front wings; abdomen usually narrow at base (figure 25); rather hard-bodied, wasplike insects (sawflies, ichneumon flies, ants, wasps, and bees)		HYMENOPTERA
18.	Tarsi (feet) three- or four-jointed (figure 21)	19	
	Tarsi (feet) five-jointed	21	
19.	Antennae (feelers on head) short, bristlelike and small (figure 26); wings with many crossveins, never held flat over the abdomen when at rest (figure 27); tarsi (feet) three-jointed (figure 28); body long and slender, ¾ to 3½ inches long (dragonflies and damselflies)		ODONATA
	Antennae long and conspicuous, wing veins variable, usually held flat over abdomen when at rest; 1½ inches long or less	20	

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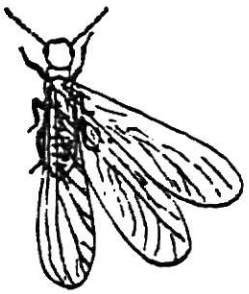

Figure 29

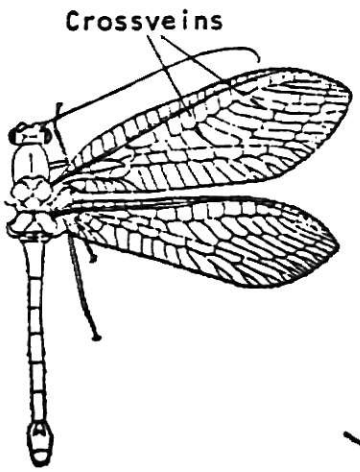

Figure 30

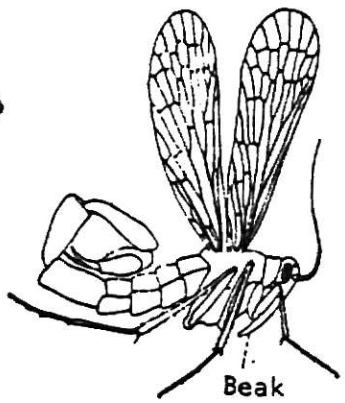

Figure 31

Steps		Refer to Step No.	Insect Order
20.	Front and hindwings similar in shape, size, and number of veins, reaching well beyond the tip of the abdomen when at rest (figure 29); no cerci (appendages near tail); body 5/16 inch long or less (termites)		ISOPTERA
	Hindwings with the rear area much enlarged and folded fanlike when at rest; cerci (appendages near tail) present; bodies mostly 1/4 to 2 inches long (stoneflies)		PLECOPTERA
21.	Front edge of front wings with many crossveins (figure 30); mouthparts not formed into a beak (as in figure 31) (fishflies, dobsonflies, lacewings, ant lions)		NEUROPTERA
	Front edge of front wings with not more than one or two crossveins; mouthparts extended downward to form a "beak" (figure 31) (scorpion flies)		MECOPTERA
22.	Usually parasites living on the bodies of birds or animals; body more or less leathery, and flattened from the upper to lower sides of body or from side to side	23	
	Free-living, not parasites on bodies of birds or animals; body usually not flattened or leathery	28	

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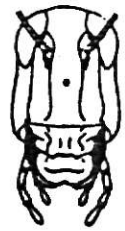
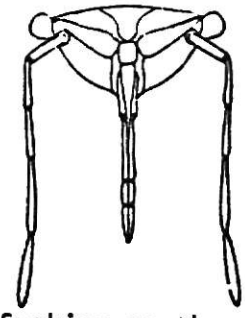


Chewing mouthparts

Figure 32



Sucking mouthparts

Figure 33

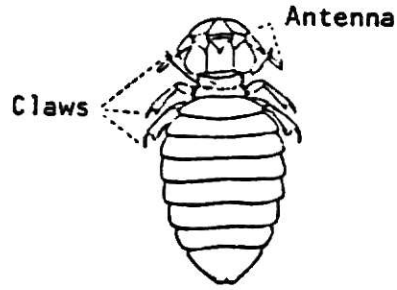


Figure 34

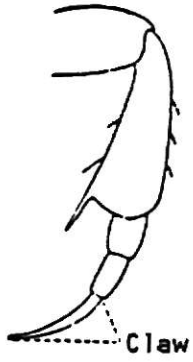


Figure 35

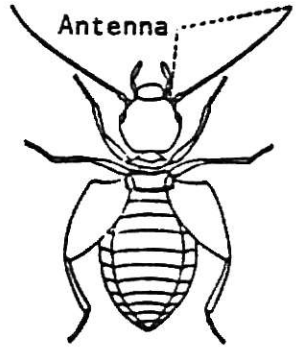


Figure 36

Figure 37

Steps		Refer to Step No.	Insect Order
23.	Mouthparts chewing (figure 32)	24	
	Mouthparts sucking (figure 33), sometimes beak or stylet (tubular mouthpart) is drawn up into the head and cannot be seen	25	
24.	Antennae (feelers on head) with five or fewer joints (figure 34); tarsi (feet) with one claw (figure 35), parasites of animals, or with two claws, parasites of birds (chewing lice)		MALLOPHAGA
	Antennae with more than five joints (figure 36); not parasitic (booklice, barklice, psocids)		CORRODENTIA
25.	Body flattened on the sides (figure 37); jumping insects (fleas)		SIPHONAPTERA
	Body flattened from upper to lower sides; not jumping insects	26	

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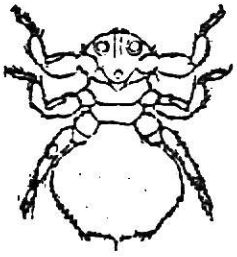

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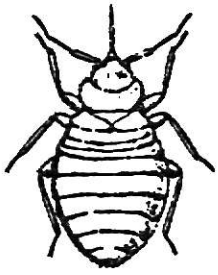

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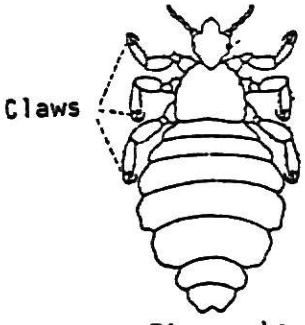

Figure 40

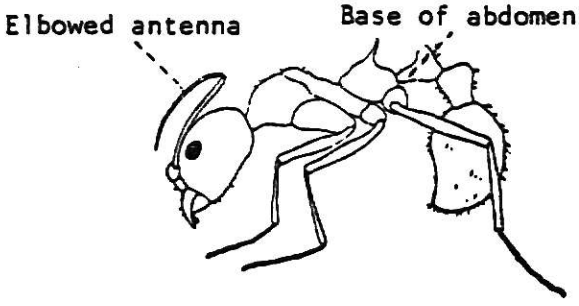

Figure 41

Steps		Refer to Step No.	Insect Order
26.	Antennae (feelers on head) hidden in grooves beneath the head (louse flies) (figure 38)		DIPTERA
	Antennae not hidden, usually easy to see	27	
27.	Beak longer than wide, four joints, (figure 33), extending back beneath the body; tarsi (feet) with two small claws (wingless bugs) (figure 39)		HEMIPTERA
	Head with only a short snout in front, the stylet (tubular mouthpart) pulled back into the head when not in use; tarsi with one very large claw (figures 35 & 40) (sucking lice)		ANOPLURA
28.	Abdomen very thin, small or narrow at base (figure 41); antennae (feelers on head) usually elbowed (figure 41); hard-bodied, antlike insects (ants and wingless wasps, velvet ants)		HYMENOPTERA
	Abdomen not particularly thin at base; antennae not elbowed	29	

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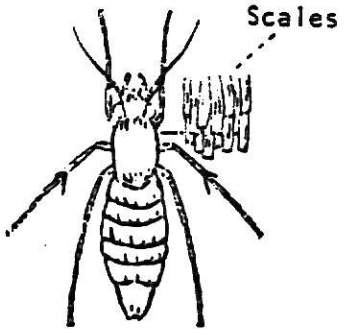

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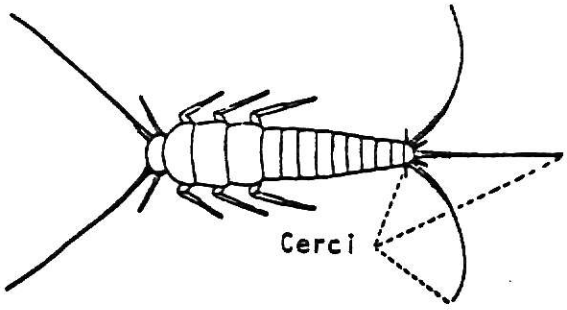

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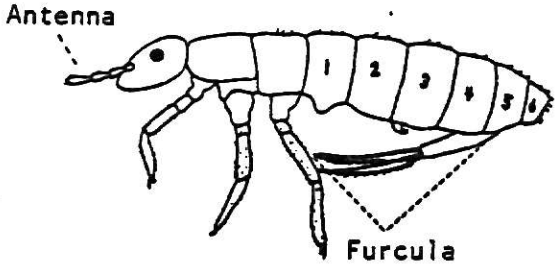

Figure 44

Steps		Refer to Step No.	Insect Order
29.	Body covered with scales (figure 42) . . .	30	
	Body not covered with scales	31	
30.	Abdomen with three long threadlike tails (figure 43), and with spinelike hairs or spikes on some abdominal joints; mouthparts chewing (silverfish, bristletails, firebrats)		THYSANURA
	Abdomen without tails or spinelike hairs (figure 42); mouthparts sucking, usually in the form of a long, coiled threadlike tube or tongue (figure 15) (wingless moths)		LEPIDOPTERA
31.	Mouthparts hidden within the head; abdomen with spinelike hairs on some joints, or with a forked tail (furcula) near the end of the abdomen (figure 44); usually less than ¼ inch long	32	
	Mouthparts not as above, easily seen, and either sucking or chewing; size variable	33	

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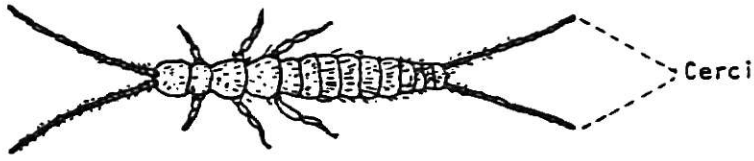

Figure 45

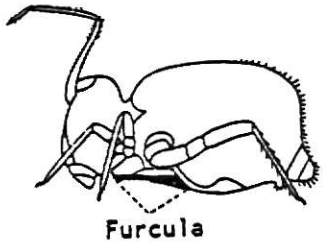

Figure 46

Chewing mouthparts

Figure 47

Steps		Refer to Step No.	Insect Order
32.	Antennae (feelers on head) long and with many joints; abdomen with at least nine joints, with spinelike hairs on some joints; without a forked tail (furcula) near the end of abdomen, but with two, short to long, forcepslike appendages (cerci) at the end of the abdomen (figure 45) (japygids, campodeids, projapygids). These insects are light colored, about ¼ inch or less, and are found in damp places under bark, stones or fallen trees, in rotting wood, etc.		THYSANURA
	Antennae short, with six or fewer joints; abdomen with six or fewer segments (figure 44), usually with a forked tail (furcula) beneath and near the end of the abdomen (figures 44 and 46) (springtails)		COLLEMBOLA
33.	Mouthparts sucking, with beak long and pointing backward from the head or cone-shaped and pointing downward (figure 33)	34	
	Mouthparts chewing (figure 47); if beaklike, then the beak is fairly long and pointed downward (figure 50)	36	

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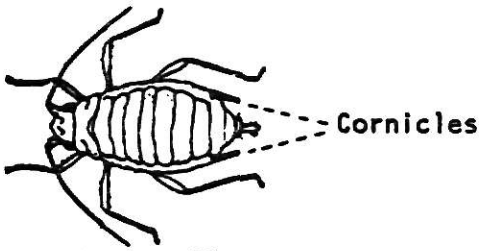

Figure 48

Figure 49

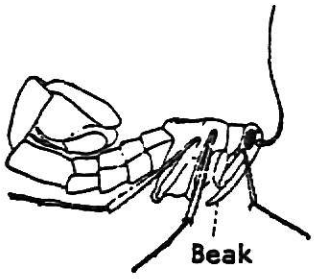

Figure 50

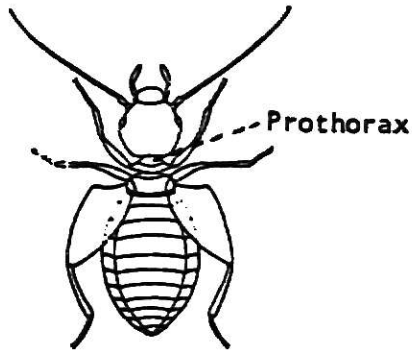

Figure 51

Steps		Refer to Step No.	Insect Order
34.	Body long and narrow; tarsi (feet) with one or two joints and often without claws (figure 17); beak cone-shaped; very small insects, usually less than 1/8 inch long (thrips) (figure 16)		THYSANOPTERA
	Body usually more or less oval; tarsi usually three-jointed (figure 28), with well-developed claws; size variable	35	
35.	Beak arising from rear under part of head (as in figures 4 and 22); abdomen often with a pair of cornicles (blunt horns or tubes) (figure 48) (aphids)		HOMOPTERA
	Beak arising from front part of head (as in figures 1 and 3); abdomen without cornicles (wingless bugs)		HEMIPTERA
36.	Cerci (appendages near tail) forcepslike (figure 49) (earwigs)		DERMAPTERA
	Cerci absent, or if present, then not forceps-like (figure 52)	37	
37.	Mouthparts in the form of a beak pointing downward (figure 50); tarsi (feet) five-jointed (figure 54); insect usually less than 5/16 inch long (wingless scorpion flies) (figure 50) . .		MECOPTERA
	Mouthparts not as above; tarsi and size of insect variable	38	

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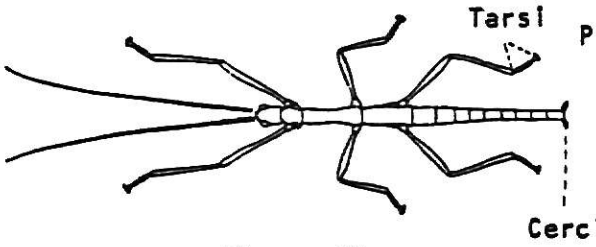

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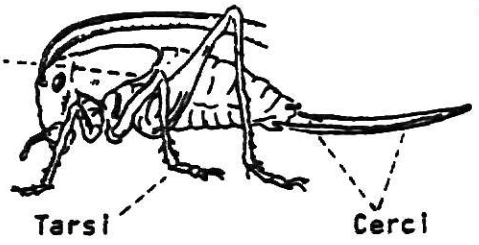

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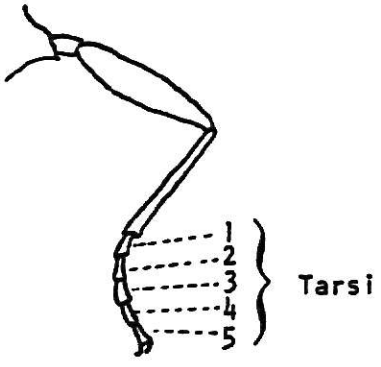

Figure 54

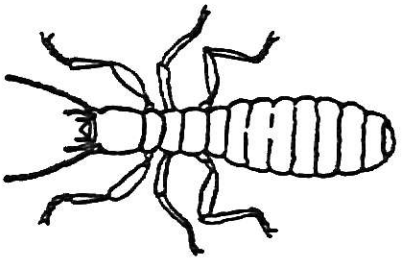

Figure 55

Steps		Refer to Step No.	Insect Order
38.	Small louselike insects (figure 51) less than 3/16 inch long; no cerci (appendages near tail); tarsi (feet) two- or three-jointed; prothorax (first ring of thorax) (figure 51) very small (booklice, barklice)		CORRODENTIA
	Not louselike, insect usually more than 3/16 inch long; tarsi three- to five-jointed; cerci present (figures 52 and 53); prothorax large (figure 53)	39	
39.	Hindlegs large, fitted for jumping (figure 53); tarsi (feet) three- or four-jointed (crickets and grasshoppers)		ORTHOPTERA
	Hindlegs not large, not fitted for jumping (figure 52); tarsi four- or five-jointed . . .	40	
40.	Tarsi (feet) four-jointed; whitish, soft-bodied, living in wood or ground; insect 5/16 inch long or less (termites) (figure 55)		ISOPTERA
	Tarsi five-jointed; appearance not as above (roaches, mantids, walkingsticks) (figure 52)		ORTHOPTERA

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9. Withington, Janice J., 1974; "Mini-Monsters a Discovery-Oriented Field Activity." Science and Children, Vol. 12, No. 2, p. 21-22.

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FIELD EXPERIENCES

THE STUDY

OF

MAMMALS

MAMMALS

Rationale: Of all the subjects that can be studied outdoors the class mammalia holds the most interest for students. This may be because we, mankind, belong to this class along with animals from rats and mice to the family of primates to which we belong. There is also a historic affiliation to many hoofed mannals, especially cattle, horses and members of the deer family. Nearly every culture has utilized herd animals of some kind. Bison, reindeer and domestic cattle have been the centers of many cultures such as the Basque herdsmen of Spain, the Plains Indian and the American bison. Because we have developed such close ties to other mammals it is only natural that we learn about their lives, for we have much in common with them.

Instructional Objectives

On completion of this module the student should be able to:

1. Select and prepare a study of small mammals.
2. Name the type of trap and bait needed to capture 5 different mammals.
3. Identify the habitat and signs of 5 different mammals.
4. Name at least 5 different types of studies that can be done with mammals.
5. Construct 3 different types of mammal traps.
6. Prepare small mammal study skins with labels for a collection.

Learning Activities:

Introductory Activities

1. Read the information in this module.

Application Activities

1. Set out live traps baited with peanut butter and oatmeal either in a woodlot or prairie until at least small mammals are caught.
2. Identify two small mammals using a key.
3. Build one live trap for small mammals.

Alternative Activities

1. Read Ernest S. Booth's book "How to Know the Mammals."
2. Use this module to prepare a mammal study for a high school biology class.

Introduction

Mammals that can be studied by students are very elusive and generally active only at night or during the early morning or late evening hours. Due to this factor it's necessary to trap and tag mammals repeatedly. This module is an attempt to aid instructors in the preparation and execution of field studies. It is also intended to provide information on the collection and preparation of mammal specimens for study.

Planning a Field Trip

The key to success is careful planning. There are many things to consider when organizing a field trip. Some are school policy, permission from supervisors, teacher liability, acquiring transportation, class time trips or extended trips, safety precautions and cost. These have little to do with mammals but are an important part of any field trip. When it is time to plan a trip to study mammals there are several questions that need to be answered.

1. What are the objectives of this trip?
2. How much time is available or needed?
3. Will transportation be necessary?
4. Where should this trip be taken?
5. When is the best time to go?
6. What kind of equipment will be necessary?

The answers to these questions will determine the type of field trip and establish an outline for the purposes of the trip. From this you will be able to evaluate the benefits the students will receive from this type of experience.

Finding Mammals

When attempting to study mammals it is important to select those mammals which are easiest to study. Marine mammals like seals and whales are beyond the range of most schools. Also, the larger mammals such as elk or bison are restricted to game reserves or remote regions. This leaves the smaller mammals of squirrels, rabbits, opossums, shrews, mice, rats and raccoons which are fairly common and some species have adapted to many urban areas. These small mammals can be found in any moderately wooded area or meadow bordered by trees. Mice, rats, squirrels and rabbits can be found in most suburbs, even opossum and raccoon can be found around city parks or other moderately open, natural areas in and around cities. Check with city park and recreation officials, first about possible locations, then about setting traps within the city.

For general introductions to mammals, trips to zoos, natural history museums, or game reserves are worthwhile. For best results an instructor will need to do homework. In advance, an instructor should tour the site, learn the names of the mammals present and become familiar with their habitats and relationship to other animals. If it's possible, visits to natural history museums are best. These will show a large variety of mammals and display them in their natural habitat plus most provide either audio-instruction or written material for reference.

Studying mammals in the field

To study or even observe mammals in the field will require trapping of some kind, whether its for the collection of study skins or live trapping for other studies. Depending on how the traps are set and where, plus how often they are set, several different studies can be undertaken. The studies listed below can be adapted for intermediate grades upward up to and including college level courses.

1. Determination of population size to calculate the population of animals in your trapping area, you do the following:

   a. Record and mark all the animals captured each time you trap.
   b. Trap and mark animals for 3-4 days, wait 1 to 2 weeks and repeat.

   c. Put the figures into this formula to determine the total populations:

$$\frac{\text{Total number of mice}}{\text{Total caught the second day (marked and unmarked)}} = \frac{\text{Total of marked mice}}{\text{Total of recaptured mice (caught the second day)}}$$

2. Sex ratio of a species population: Trap as many individuals of a species population as possible, marking the individuals to avoid duplication. Determine the sex ratio of the population - male/female.

3. Age ratios of species population: Age can sometimes be estimated on the basis of external genitalia. Research into aging methods for individual species will be necessary.

4. Inventory of species in study area: Set out a variety of traps using different baits to catch as many different species as possible. Compare data with regional mammal lists published by local, state or federal agencies.

5. Delineation of home ranges or territories of individuals in a population: Note locations where marked individuals are retrapped over a period of several weeks to determine the limits of their home ranges. Traps should be placed in a grid pattern with traps set at equal distant points as shown below.

6. Behavioral patterns of individuals in a species population: Individuals can be tracked using radio telemetry equipment. With the new mini-circuits, the equipment is becoming inexpensive.

7. Ectoparasite variations in a mammalian population related to age, sex and season: Remove and preserve ectoparasites from many individuals and compare the variations found.

These are just a few of the studies that can be done with mammals. Others can be found in The Journal of Wildlife Management, The Journal of Mammalogy and Wildlife Management Techniques (available from the National Wildlife Federation, 1412 16th N.W., Washington, D. C. 20036).

Trapping and Tagging Techniques

Trapping techniques will vary depending on the types of mammals to be caught. The type of trap will vary with the mammal being sought and whether it's a jawed or live trap. As a conservation measure, unless the animal is being collected for a skin collection or the study of internal parasites, use live traps. In many ways they are easier to use than steel jawed traps, require less care when setting and allow the use of more enticing baits. When placing out traps, camouflage the traps first by painting them with earth color spray paints, then covering with leaves, twigs, etc. It's also wise to set traps out for three or four days unbaited and open, during which time the animal can enter and leave the trap freely. After the traps have been placed it's important to set and bait them in conjunction with the activity periods of the mammals to be caught. In most cases traps only need to be checked early in the morning and late evening, unless, there are extreme temperature changes or conditions were the animal could suffer from the heat or cold. Under these conditions traps should be checked every couple of hours.

To set out traps, except for habitat or territory research, place them in locations that the mammal is likely to use frequently. Suggestions on where to place traps for certain mammals are given below. The ones listed are the more common mammals of the Central and Eastern U.S. Most, however, can be used in the Western states.

MICE: Mice are probably the best subjects of study for school kids. They are plentiful, easy to trap and easy to handle. Plus several different studies such as distribution, population size and sex ratios. Mice can be found in a wide variety of habitats with forests and meadows the most productive. In meadows and other grassy areas small tunnel-like runways are positive indicators of mouse activity. Traps can be placed on these runways so that the mouse can run through it and trip it. Baited traps should be placed near but not on these runways. Traps in wooded areas or forests should be set under bushes, logs, brush piles and at the base of trees and stumps. Bait for mice include sunflower seeds and a mixture of peanut butter and oatmeal

SHREWS: Shrews are sometimes caught in traps and locations set for mice. Better results can be had by placing traps along streams and in marshy areas. Shrews nest under logs and in old rotten stumps, traps can be placed there also. Booth (1971) suggests burying a large wide-mouth jar or deep tin can in the soft ground near a stream, then hanging a small piece of meat on the end of a string suspended from a stick projecting up over the opening of the can or bottle. To find shrews alive it's necessary to check them every couple of hours. Their metabolism is so high that if they don't eat every few hours they starve. Other baits for shrews are peanut butter and otameal with sardines for spice. Sunflower seeds also work well.

GOPHERS & MOLES: To locate moles and gophers, look for lines of earth that have been pushed up. Gopher burrows are about 8 to 16 inches under the surface in ground that is slightly moist and easy to work, such as lawns and meadows near water. Moles generally are found in moist sandy soils such as meadows, golf courses and lawns. Occasionally both are found in wooded areas along streams. Trapping is generally the same for both. Live traps are tunnel like and must be set in a main runway by digging out a section, inserting the trap and replacing the dirt to look as natural as possible. No bait is necessary.

RATS, RABBITS, SQUIRRELS and CHIPMUNKS: These mammals are elusive and difficult to trap but are caught by similar methods. All can be caught in a rabbit-sized box trap. Baits vary with rabbits and rats preferring vegetable matter and sunflower seeds. Squirrels and chipmunks go for unshelled peanuts and sunflower seeds. Rabbits and rats use brush piles for cover and are active along the border of woods and meadows as well as in woodlots. Traps should be placed near those sites. Tree squirrels are of course found in forests and woodlots. Traps should be placed at the base of large trees. Rabbits and rats leave little sign of their presence, mostly tracks and droppings. Squirrels will leave broken nut and seed shells under trees they feed from and in dead logs or stumps where they eat. Ground squirrels and chipmunks will leave shells around their burrows and on rock outcrops where they are active.

SKUNKS, RACCOONS and OPOSSUM: To trap any of these mammals takes a larger trap but of the same design for rabbits and squirrels. All can be found along streams and in woodlots or parks. Skunks especially can be found in urban areas. No special measures are needed when setting traps, just set in isolated places and bait them. In most cases the only indication these animals are in the areas is usually their tracks. Because they are wide ranging, it helps to set them near their tracks but not really necessary. Skunks and opossum are fond of meat but it can be aged with the same results. They will also take apples. Fresh meat and corn will usually attract raccoons.

MUSKRATS and BEAVERS: These fur bearers are two of the most trapped mammals in North America. They are found in or near waterways and both construct homes on the waterways and both construct homes on the water. Beavers are well known for daming streams and constructing a lodge or home of logs, branches, twigs and mud in the middle of the resulting pond. Muskrats also build a home in ponds or on lake shores of twigs, reeds and sedges 3 to 5 feet in diameter. But on the plains and more arid Western regions with fewer trees or even woody regions with few soft trees as cottonwood, aspen and willows, these mammals dig tunnels in the bank of streams or ponds for their dens with the entrance below water level. Both in most cases will make runways leading to their burrows, feeding areas or other bodies of water. These runs are easy to identify, they are usually muddy depressions covered with tracks if they are being used. Another indication of muskrat activity are feeding platforms of cattails or bulrushes on the water. Beavers leave signs mainly of gnawing on trees and limbs. Traps should be placed near the runways baited with apple, carrot, potato or parsnip

for muskrats and fresh willow and upper branches of fresh cottonwood or aspen depending on the trees in the area. Muskrats range from 3 to 5 pounds so rabbit sized traps can be used. Beaver can be between 30 and 55 pounds requiring a large trap. It may be possible to borrow beaver traps from a local fish and game office.

To mark any mammals, the best and cheapest method is to number the animal by brushing on indelible india ink. It will remain in the fur for months and will disappear when the mammal sheds in the spring and fall.

Equipment

When going to the field the amount of equipment to take will vary with the amount of information you desire to record. The following is a list of items that may be needed in the field.

1. Anesthetic: for putting the larger mammals like squirrels, raccoons and opossum to sleep to protect you and the animal.

2. Bait: selected for the animal or animals that you hope to catch.

3. Choke pole: used in handling larger mammals such as raccoon and opossum.

4. Gloves: for protection from bites and parasites or disease that might be in the fur.

5. Record book: for recording information on trap location and information on the animals caught.

6. Scale: for weighing the animals.

7. Tape measure: used to measure length, girth, tail, hind foot or other statistics.

8. Tags: to number trap locations which should be located on a map.

9. Traps: of primary concern, reflecting the type of animals to be studied.

Traps vary in size and are usually designed to accommodate several species of similar size and habits. Most biological supply companies carry a line of live traps. The home-made traps described here are less expensive and generally work as well.

For shrews and mice a simple live trap is made from a mouse trap and a tin can. The tin can is fastened to the mouse trap in such a way that the trigger is inside the can and a piece of tin is placed on the spring wire. When the trap snaps the tin comes over the opening of the can and makes a closed can with the mouse inside. A large wad of cotton should be placed in the back of the can so that the mouse can make a nest for himself. This is very essential if the weather is

cold. A slot must be cut from the can to make a place for the trigger. Also a hole must be made in the lid to allow for the trigger wire to stick through. Figure A will give the rest of the details.

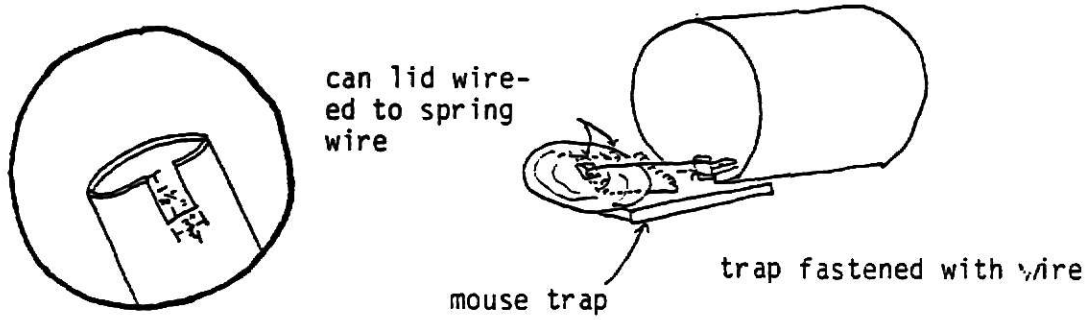


Figure A

Instructions for this trap were taken from "How to Know the Mammals" by Ernest S. Booth.

The directions for building a Fitch type trap come from an article by Robert Rose published in the Transactions of the Kansas Academy of Science, January 1974.

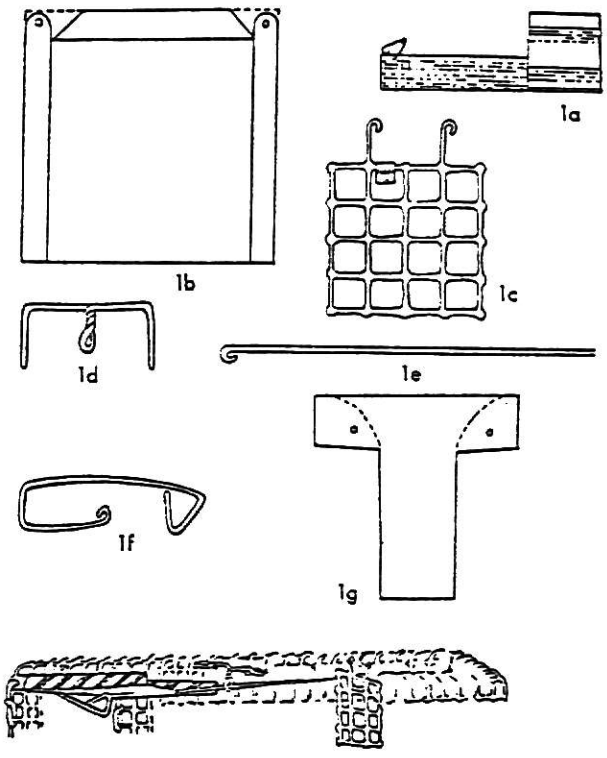


Figure 1. Parts and patterns of the Fitch-type live trap. Fig. 1a. Completed trap (1/12 X). Fig. 1b. Sheet metal door (½ X). Fig. 1c. Treadle, swinging style (½ X). Fig. 1d. Trigger guide (½ X). Fig. 1e. Trigger wire (½ X). Fig. 1f. Springclip of brass wire used to lock trap open (½ X). Fig. 1g. Pattern for marking the cutting path on the No. 10 tin can (½ X). Fig. 1h. Cutaway side view of the position of the movable parts of the Fitch-type trap (1/3 X).

"A 12 x 12 inch piece of 3/8-inch hardware cloth (also called hail screen) is used for each trap. The square is trimmed on three sides, with the fourth side retaining the open mesh wires which are later bent to hold the trap body together. The pattern for bending the bodies is a one-inch board, measuring 2¾ x 16 inches, placed on the screen. With the untrimmed side pointing away, the builder's thumbs are used to bend ¾ inch of screen to form the first corner. By alternately moving the board and making another 90° corner in the same manner, the tunnel of the trap body is formed. The wires of the untrimmed side are intermeshed in the first-bent corner, and, with a needle-nosed pliers, each wire is then bent over or around an adjacent wire in the mesh of the corner of the trap, thereby producing a very sturdy and symmetrical trap body.

The blank for the sheet metal door is 3⅜ inches square, and when drilled and cut appears as in Fig. 1b. Several doors can be made concurrently. Scrap sheet metal of medium weight, which may be obtainable free from a local heating contractor, is readily marked using a ruler and felt pens or an awl. Holes (⅛ inch) for attachment are drilled next, and after the squares have been cut, a triangle of metal is removed from each side, and the margin near the hole is rounded (see Fig. 1b). With a vise, or a narrow cut in a two-inch board, the sides of each door are bent to an angle of 90°. Escape from the hinge is minimized when the top of the door is bent to a 60° angle.

The suspended treadle (Fig. 1c) of the Fitch-type trap is "tripped" when the small mammal pushes it on the way toward the bait in the can. Since the treadle is in contact with the animal

Reprinted from Rose,"Transaction of the Kansas Academy of Science," Jan.1974.

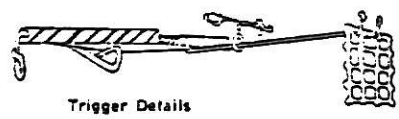
more than any other part, its construction requires considerable care. One-half inch hardware cloth makes the best treadle, with each treadle being four squares (2 inches) on a side, to which are left attached two wires, each 1½ squares (¾ inch) long. Soldered joints on the two suspending wires must be cut away with tin shears, with remnants loosened and removed with needle-nosed pliers. A small tab of sheet metal, ¼ inch wide and twice as long, is bent, folded and crimped between the suspending wires to increase trapping efficiency by eliminating lateral movement of the trigger at its origin on the treadle. The tips of the suspending wires are then bent into tight loops.

When assembling the components, several trap bodies are laid out on a workspace and a sheet metal door is inserted into the trim end of each trap body. The door hinge, made from a 7-inch piece of wire, should be inserted to support the door and then bent into a U-shape. (All wire should be pulled to straighten it before use.) The pendant ends of the wire are then bent, inserted through squares at the leading edge of the trap, turned up, and "sewn" around the wires of the mesh to make the hinge as sturdy as possible. The door in the "up" or open position must be parallel to the floor of the trap body.

The trigger guide is made from a 5-inch piece of wire, bent as in Fig. 1d. The number of twists above the closed loop is related to the height of the sides of the doors. The closed loop is suspended through the top of the tunnel portion of the trap one inch behind the door in the raised position. If the trigger guide is placed too close to the door, the trigger will fall out of the guide when the trap is set off; if the guide is too far from the door, the weight of the door will soon bend the trigger wire. The ends of the trigger guide are then bent and "sewn" through the mesh wires.

The treadle is placed eight inches from the door hinge. In proper position the treadle swings freely but does not move laterally.

Finally, the trigger wire (Fig. 1e) is measured to exact length by placing the loop on the transverse body wire from which the treadle is suspended and cutting at the end of the door in the "up" position. The trigger is then held at the loop end with the pliers, the straight end is sent through the trigger guide, and the loop is closed beside the mental tab on the top of the treadle. The sensitivity of the trap is greatest when the trigger wire is parallel to the longitudinal wires of the tunnel.



Trigger Details

A springclip can easily be made to keep the trap open when not in use. Ductile 18-gauge brass wire is cut into 5½-inch pieces and bent as shown in Fig. 1f. A distance of one inch from the loop to the first right angle is critical for proper operation. The springclip is attached by the loop about ½ inch from the side of the tunnel body, not above the middle of the door.

Figure 1g shows the pattern used to mark the No. 10 can to which the trap body is attached. The dotted line represents the cutting path of the sheet metal scissors; the holes are drilled with the ⅛-inch bit. After cutting, the metal tongue is pulled up and cut off transversely close to the can. The adjacent cut portions of the can are bent outward to form the "wings" which are inserted into the back of the trap body. A 6-inch

Reprinted from Rose, Transactions of the Kansas Academy of Science, Jan.1974.

Wire is passed through the holes and mesh then bent, turned and crimped to make a sturdy joint. The lid of the can forms the floor of the next box and droppings and other debris can easily be removed each time the trap is baited and set. Nesting material, in the form of dried native grasses, is provided and, if stuffed into the top of the can is out of the way of the bait. When set on rough ground the ability of the Fitch-type trap to hold large individuals of small mammal species is increased by placing a square of wood or roofing material under the can lid.

By tripling the dimensions, this trap can be adapted for catching rats, squirrels and small rabbits.

A simple box trap designed for rabbits, opossum, raccoons and other mammals of comparable size can be made from one inch lumber at little cost. Materials needed are listed below.

A.	1- 1"x 12"x 35 1/2	No. 2 white pine or other low-cost lumber
B.	3- 1"x 12"x 36"	No. 2 white pine or other low-cost lumber
C.	1- 1"x 2"x 24"	No. 2 white pine or other low-cost lumber
D.	2- 1"x 2"x 11"	No. 2 white pine or other low-cost lumber
E.	2- 1"x 2"x 13"	No. 2 white pine or other low-cost lumber
F.	1- 11 1/4"x 14"	galvanized sheet metal
G.	2- 1"x 2"x 12"	boards or 2-12" shelf brackets
H.	1- 1"x12"	dowel
I.	1- 14"x 16"	1/2" hail screen
J.	3- 1/4"	eye hooks
K.	1- 1/4 x 3"	bolt with nut
L.	1/4 lb	8 penny box nails

Start by nailing pieces A and B together to form a box so that the boards are even on one end (Figure 2). Boards D fit on the inside of the end with one short board. They should be placed about 1/4" from the end of the box (Figure 3). Pieces E go on the outside of the box to form a slot between D and E for the trap door F which needs a 1/4" hole drilled in the center of one end about 1" from the edge.

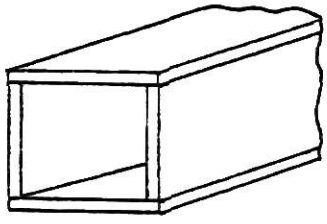


Figure 2

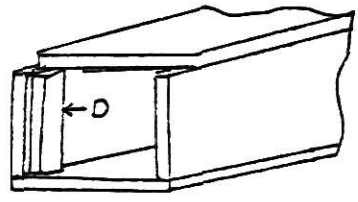


Figure 3

The pieces labeled G are placed in the center of the top of the box so that there is a 1" space between them. If the shelf brackets are used the excess can be bent over the sides. The boards can be supported with 3 - 2" 90 corner brackets. A hole for the trip pin should be 1 1/2" in diameter and 24" from the opening in the center of the top (Figure 4).

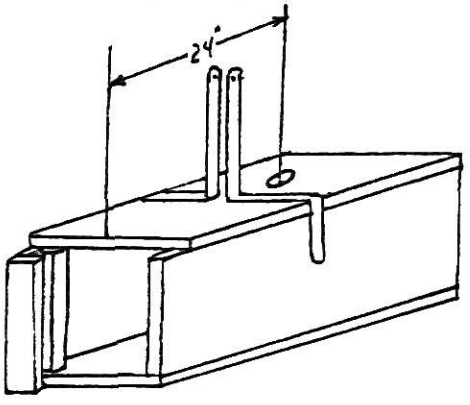


Figure 4

Now drill a 1/4" hole in C on the flat side 18" from one. A diagram of the triggering assembly is in Figure 5. The dowel trigger pin has to be notched so that it will hook on the hole drilled in the top of the trap, shown in Figure 6. The 1/4" eye hooks are used to attach the dowel to the trigger arm and to fit a wire from the door to the arm also. Finally take the hail screen and cut the corners so that it fits over the open end of the trap.

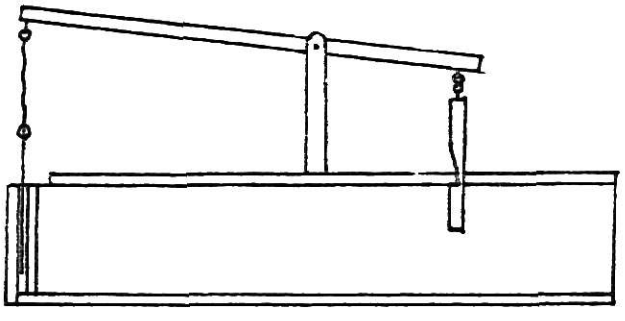


Figure 5

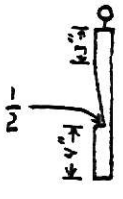
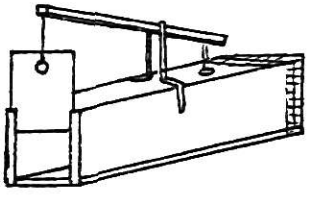


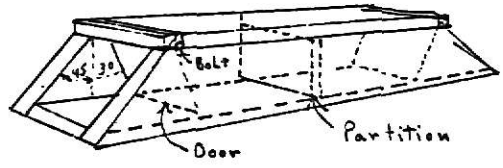
Figure 6



Completed Trap

To set the trap, raise the door until the slot on the dowel hooks on the bottom of the top board. To bait, place the bait inside near the screened end of the trap. As the animal goes for the bait it will hit the dowel knocking it loose and closing the door.

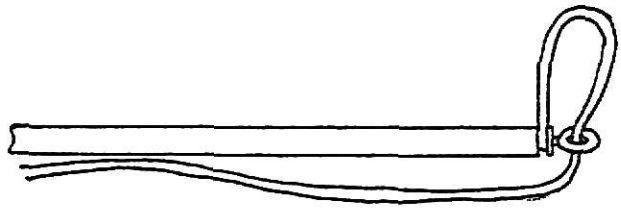
Specialized traps for gophers and moles and very easy to construct, a wooden trap is shown below. It's designed so that the gopher or mole can push its way in but cannot get out. It's important that this trap is camouflaged by working the dirt around the opening to resemble the original tunnel. Another less troublesome method is to use a tin can



Mole and Gopher Trap

approximately the same size as the tunnel. It should only be open on one end so when he crawls in he can't go through but is wedged in and can't go back. To catch them alive it will be necessary to check the traps every 4 or 5 hours.

For handling opossum, raccoons or other medium sized mammals a choke-pole is desirable. These are made from an old mop or broom handle, with a piece of flexible rubber hose used for the loop. The use of a choke-pole is discussed under handling techniques.



Choke-Pole

Handling Small Mammals

Detailed instructions for the handling of wild animals are taken from an article by Loren Lustig and Emmett Wright published in The Science Teacher, November 1979, pages 19 and 20 entitled "Small-Mammal Studies in the Out-of-Doors."

It is important to realize that working with wild animals involves a certain risk of injury both, to the animal handler and to the animal. It is essential that teachers and students be aware of and discuss safety considerations. Of primary concern is the possiblility of incurring infectious diseases from wild animals--such as leptospirosis or rabies. The former refers to several diseases that may be transferred to humans via the urine of infected animals; the use of gloves and strict sanitary measures at all times--keep hands away from mouth, and wash them thoroughly after handling an animal--will effectively neutralize the danger of exposure to leptospirosis. Rabies is rare in terrestrial the size of or smaller than tree squirrels. The frequency of rabies, however, is much greater in larger wild mammals, for example, skunks, raccoons, and foxes.

With the above considerations in mind, we advise that only the instructor be allowed to handle or interact with animals that are caught until after they are anesthetized.

In addition, though in using the procedures we recommend it is unlikely that anyone would be bitten. Should a scratch or bite occur, thorough cleansing of the wound and a tetanus shot are musts. (Hand-aids and disinfectant should be carried in the field at all times.) The person bitten should be taken to the doctor immediately, and the animal inflicting the wound retained for observation.

The proper handling of any trapped small mammal requires skill and dexterity. Light pliable leather gloves should be worn by the teacher to protect his or her hands from scratches. Calm, controlled actions will minimize the stress involved for both the handler and the animal. The technique for handling mammals the size of tree squirrels and smaller is as follows.

First, an interwoven plastic bag (cone-shaped and approximately 60 cm long) should be placed over the mouth of the trap and the slack at the entrance drawn out. This is important because it eliminates any possibility that the animal will escape. The animal will usually bolt out of the trap as soon as the door is opened or removed, however, if prompting is necessary, the handler should remove the trap covering (in the Soots trap) or open the rear door (in the Sherman trap) and then simultaneously blow at the animal while prodding it gently with a thin wooden dowel. Following its entrance in to the bag, the animal should be grasped firmly, yet gently behind the head and along the forequarters. This will facilitate examination and further procedures.

Following removal from traps, small mammals can be easily anesthetized with Metophane (Methoxyflurane), which is available through many animal hospitals or from local veterinarians. (Check local, state and or federal regulations concerning its use and obtain proper authorization

prior to beginning the project.) We have found that this mild, gaseous anesthetic works especially well for small mammals since deaths due to over exposure are negligible, even among those animals held in an unconscious state for long periods of time. The anesthetizing procedure simply involves placing the animal's head into an appropriate-sized jar containing Metophane-saturated cotton or gauze, until the animal is unconscious.

In addition to checking regulations governing use of the anesthesia, teachers may also want to refer to the book Wildlife Management Techniques which offers excellent thorough information on the subject.

In handling larger mammals, one must take more care to avoid being bitten. Mammals such as raccoons and opossums can be easily controlled with a choke pole. The rubber loop is slipped under the partially opened door of the trap and guided around the animal's neck before the slack is drawn out. With this done, the animal can be safely and easily maneuvered in the trap. The animal may then be injected with 1-1.4 mg/lb of Nembutal (Sodiumpentobarbital) or 5-10 mg/lb of Ketaset (Ketamine Hydrochloride) to incapacitate it prior to its removal from the trap. (Again, be sure to check regulations governing use of these drugs before beginning the program.)

Smaller mammals, such as white-footed mice (Peromyscus leucopus), flying squirrels (Glaucomus volans), rabbits (Sylvilagus sp.), hares (Lepus sp.), and short-tailed shrews can often be removed from the trap and examined without the use of an anesthetic. (In this case, however, students should not be allowed to handle the animals.)

After an animal is anesthetized, students may be allowed to handle it (provided gloves are worn). When an animal begins to come out of the anesthesia the teacher should take the animal and put it back in the cage--or, if more study is desired, administer more anesthesia. For the protection of animals and humans, animals should always be allowed to regain total consciousness before being released from the cage. Then, when releasing the animal, teacher and students should stand well behind the cage, so that the animal has a clear avenue of escape.

Keys and Their Use

Keys come in two basic forms. Some are essentially picture books with either photos or paintings of representative mammals. These are by far the best for amateur naturalists. The majority of mammals are very distinct and it's easy to distinguish one species from another. Audubon and Peterson Field Guides are two of the best and are listed in the appendix. Most difficulty in identification will arise in naming the shrews, mice, rats and squirrels. In many of these species there are subtle differences in coat color or markings which may require a dichotomous key for precise identification. A few of these keys are also listed in the appendix. To use a dichotomous key, especially for mammals is really easy. Each key will begin with two descriptive

phrases. Merely match the phrase with the animal then follow the directions to the next pair of phrases and repeat the procedure until reaching an identify. The more scientific the key the more complex the language, but those generally have a glossary with easy to understand definitions.

Field Notes

When making a collection or doing any type of field work, it is wise to maintain a field notebook. Include information about locality, habitat, weather, date, time, conditions and those in the field party. When a specimen is collected, it should be given a number that is recorded in the field notes and on a tag that accompanies the specimen. Also it's helpful to draw a rough map of the study area in the front of the field indicating where traps are located, they should also be numbered. On the specimen's tag put the number of the trap where it was caught to indicate its habitat. Do not fail to include information on animals other than mammals encountered in the field.

Preparation of Specimens

This material was written by Ernest S. Booth in his book How to Know the Mammals published by the Wm. C. Brown Company, Dubuque, Iowa.

The usual way to prepare a mammal for preservation is to skin it, make and insert an artificial body of cotton, sew it back together, pin it down on a board, attach the label, let it dry and place it in a cabinet along with the cleaned skull, clearly labelled as to collection data, measurements and other essential information. This is then spoken of as a study skin and skull. All the large museums have collections prepared this way even though the general public never sees them. They are not suitable for display, but are ideal for study since they take up very little space,and can be handled easily and safely. This is the method to be described in this section.

SKELETONS

Too little attention has been directed to the making of mammal skeletons. Consequently, many large collections are lacking in these, when they just as well might have them. If collectors would take a little more time to save those specimens which are otherwise thrown away due to spoilage, many skeletons would be preserved. These need only to be "roughed out," dried away from flies, then cleaned by beetles just as the skulls are cleaned. "Roughing out" is merely skinning and removing the internal organs, and any larger bits of flesh that will come off readily, then allowing the animal to dry without decaying. When dry, it may be cleaned by beetles, then preserved in a cardboard box along with the same data which is saved for the skins and skulls. Skeletons of the animals which are prepared into skins should be saved as well, if the specimen is something unusual. Museums are generally desirous of obtaining skeletons of even smaller mammals for comparative study.

PRESERVING IN SOLUTIONS

It is possible to preserve mammals in solutions of several kinds. Bats may be preserved in 70 to 85% alcohol. While this method has been used a great deal in large museums, it is not so good as the study skin method. If a large number of bats are caught and it is impossible to skin all of them, the rest should be preserved in 85% alcohol.

On intensive collecting trips it is sometimes impossible to stuff all the specimens caught. There is a method whereby the animals may be preserved temporarily until after the trip is over, then skinned at a later time. This process is simple enough to use. The animal is injected in several places throughout the soft parts of the body with embalming fluid (formalin, full strength, 5 parts; phenol, full strength, melted crystals, 5 parts; glycerin, 5 parts; water 85 parts), then the entire animal is placed in the fluid. Data must be recorded as usual, and placed on a water proof label. In one or two months the animal may still be skinned and made into a good study skin. There will be much difficulty in cleaning the skull, however. At best, this method is an emergency method to be used only when specimens could not otherwise be saved.

DATA TO RECORD

It is hard for a beginner to understand that a specimen has no scientific value without a label. Record keeping is one of the most

particular phases of mammalogy. It is impossible to record too much data about the specimen, and most people do not record enough. First a label must be attached to the right leg of the specimen, tied ¾ of an inch from the leg by No. 8 thread. The label may be rather small, ½ inch by 2½ inches, or it may be as large as ¾ inch by 3 inches. If you can afford it, it is best to have your name printed at the top, and your permanent address, if you have one. As illustrated (fig. 9), the trapping locality—state, county, and city—comes next. If the place is not close to a city or town, it is best to record the distance and direction from the nearest town. Any place that can be found on a map, such as a lake or a mountain, is a suitable locality. The next line is for the date; the third line for your name (unless printed labels are used); the fourth line is for the measurements of the animal in millimeters. The sex (the sign ♂ symbolizes the male, and ♀ the female) is indicated at the right end, and your collector's number (beginning with 1 for your first specimen, 2 for your second, and so on through life) after your name. On the back of the label the scientific name comes first, then common name, if any, and other information like habitat, elevation, or any other information you wish to record. One item that many leave off, but which should always be recorded, is whether or not a female has embryos or

Figure 9

whether or not it is lactating. This is usually indicated on the front side at the lower right hand corner.

Labels must be tied in a certain manner. Two holes are punched in the left end of the label, and the thread passed through these. The ends are crossed and passed back through the loop so that the finished label looks like the drawing. Then the knot is tied ¾ inch from the label, and the label tied to the right hind foot securely by a square knot, and the loose ends trimmed off.

You must have a field catalogue. This is usually a looseleaf notebook containing the same information that you recorded on the label, and in about the same order. It is really a duplicate label record and should be guarded against loss. Should a label accidentally be destroyed, it might be possible to identify it by this duplicate record. You will also have a permanent record of the mammals you may trade to other collectors.

The field notes are kept in another notebook. Here, individual needs can determine the information recorded. Some people make an entry for every specimen, recording additional information that is not on the label. Others make an entry for each trapping locality and night. In other words, if you set 29 traps for one night in a certain place, you record all the general data about that under a single entry in your field notes. You record weather, condition of the territory in which you are trapping, various habitats, kinds of bait, traps, how many specimens you caught, how many skinned, and the numbers of the skinned specimens, and always the number of trap-nights. A trap night is one trap set one night. So if you had 29 traps set for one night you had 29 trap nights. If you set them in the same place for two nights, you had 58 trap nights even though you had only 29 traps. You will think of other items you want in your notes. Do not make them too brief, for this is your record of activity in mammalogy. It is valuable, keep it always. If you ever give your collection to a museum, your notes go with the collection.

All entries on labels are to be made with black India ink, and done as neatly as possible. Entries in field catalogues and notebooks are best done in India ink as well, unless a typewriter is available.

SKINNING SMALL ANIMALS

It is probably best to use an animal the size of a chipmunk, squirrel, or wood rat for your first specimen, although when you gain some experience you will likely come to feel that meadow mice are the easiest of all, with pocket gophers running a close second.

Suppose that you now have a wood rat in your hand, and are ready to begin to make a study skin out of it. The first thing to do is to take the measurements in millimeters. The total length, length of tail, length of hind foot from the heel to the tip of the longest toe nail, and the length of the ear from the notch are the usual ones to take (figs. 10 to 14). Bats have a fifth measurement, the length of the tragus,

Figure 10

Figure 11

Figure 12

Figure 13

Figure 14

a small rod-like structure in the ear. These are all recorded in order at the bottom of the front side of the label, thus: 290-130-29-25. The weight in grams is often added, and if one can afford a good balance, that is a worth while record to obtain. It is added after the measurements. If there is any chance that you might get the measurements mixed up it would be well to have them marked on the label. (See fig. 9).

The sex is now recorded, and the label completed before you start to skin the animal. Some mammalogists insist that the label be tied to the foot before skinning is begun. However, I find that the label often becomes soiled if it is attached to the specimen, but it may be laid to one side until the skin is ready to pin down, then it must be attached before you start the next specimen. This is important, for you must never get the label for one specimen attached to another specimen. There is no hurry about finding the name of the creature, so leave that until all the skinning is done. It is essential to finish the skinning as soon as possible, for it will be a better specimen if it is done quickly before it has a chance to spoil or to become dry.

Mammalogists differ in their preferences for skinning tools. Some use a scalpel or pocket knife almost entirely, while others use scissors. You might try both methods and choose the one you like best. I prefer scissors, so will describe the process with scissors.

Figure 15

Figure 16

With the scissors make an incision down the middle of the belly as shown in the drawing (fig. 15), then peel the skin back with the fingers until the knee joint is exposed. Cut through the knee by going through the joint rather than through the bone (fig. 16), then remove the flesh from the leg attached to the skin; do the same for the other leg, and pull the skin back toward the tail. During this time you will need to pour fine cornmeal or hardwood sawdust onto the skin to absorb moisture, to keep the fur clean, and to make it easy to get hold of the skin with your fingers.

Actually, most of the work is done by your fingers and you will appreciate the aid of the cornmeal.

Then, grasp the tail with the fingers and pull firmly (fig. 17). Be sure that you do not pull on the hair of the tail, but put the pressure on the tail bone below the skin, thus allowing the tail bone to pull out of the skin rather than pulling the skin off the tail bone.

Figure 17

Now, it is a simple matter to peel the skin off the back of the animal until you reach the front legs. These will be severed at the joint as were the hind legs, and the peeling continued until the head is reached. It is necessary to be very careful in this peeling process so that you do not pull on the skin very much, for this may cause the skin to stretch and the animal to be much larger than it should when you are through. This is especially true of gophers and other thin skinned animals.

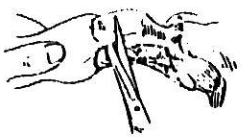


Figure 18

Care must be used in cutting over the ears, for they could be cut off (fig. 18). The eyes are the next problem; if you hold the scissors very close to the bones of the skull and take very small cuts you will soon learn not to cut the eyelids (fig. 19). The teeth are a difficult matter in some animals, especially the rodents, for the mouth has two chambers, and care must be used not to cut through the skin. By keeping the scissors very close to the skull and cutting carefully you will soon have the skin at the very tip of the nose. Then, all you need do is to cut through next to the bone, and the skinning is done (fig. 19A).

Figure 19

Figure 19A

Next you will sew up the mouth. In rodents and rabbits the mouth opening forms the shape shown in the sketch.

Sew as the dotted lines indicate (fig. 20). Check over the skin now to make sure there are no bits of flesh clinging to it, and remove all fat present. Before going any farther dust a liberal supply of Borlaxo all over the flesh side of the skin, before you place the cotton body in the skin and before you sew it up. This is to prevent insect damage later on.

Figure 20

Figure 21

Take a wire the right size for the tail, wrap the base of it so as to fill out the tail, then insert it in the tail (fig. 21). Make sure that the wire goes clear to the tip, even if you have to use a file to make the wire small enough to go that far. If the wire does not reach the end of the tail, the tail will be broken off some time later when it is dry. Wrap enough cotton about the leg bones to make them the size of the original legs, and turn legs right side out. If a leg is broken, a wire, wrapped with cotton, should be placed in the leg to take the place of the bone.

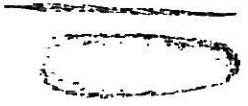


Figure 22

You are now ready for the cotton body. Take a thin strip of cotton wide enough to extend from nose to base of tail, roll it up lightly, but rather firmly, and make a long slender roll a bit larger than the original body, and the same diameter throughout its length (fig. 22). Then with the tip of a pencil (the skin has been turned wrong side out all this time) poke a small dent in the nose, and, after pinching the cotton body down into a sharp point, stick this point into the dent made in the nose (fig. 23). Now turn the skin back slowly, making sure that the cotton is remaining in place, and filling out the head clear to the tip of the nose. If the skin has become a bit dry by this time, (as it may the first few times you do this) moisten it with water so that it will turn back freely.

Figure 23

Figure 24

Make sure that the cotton body completely fills the skin, and extends back as far as the base of the tail (fig 24). If it is too short, do not stick in small wads of cotton to fill in the gap, but remove the entire body and make another one that will be long enough. If the body is too long the excess part may be cut off with scissors, or torn off carefully. Pull the sides of the body over the cotton and bring them together, ready for sewing. Make sure that the tail wire fits well, and sticks outside the cotton on the belly side. See that the legs are in place. You are now ready to sew up the belly. If the skin does not come together moisten it with water so that it will cover the cotton easily.

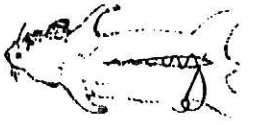


Figure 25

Sew the belly skin together starting at the anterior end and making cross stitches about a half inch apart (fig. 25). A single thread is best, for it will not tangle so readily. When you are through just make a few extra stitches down through the skin, then cut off the thread near the skin. This should leave no visible thread. Now the specimen should be well streamlined from tip of nose to end of body. Smooth out any bulges or dents, tie on the label, and pin down to a board or piece of cellotex as the sketch shows (fig 26). Leave there until dry.

Figure 26

The skull is removed from the body, and a small label, bearing your name, collector's number, and sex of the animal is attached carefully through the lower jaw (fig. 27). This is put away in a safe place to dry, protected from flies, as is the skin. The beginner may see no reason for so much attention accorded the skull. Determination of subspecies, and often species, many times depends on cranial differences.

Figure 27

If the skin is bloody or dirty it should be cleaned with a piece of cotton dipped in cold water. Dry the wet area by rubbing cornmeal over the fur until it is fluffy again. Never use warm water on blood.

Many mammalogists put powdered arsenic on the skin before the body is placed in position. Because of the danger of poison I do not recommend this practice for beginners. A live mammalogist is worth far more than a dead one! Boraxo is nearly as good as arsenic for preventing insect damage, and is never dangerous; use it instead of arsenic to protect your specimens from insect pests.

SKINNING LARGE MAMMALS

Mammals up to the size of woodchucks and badgers may be prepared the same as small mammals, with the added precaution that all the fat must be carefully removed, or the hair will come out of the skin. Larger animals such as coyotes, bob cats, deer, and the like are best tanned. The skinning can be done much the same as in the small mammals, but large skinning knives will be necessary, and the legs will be split down to the foot. The toes and claws must always be left on the skin. Animals larger than coyotes should have the skin on the underside cut all the way from the anus to the throat.

The skin should be tacked out on a large board, or against the side of a wall in the shade and left to dry. Flies should be kept away by spray.

As soon as possible the skin should be sent off for tanning. If the skin cannot dry quickly it would be wise to rub salt into the thicker portions around the lips, ears, feet, and any other area that does not dry readily. Measurements and data are kept in the manner previously described.

CLEANING SKULLS AND SKELETONS

After the skulls and skeletons are thoroughly dry, the next step is to place them in a suitable container with a colony of dermestid beetles. These are the little black beetles with silvery bellies that you may find under the dead carcass of an animal lying out on the ground. However, if that method of collecting the beetles does not appeal to you, you may be able to get your own colony by merely placing the skulls or skeletons on a high window ledge or other place where they will not be in danger from cats or dogs, and where the beetles can find them. As soon as you have a few beetles present on the skulls place them all in a tight metal can of about five gallons capacity (fig. 28). Keep the can where it will remain at about room temperature for best results. Place a fairly large wad of cotton in the can, for the beetles will not pupate in the skulls. As soon as the new beetles hatch out they will be laying more eggs on the skulls, and then the colony will grow rapidly. In a week or so the skulls will be nicely cleaned and can be removed from the can. If you desire to maintain the colony permanently you will have to remember to keep them supplied with food. If you do not want to keep the colony then nothing more need be done until a new start is needed.

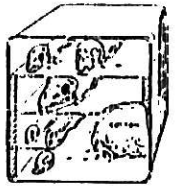


Figure 28

When the beetles have finished their work, the skulls may be placed in full strength commercial ammonia for a half hour or longer until the bones are nicely whitened. Then, wash them carefully in water and allow to dry before placing them in the permanent collection. The data label originally attached to the skull should be placed with the skull in a glass vial about the right size for the skull. Only one skull should be placed in a vial, so as to avoid any possibility of error. To make it doubly sure you may write the specimen number on the top of the cranium in India ink, but always keep the original skull label in the vial with the skull.

Large skulls like those of deer or sea lions may be cleaned by boiling and picking off the flesh. They may be whitened in ammonia like the others. Small skulls must not be boiled, for they may be seriously damaged.

If it is not convenient to make a beetle box for cleaning skulls or skeletons, they may be cleaned by another method. First place either freshly skinned or dried skulls in full strength commercial ammonia just as you buy it at the grocery store. Leave the skulls in this for several days, making sure that you have marked each skull so that you will not get them mixed up. It is best to place only one skull in a small bottle, with the specimen number marked on the outside of the bottle. After soaking in ammonia for several days, place the bottles with skulls in an electric cooker and heat to 150° for about 10 minutes for small skulls, and up to one hour for larger skulls. Small skulls cannot take more than a few minutes in the hot ammonia. Be careful not to breathe the ammonia fumes when you open the bottles. After the bottles have been in the hot water bath in the cooker for the required time, remove them from the heat, pour off the ammonia, rinse several times in clean water, then carefully rinse off and pick off all pieces of remaining flesh. Lay the skulls out to dry in a safe place. They will now be clean and white when dried. It takes a little experience to keep from injuring delicate skulls by this process.

PRESERVATION OF SPECIMENS

It is just as important to take good care of specimens as it is to prepare them carefully. First, make yourself a tight cabinet (fig. 29) with a removable door, and sliding trays which may be placed either close together or far apart as the case demands. The sides of the cabinet should have a series of small cleats which allow the trays to be placed anywhere. Most museums make their cabinets of white cedar, and cover them with zinc. The tray size is usually about 24 x 41 inches, while the cabinet is 42 inches high. Any other size or material that suits one's fancy may be used, of course. Be sure to build the cabinet in such

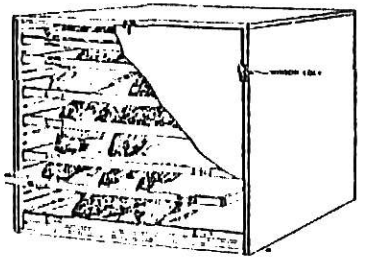
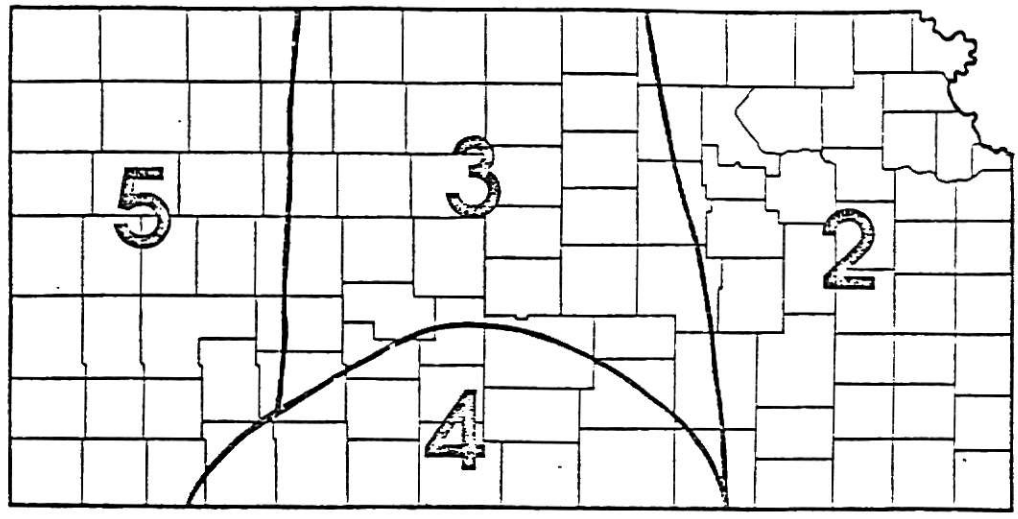


Figure 29



1 - ENTIRE STATE

The map shows the different biotic areas of Kansas. They differ in their geology, plants, animals, and the amount of rainfall they receive each year. On the following page is a partial list of mammals that are found in Kansas and beside each name is a number corresponding to the number of the area of Kansas in which that animal is found. The following letters (categories) indicate the types of habitat the mammal prefers: A. Found in all types of habitats; B. Animals found primarily in cities and towns; C. Animals found in or around houses and buildings in rural areas; D. Found in woodland situations; E. Found around streams, ponds or lakes; and F. Found in open fields or grasslands.

Opossum	1	A
Short-tailed Shrew	2,3	A
Least Shrew	1	A
Eastern Mole	1	D,E
Little Myotis	1	A
Cave Myotis	4	F
Keen's Myotis	2	D
Pipistrelle	2,4	A
Big Brown Bat	1	A
Evening Bat	2	D
Silver-haired Bat	1	A
Hoary Bat	1	A
Red Bat	1	A
Long-eared Bat	4	F
Pallid Bat	4	F
Brazilian Free-tailed Bat	1	F
Big Free-tailed Bat	5	F
Armadillo	2,4	A
Cottontail	1	A
Swamp Rabbit	2	D,E
Black-tailed Jackrabbit	1	F
Gray Squirrel	2	D
Fox Squirrel	1	D
Woodchuck	2	D
Black-tailed Prairie Dog	3,4,5	F
13-lined Ground Squirrel	1	F
Franklin's Ground Squirrel	2,3	F
Eastern Chipmunk	2	A,D
Spotted Ground Squirrel	5	F
Southern Flying Squirrel	2	D
Plains Gopher	1	F
Plains Pocket Mouse	3,4,5	F
Silky Pocket Mouse	5	F
Kangaroo Rat	3,4,5	F
Beaver	1	D,F
Northern Grasshopper Mouse	3,4,5	F
Harvest Mouse	1	F
Brush Mouse	2	D
Cotton Rat	1	F

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Wood Rat	1	A
Lemming-mouse	1	F
Muskrat	1	E
Voles	1	F
Norway Rat	1	B,C
House Mouse	1	B,C
Jumping Mouse	2	F
Porcupine	4,5	D
Coyote	1	A
Red Fox	1	A
Gray Fox	2	D
Swift Fox	3,4,5	F
Raccoon	1	D,E
Mink	1	E
Longtailed Weasel	1	E
Black-footed Ferret	3,4,5	F
Badger	1	F
Striped Skunk	1	A
Spotted Skunk	1	F
Bobcat	1	D
Black-tailed Deer	3,5	F
White-tailed Deer	2,3,4	A
Pronghorn Antelope	5	F

How to Identify Mammals

The keys to mammals are designed so that you can identify most of the mammals found in the state. The key is used like a true and false test. If (1a.) is true, then you go to the number listed on the right. If it is false, you go to (1b.) and then go to the number shown. Continue to do this until you reach the statement that has the name of the animal. To be sure that you have correctly identified the animal, check the list on page 6. This will identify the general range of the animal and type of habitat. To find out more about the animal, look the species up in one of the books listed at the end of this one.

KEY TO THE MAJOR GROUPS OF MAMMALS

1a. Front limb developed into wing	1. BATS (Pg. 7)
1b. Claws or hoofs on front feet or toes	2.
2a. Inner toe (closest to body) without a nail and thumb-like, pouch in females	OPOSSUM
2b. All toes with nails or hoofs	3.
3a. Two hoofs per foot	DEER FAMILY
3b. Claws on all feet	4.
4a. Front (incisor) teeth relatively large, flattened and chisel-like, (2 upper & 2 lower), yellow or yellow-brown in color	5.
4b. Front teeth small or absent	6.
5a. Two upper front teeth only, long-tailed (one-third of body length or longer), ears rounded	RODENTS (Pg. 8)
5b. Two tiny teeth directly behind large front upper teeth. Long, pointed ears, short tail (much less than one-third of body length	RABBITS (Pg. 8)
6a. Front teeth absent, upper body covered by bony plate, pointed snout	ARMADILLOS
6b. Front teeth present	7.
7a. Front teeth (incisors) small, but with fourth tooth (canine) enlarged; not reddish-brown, tail covered with fur; at least twice as large as a mouse and usually much larger	CARNIVORES (Pg. 10)
7b. Two front teeth relatively large and pincher-like, no canines, larger than a mouse with front feet adapted for digging; short, silver-gray fur	SHREWS and MOLES (Pg. 8)

Reprinted from Ashton, "A Study Guide to Kansas Mammals",

KEY TO THE BATS

1a. Wing membrane includes all of the tail ..... 2.

1b. Wing membrane only includes base of tail (nearest the body) ..... FREE-TAILED BAT

2a. Small but usually brown in color; membrane between hind leg and tail has only a few hairs ..... LITTLE BROWN

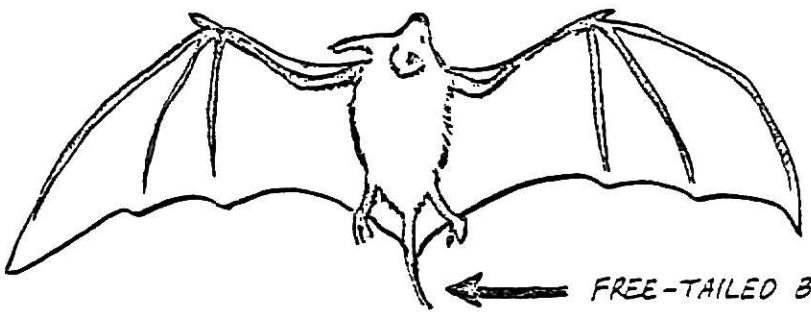
2b. Large bat with wingspan of more than six inches ..... 3.

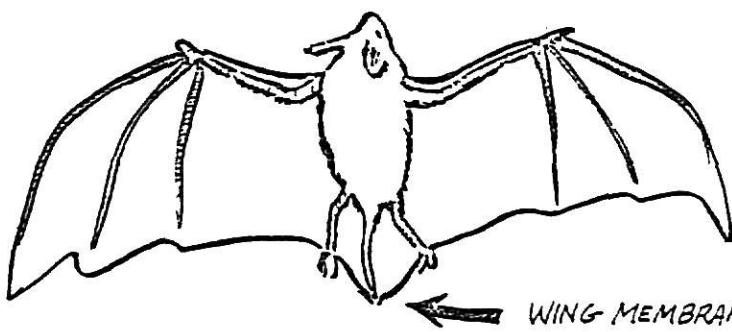
3a. Membrane between hind leg and tail with only a few hairs, all dark brown (common in houses) ..... BIG BROWN BAT

3b. Membrane between leg and tail furry ..... 4.

4a. Bats red in color with tips of longer hairs white (found in trees) ..... RED BAT

4b. Large bat, black or dark gray, strongly frosted with silvery white ..... HOARY BAT





Reprinted from Ashton, "A Study Guide to Kansas Mammals".

KEY TO THE MOLES AND SHREWS

1a. Eyes and ears very small and hard to see; front feet large and designed for digging ..... EASTERN MOLE

1b. Front feet small, eyes are small but present, the size of a mouse or smaller, pointed snout, colored teeth ..... 2.

2a. Much smaller than a mouse, small furry tail, cinnamon color ..... LEAST SHREW

2b. Mouse size, grayish-black color, very small external ears ..... SHORT-TAILED SHREW

Skull of the least shrew — shown about six times actual size.

KEY TO THE RABBITS

1a. Short front legs, ears nearly as long as the length of the head (nose — back of skull), no black tips on ears ..... COTTONTAIL RABBIT

1b. Ears longer than head length, black-tipped ears ..... 2.

2a. Tail with black on top and rump ..... BLACK-TAILED JACKRABBIT

KEY TO THE RODENTS—THE SQUIRRELS

1a. Tail almost as long as body, bushy ..... 2.

2b. Tail one-half body length or less ..... 3.

2a. Upper part of animal reddish with black; underside — red-orange ..... FOX SQUIRREL

2b. Dorsal part of animal gray, white behind the ears ..... GRAY SQUIRREL

3a. *Animal dark brown, frosted tips on long hairs,* short-legged, 16 inches or more in length, feet black ..... WOODCHUCK

3b. Head and body less than 16 inches in length ..... 4.

4a. Short tail, black on last one-third, upper back cinnamon, undersides whitish (live in colonies) ..... BLACK-TAILED PRAIRIE DOG

Reprinted from Ashton, "A Study Guide to Kansas Mammals".

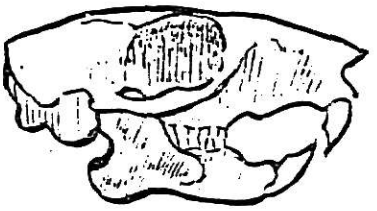
4b. Little or no black on tail ..... 5.

5a. Tail bushy, one-third head and body length, gray-brown on back ..... FRANKLIN'S GROUND SQUIRREL

5b. Tail less than one-third of body length ..... 6.

6a. Broken lines and stripes from back of head to rump numbering thirteen ..... 13-LINED GROUND SQUIRREL

FOX SQUIRREL



KEY TO THE RODENTS—MICE

1a. Tail with little or no hair ..... 2.

1b. Tail with hair ..... 6.

2a. Mouse size; three inch body size or less ..... 3.

2b. Body size larger than three inches ..... 4.

3a. Color—grayish on back and belly, tail about same length as body (found among buildings or nearby fields) ..... HOUSE MOUSE

3b. Color tan above, especially on sides, whitish on belly with tail longer than body ..... JUMPING MOUSE

4a. Tail flattened, rich brown color, back feet webbed (found in or around water) ..... MUSKRAT

4b. Tail rounded ..... 5.

5a. Tail nearly as long as body, body drab brown on back and belly (found around buildings) ..... NORWAY RAT

5b. Tail thinly furred—half body length, body black, brown above, whitish on belly ..... COTTON RAT

6a. Tail almost twice as large as body, large hind feet, bright brown above, very large eyes ..... KANGAROO RAT

6b. Tail less than length of head and body ..... 7.

7a. Tail short, less than one-third body and head length ..... 8.

7b. Tail one-half body length, big ears ..... 9.

Reprinted from Ashton, "A Study Guide to Kansas Mammals".

8a. Short legs, body brown, long hair, small ears ..... VOLE

8b. Light brown above, white on belly, white tip on tail ..... GRASSHOPPER MOUSE

9a. Tail dark above, light below, big ears and eyes, gray or tan above, white on belly (found in woods) ..... DEER MOUSE

KEY TO THE CARNIVORES—DOGS

1a. Large, 18 pounds or more, long legs, gray or tan ..... COYOTE

1b. Less than ten pounds ..... 2.

2a. Red above, white on belly, white tip on tail ..... RED FOX

2b. Gray on back, red on sides of body and tail, black along center of tail (eastern woodlands) ..... GRAY FOX

KEY TO THE CARNIVORES—WEASELS

1a. Tail bushy, short legs, stocky body ..... 2.

1b. Body slender ..... 4.

2a. White stripe on face, short tail, gray or brown on back ..... BADGER

2b. All black and white ..... 3.

3a. Black with white cap on head, usually two stripes down back ..... STRIPED SKUNK

3b. Black, four narrow zig-zag stripes on back and sides ..... SPOTTED SKUNK

4a. Rich brown color with white throat patch, slightly bushy tail (usually around water) ..... MINK

4b. Brown above, light tan to white on belly, black tip on tail ..... LONG-TAILED WEASEL

SPOTTED SKUNK

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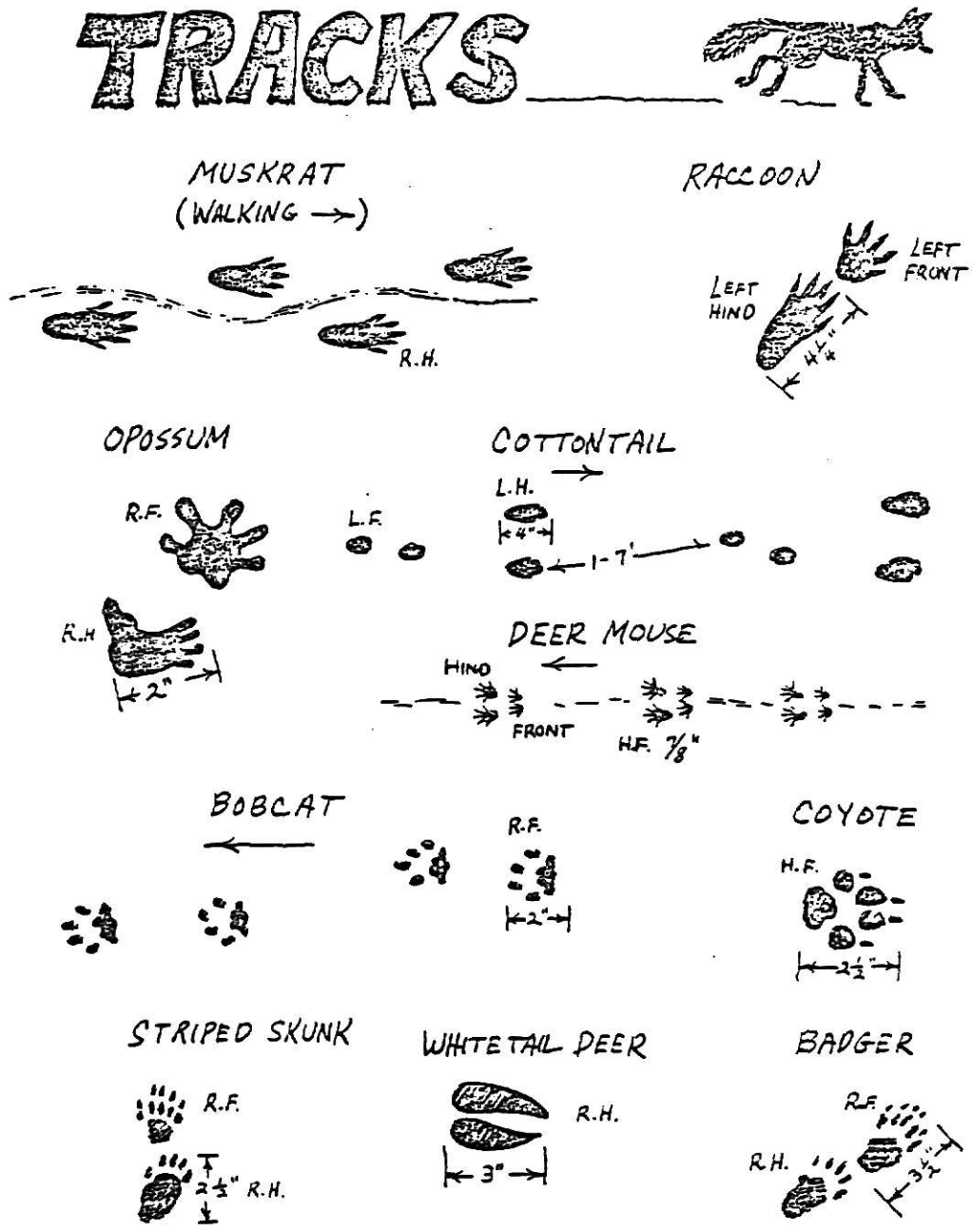

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FIELD EXPERIENCES

THE STUDY

OF

PLANTS

RATIONALE:

Outdoor education is an essential part of any biology education and an important component of any field study is plant identification. Plants as a whole are the food sources of every animal on earth. Because plants are the starting point of all food chains, including man's, it is only logical that the ability to identify plants would be important. When identifying plants, not only are names assigned to plants, but the role of plants also becomes evident. Names originated for plants that we used for food, clothing, shelter, decoration and other uses. Conservation, ecology and environment are few of the concepts that can also be discovered by identifying plants.

INSTRUCTIONAL OBJECTIVES:

Upon completion of this module the student should be able to:

1. Construct a plant press.
2. Press a plant and prepare it for entry into a herbarium.
3. Identify an unknown plant with the use of a key.

LEARNING ACTIVITIES:

Introductory Activities

1. Read the information in this module.

Application Activities

2. Locate two taxonomic keys to the plants in your area.
3. Make a collection of at least 10 plants and identify them.

Alternative Activities

4. Read "Vascular Plant Families" by James Payne Smith, Jr.

INTRODUCTION

The driving force behind all animal life is food energy produced by plants. Because of their importance in sustaining life as we know it, understanding something about them is important. Identification of particular plants becomes extremely important when studying the variety and uses of higher plants. With an increasing world population and the amount of arable land decreasing, identification of new and old foods is necessary. Plants can be studied to examine the infinite variety of flower colors and shapes for their own sake or identify and propogate economic species. If nothing else, knowing plants can lift your spirits by being able to identify an obscure plant for a friend.

PREPARING FOR FIELD TRIPS

The key to success is careful planning. There are many things to consider when organizing a field trip. Some are school policy, permission from supervisors, teacher liability, acquiring transportation, class time or extended trip, safety precautions and cost. They have little to do with plants, but are an important part of any field trip. Here are some questions that should be asked before going on a field trip.

1. What are the objectives of this trip?
2. How much time is available or needed?
3. Will transportation be necessary?
4. Where should this trip be taken?
5. When is the best time to go?
6. What kind of equipment will be necessary?

The answers to these questions will determine the type of field trip and establish an outline for the purposes of the trip. From this you will be able to evaluate the benefits the students will receive from this type of experience.

CONDUCTING THE FIELD TRIP

There are probably as many ways to conduct field trips for plants as there are teachers. Some activities assigned to facilitate the study of plants are comparing the textures of different plants, leaf shapes, flower shapes and colors, and making up your own names to plants. Games have been created to organize these activities and have such names as the Blindfolded Botanist, The Twig Game, A Plant Identification Game, and Claim It, Name It. Information on these games can be found by locating them through the list of references. Most of these games are K-12, but could be upgraded. For older students a formal collection of plants is recommended.

When going to the field during a school year, the spring and early fall are best. In the continental U.S. many plants flower in the spring and summer, so fall and winter are not recommended. However, if an instructor is willing to go to the effort to locate keys to winter characteristics, a person can identify most trees and shrubs. But flowering plants of spring are more interesting to students plus being easier to identify.

Choosing a place to collect depends on the plants. There are two categories of plants to consider, cultivated and wild plants. In most cases it's better to identify wild plants because cultivated plants are usually found in someone's flower bed. Many cultivated plants that have gone wild are included in the keys for wild plants. Most wild plants are considered weeds so few people complain about digging them up. Any yard or lawn will have many different species in them, so school yards and playing fields are useable. Other places are along railroad tracks, roadside ditches, alleys, vacant lots, etc. Wherever you plan on collecting plants, it's best to ask permission because for proper identification, it's necessary to dig up a plant or cut off part of it.

Plant collecting trips are extremely easy to conduct. Once you have selected a site and have managed to get the group there, it's merely a matter of combing the area looking for flowering plants. The only equipment necessary for collection is some plastic bags, notebook, labeling tags, a digging tool and a knife. When the students are collecting plants, instruct them to leave some plants from a population to repopulate the area. Also after the ground has been disturbed, be sure to replace the dirt and any rocks that have been moved to preserve the natural state as much as possible. Directions on collecting plants are included in the section on herbariums.

PLANT IDENTIFICATION

Introduction

Identification of plants can be difficult and frustrating at times due to the complexity of plants and the special terminology developed to describe them. There is, however, some basic knowledge that a person will need to begin the identification of plants. In the long run, practice in using the material is the most important.

Basic Terminology

Plants are grouped into families, genera and species. An example of this is the common dandelion which belongs to the family Compositae, the genus Taraxacum, and the species laevigatum. T. laevigatum is only one species of dandelion of which there are many. After identifying a few plants, go back and study the family characteristics. Floral structures for families are constant for the most part. By dissecting a flower and determining its structure, you can place it in a family. An example is the family Cruciferae. Flowers in this family are actinomorphic, have 4 short stamens and 2 long stamens, 2 locules in the ovary, are rarely stipitate and the fruit is a silique.

The best method to use when learning terms is to pick a plant that you have a common name for. Select a key that has that plant in it, then go through the key using the plant's characteristics to identify it. To learn the characteristics, go to the glossary for definitions and descriptions of each term.

USING A KEY

Some keys will have directions on how to use them somewhere in the book, so be sure to read over the instructions. Even experienced persons should read over these descriptions to familiarize themselves with the general working of that key. Before selecting a key it's wise to talk to a plant specialist in your area and have them recommend a key for that region. Most detailed keys will have to be specially ordered. Some books on plants cover wide regions of plants such as spring flowers of the Rocky Mountains, or the trees of North America. A listing of some of the more commercially accessable books on wild plants is in the appendix. Many of these keys group plants by flower color or families and provide drawings or pictures for matching purposes. However, in the realm of scientific plant taxonomy and positive identification, a dichotomous key is used.

A dichotomous key is a two directional work based on the descriptive characteristics of plant group and individuals. The first step in naming a plant is to determine the name of the family to which it belongs. Most keys begin with a key to the families. An example of the first step to using a dichotomous key is given below. Compare your plant to these descriptions.

1. Trees, shrubs, or woody vines, woody at least in the lower portions.....2

1. Herbaceuous, i.e., non-woody plants (including water plants & vines).....102

   2. Leaves scale-like, needle-like, or awl-shaped, very narrow, mostly evergreen.....3

   2. Leaves flat and 3/16" (5mm) or more broad, mostly falling in the autumn (deciduous).....4

Notice that the numbers are in pairs. For instance, your plant will go into either the first "1" or the second "1". If your plant fits the description of the first "1", you would go to number 2; if the second "1", you would go to 102. If you decided your plant is described by the second 2, the key will guide you to 4. From either of these you continue until you find the name of the family to which the plant belongs, or as far as there are two or more numbers to choose. If the description does not entirely agree with your plant, you should start again at the beginning of the key, for you have probably made a mistake.

This procedure is followed through the key which will begin by keying your plant to a particular family. The key for the family follows the same procedures of the dichotomous key. The family key will identify the genus and a key of the genus will identify the species. Generally, a brief description of the plant is given with major characteristics and geographic range.

PLANT EXAMINATION

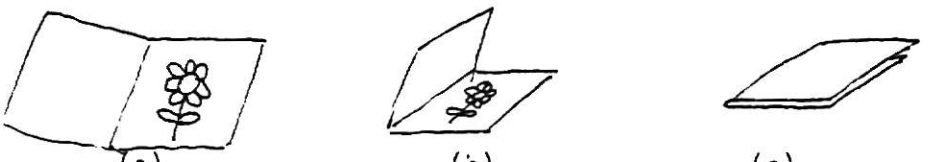
When collecting plants it's helpful to collect a few extra flowers for examination. Many keys include flower descriptions as part of the identification process. First determine the number of sepals, petals, stamens and dissect the gynoecium to find the number of carpels. Also determine whether the petals and sepals are united or separate. The dichotomous descriptions will indicate what to look for on your plant. If only pressed flowers are available, moisten them with a little soapy water.

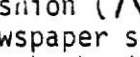
HERBARIUMS

The collection and preservation of plants especially for reference collections requires some specific guidelines. Some instructions on the collection and preparation of plants for a permanent collection are given below.

1. Plants to be placed in a permanent collection should be pressed in the field or placed in a plastic bag which will retain their freshness. Plants that are allowed to wilt before they are pressed make poor specimens for comparison with newly collected plants. As plants are collected, it's wise to add a note with the date, location and habitat, since it's nearly impossible to remember later.

2. All collected specimens should fit in a folded newspaper sheet. A single page is usually enough. Place the plant on ½ of the page and fold it as shown in the illustration. Longer specimens



may be folded in an accordian fashion (). No plant parts should stick out of the newspaper since this is the correct size for mounting specimens on an herbarium sheet. If a large specimen is collected which will not logically fit on one sheet, do not hesitate to use two or more sheets. Be certain that you number the sheets from tops to roots.

3. Do not place more than one species from one collecting site in the folded newspaper sheet. Use only one sheet of newspaper per collection. Newspapers can easily be torn into separate sheets.

4. Collect sufficient individual plants (of the smaller forms) to make a good herbarium specimen. Enough specimens should be used to fill half a page.

5. As you are collecting, if possible, collect a few extra flowers for dissection use in your identification. Ultimately, the extra flowers will be discarded.

6. When pressing the plants, place a sheet of blotter paper or cardboard on either side of the folded newspaper containing the plant specimen. When using blotters, use a cardboard divider after each 8 or 10 specimens. Blotters or cardboard should be changed at least every 24 hours for the first 3 or 4 days. After that they should be changed as necessary until the plants are dry. Spread the blotters out individually on a table or some other space. They should dry within a short time and will be ready for re-use.

7. At the end of 12 to 24 hours after the plant has been pressed, it should be examined. At this time you may have an opportunity to straighten the leaves, flowers, etc. Arrange the leaves in such a way that some have the ventral surface upward while otners show the dorsal surface.

8. For all annual plants, root systems should be included. Wash the dirt from the roots before pressing the plant. For perennial plants, collect enough of the underground parts (roots, rhizomes, etc.) to enable you or anyone else to tell at a glance that the plant is a perennial. In the case of woody plants--trees, shrubs, bushes and vines, this is not necessary since they are obviously perennials. A branch with leaves, flowers or fruits is sufficient.

9. Make notes on the exact locality, habitat, and date of collection. Include any other notes that might be useful to you (or future viewer). The color of some petals either fade or darken in the press, so it's often useful to note the exact color of the fresh flowers. Notes on abundance are useful. In the case of parasites, the host plant should be identified whenever possible.

10. Labeling each specimen is very important for keeping accurate records. The following is an example of a label used in an herbarium.

HERBARIUM

No._____ _____, 19__
Family_____
Scientific Name_____
Locality_____
Habitat_____
Remarks_____
Collected by_____ No.___

11. Be careful to prepare labels after the plants are dried so as not to ruin them. Number your specimens in sequence as they are collected. If you plan to continue through the years, you may wish to record these in a bound notebook of some sort. The specimens may be numbered 1, 2, 3, 4, etc. or 80-1, 80-2, 80-3, etc. If you use the latter, then the next year you would use 81-1, 81-2, etc. Note personal collection numbers are put in the lower right hand corner. The number in the upper left is the herbarium number for the permanent collection. Use blue or black ink to prepare your labels. Print as large and as legible as possible, but small enough to include everything. Be certain to include the authority on all scientific names. For dates, use month/day/year. As plants are first placed in the newspapers, you may write the information required on the edge of the newspaper. This may be transferred to the herbarium label at a later time.

12. Specimens to be maintained in a permanent collection should ultimately be glued to 12" x 16" white paper (you can purchase herbarium sheets) with the label in the lower right hand corner. Most professional herbariums place species of one genus in the same folder. Arrangement of your herbarium is up to you, but many collections are arranged alphabetically by families with the genera of each family also arranged alphabetically.

13. Any collection of plants kept for any length of time should have a pesticide in the storage cabinet to kill parasites.

A novel approach to plant collections was designed by Roth. He devised a miniaturized plant press and herbarium using 3x5 or larger cards and file. Instead of the larger herbarium sheets, pressed flowers and leaves were pasted on 3x5 cards with the family, genus, and species written across the top and other useful information written on the back. Then the card was covered with plastic for protection and arranged in the card file. This kind of herbarium is portable and would be excellent as a personal collection or for a school that has little space.

EQUIPMENT

The amount of equipment needed for collecting, identifying and preserving plants is very small. All that is needed is a plant press, a digging tool, knife and some kind of magnification. A digging tool is used to extract roots and other underground parts from the ground. Garden trowels, knives, tire tools, and many others can be used. Leave it to each person to find his or her own tool. A knife for cutting limbs from trees and dissecting flowers can be of any type, the only requirement is that it be sharp. Magnifying lenses for examining plant parts is necessary for smaller plants. The type necessary can vary, any type of hand held lens will work and need only be around 10X power. Stereoscopes found in most biology departments are excellent.

Plant presses would probably be the most expensive if you were to order one for each student from a biological supply company. But it's very cheap and very easy to make a plant press. Any scrap boards or plywood roughly 14" x 16" and 1/2"-3/4" thick will work. Cardboard can be substituted for blotter and heavy objects placed on top can be used in place of straps. If nothing else is available, place the newspaper sheets between the pages of old catablogs weighted with heavy objects. Blotters may also be cut from rolls of building felt (deadening) that is without asphalt.

Keys can be an expensive item, especially if more than one copy is needed. In many cases it will be possible to get a school library to purchase several volumes.

Appendix

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10. Steyermark, J. 1940; "Spring Flora of Missouri". Lucas Bros., Publishers, Columbia, Missouri.

Glossary

1. acaulescent - becoming stemless, stemless or apparently so; stem often subterrain.
2. --aceae - placed at the end of a name indicating family.
3. actinomorphic - (ray shaped) a flower in which the perianth parts are essentially the same size, shape and texture within a series, and which radiate from the flower.
4. --ae - placed at the end of a name indicating tribe.
5. --ales - placed at the end of a name indicating order.
6. aerial - growing in the air, rather than the soil.
7. alternate - the leaf arrangement characterized by a single leaf per node.
8. androecium - (male & house) the floral series lying between the corolla and the gynoecium; the collective term for the stamens of a flower.
9. anther - the sporogenous portion or pollen-bearing part of the stamen.
10. annual - living for a single growing season.
11. apetalous - (without & flower leaf) said of a flower which lacks a corolla.
12. apocarpous - the condition of the gynoecium in which the carpels are separate from one another.
13. arborescent - tree-like, the trunk relatively short.
14. biennial - living for two growing seasons.
15. blade - the flattened expanded portion of a leaf or petal.
16. bulb - a subterranean plant structure consisting of a series of overlapping leaf bases inserted on a much reduced stem axis, as in the onion.
17. calyx - the outermost of the four floral series, the sepals collectively.
18. carpel - the ovule-bearing structure of a flower, therefore, the basic unit of the gynoecium; generally thought to be homologous with a megasporophyll.
19. caulescent - a stalk, bearing an evident aerial stem.

20. complete-filled - a flower with all four floral series; a floral series consists of a calyx, corolla, androecium and gynoecium.

21. compound leaf - a leaf composed of two or more leaflets.

22. cordate - heart shaped.

23. corm - a dense, underground vertical stem with dry papery leaf bases.

24. corolla - the floral series lying between the calyx and the androecium; composed of petals, it is typically white or brightly colored.

25. deciduous - falling from the plant at the end of a season.

26. decumbent - applied to stems which lie on the ground, but whose ends are upturned.

27. deltoid - triangular in shape.

28. dioecious - having staminate and pistillate flowers on separate plants of a species; the term is best applied to species, never to individual flowers.

29. entire - leaf edge which lacks marginal features such as teeth, spines, etc.

30. epigyny - the condition of a flower in which the ovary is below (inferior to) the points of insertion of the androecium and the perianth.

31. epipetalous - inserted upon the petals or corolla, applied particularly to stamens arising from these structures.

32. filament - the stalk which supports the anther in a stamen.

33. fruticose - shrub-like with more than one major stem.

34. gynoecium - the innermost of the four floral series; the collective term for the carpels; the female portion of the flower.

35. hypogynous - the condition of the flower in which the insertion of the perianth and androecium is below that of the gynoecium.

36. imperfect - unisexual; a flower which bears either stamens or carpels, but not both.

37. incomplete - lacking any of the four floral series.

38. inflorescence - the arrangement of flowers on a floral axis; also used to designate the sequence of flowering within a flower cluster.

39. internode - the portion of the stem between two successive nodes.

40. liana - a woody climber with elongate, flexible, non-self supporting stems.

41. monoeciuos - having staminate and pistaillate flowers on the same plant; note the term is not synonymous with imperfect and should never be applied to individual flowers.

42. node - the point or region on a stem where one or more leaves are borne.

43. ovary - the lower swollen portion of the gynoecium which contains the ovules.

44. ovule - the structure within the ovary which, after fertilization, will become the seed; a young seed.

45. pedicel - the stalk which supports a single flower; pedicellate, having a pedicel.

46. perennial - a plant which lives for three or more years, often flowering and fruiting repeatedly.

47. perfect - bisexual; having both stamens and carpels in the same flower.

48. perianth - the calyx and corolla collectively.

49. perigynous - a flower whose gynoecium sits within an open cup-like to tubular hypanthium, the distinct portions of sepals, petals, and stamens arising from its edge.

50. petal - a component part of the corolla.

51. peticle - the leaf stalk; the portion of a leaf which supports the blade.

52. petiolule - the stalk of a leaflet.

53. pinnate - with leaflets arranged on both sides of a common axis.

54. pistil - a component of the gynoecium, consisting of a single stigma, style and placenta.

55. polypetalous - having a corolla of separate petals.

56. pubescence - a general term for hairiness.

57. rachis - the axis of an inflorescence of a pinnately compound leaf.

58. receptacle - the expanded apex of the pedicel upon which the flower series are inserted.

59. rhizome - an underground horizontal stem which bears reduced scaly leaves.

60. sepal - one of the component parts of the calyx.

61. serrate - having sharp forward pointed teeth, as on a leaf margin.

62. sessile - without a stalk; seated directly on the supporting structure or substrate.

63. silique - (a pod) the elongate bicarpellate, longitudinally dihescent fruit of the Cruciferae.

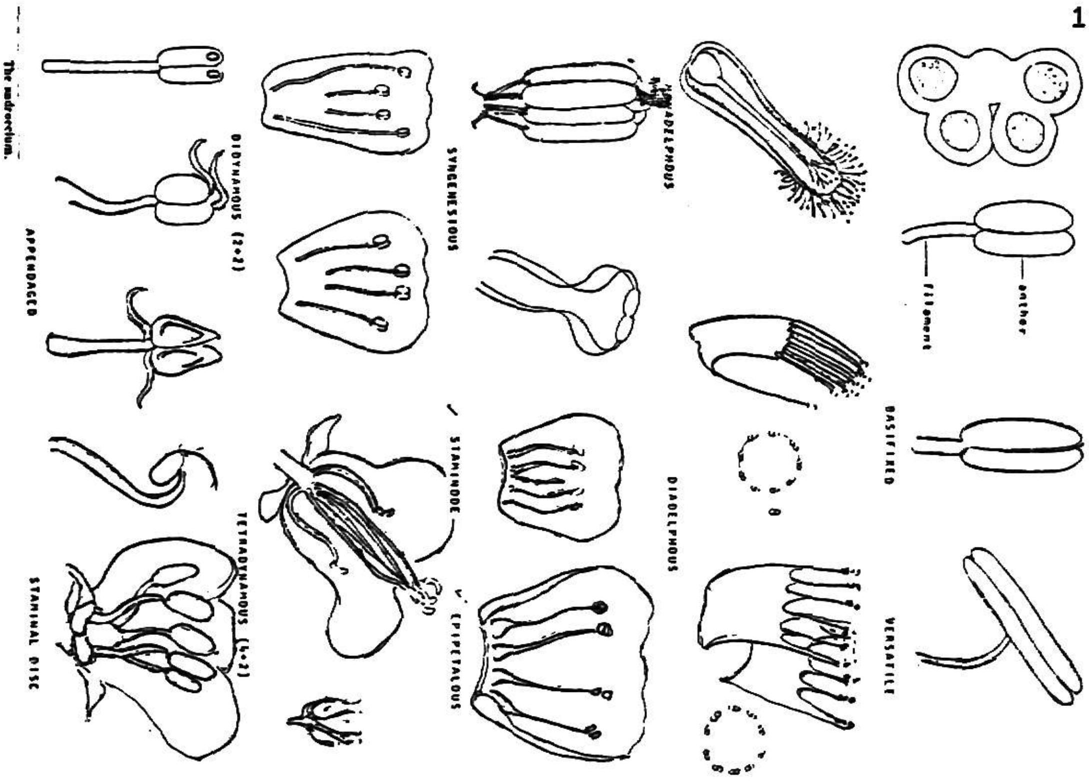
64. stamen - the basic unit of the androecium; the pollen-producing organ of the flower.

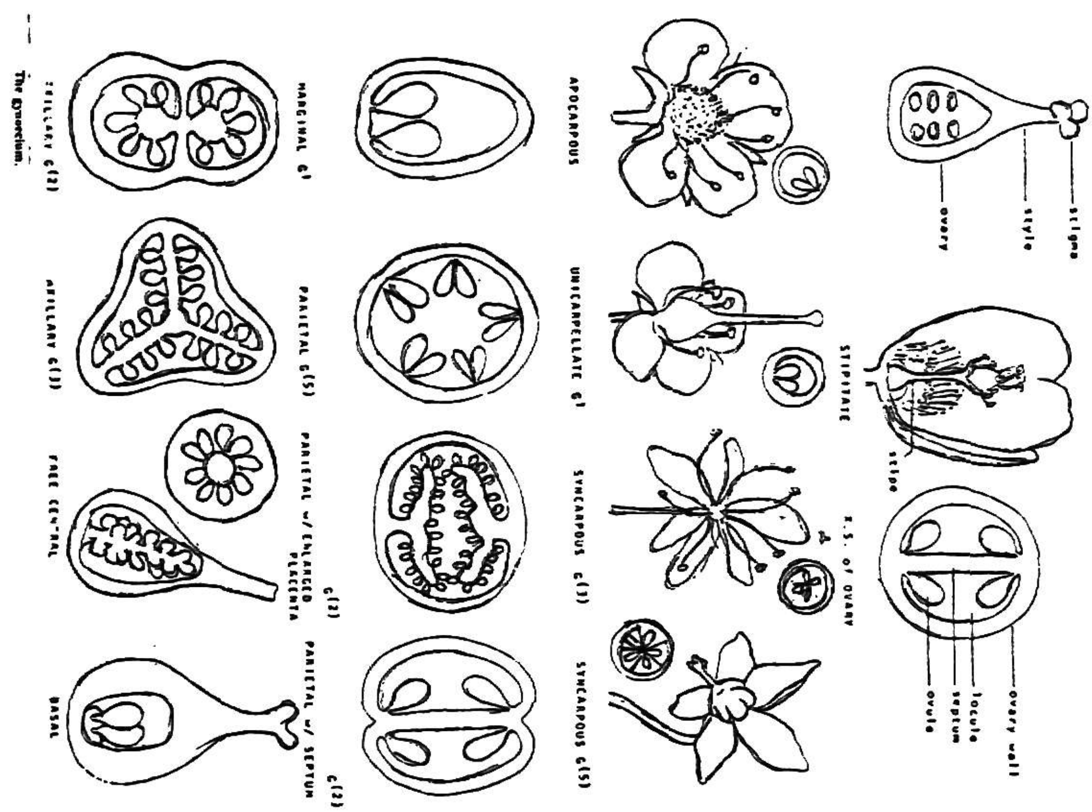
65. stipule - an appendage, usually seen as paired structures, inserted at the base of the petiole; stipules are part of the leaf and not bracts.

66. superior - above or on top of, as in the superior ovary which is inserted above the points of insertion of the perianth and androecium.

67. tuber - a swollen underground stem tip, as in the Irish Potato.

68. vine - herbaceous plants with elongated, flexible, non-self-supporting stems; see also liana.





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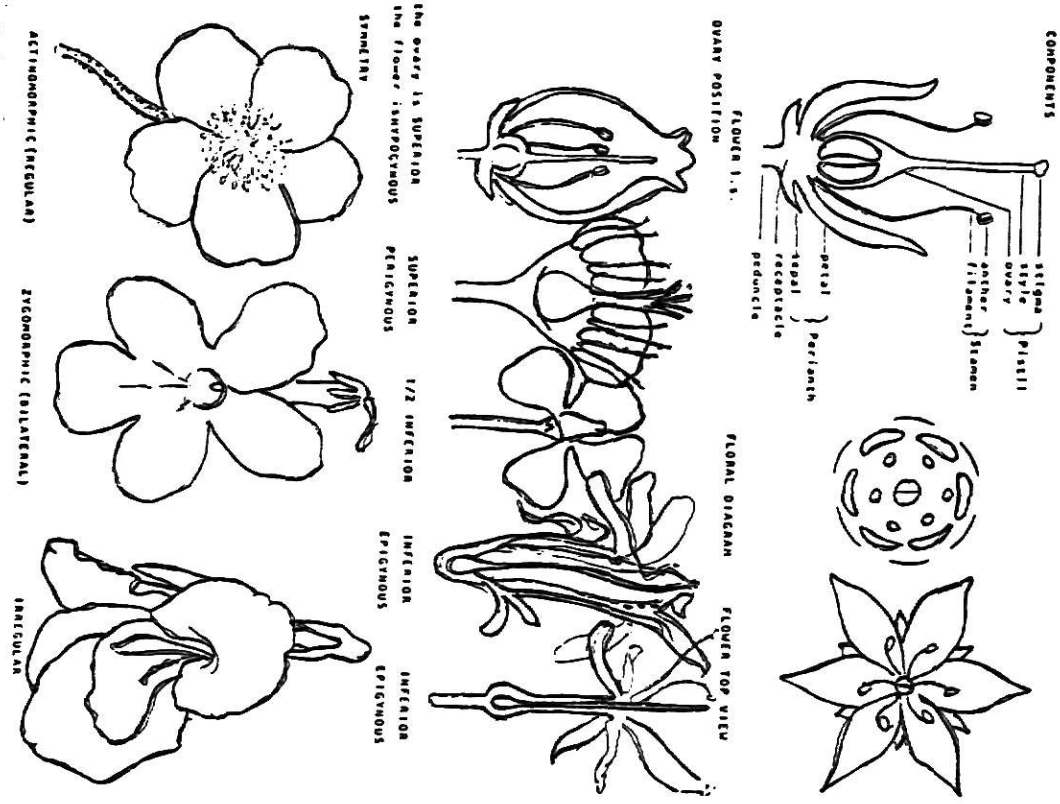

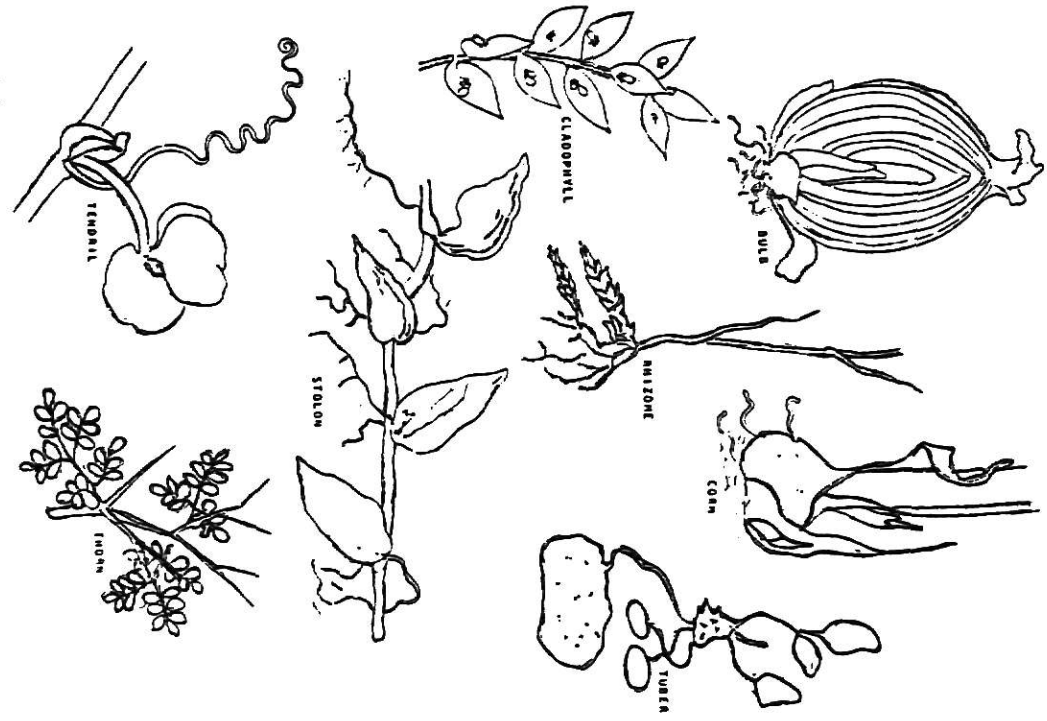

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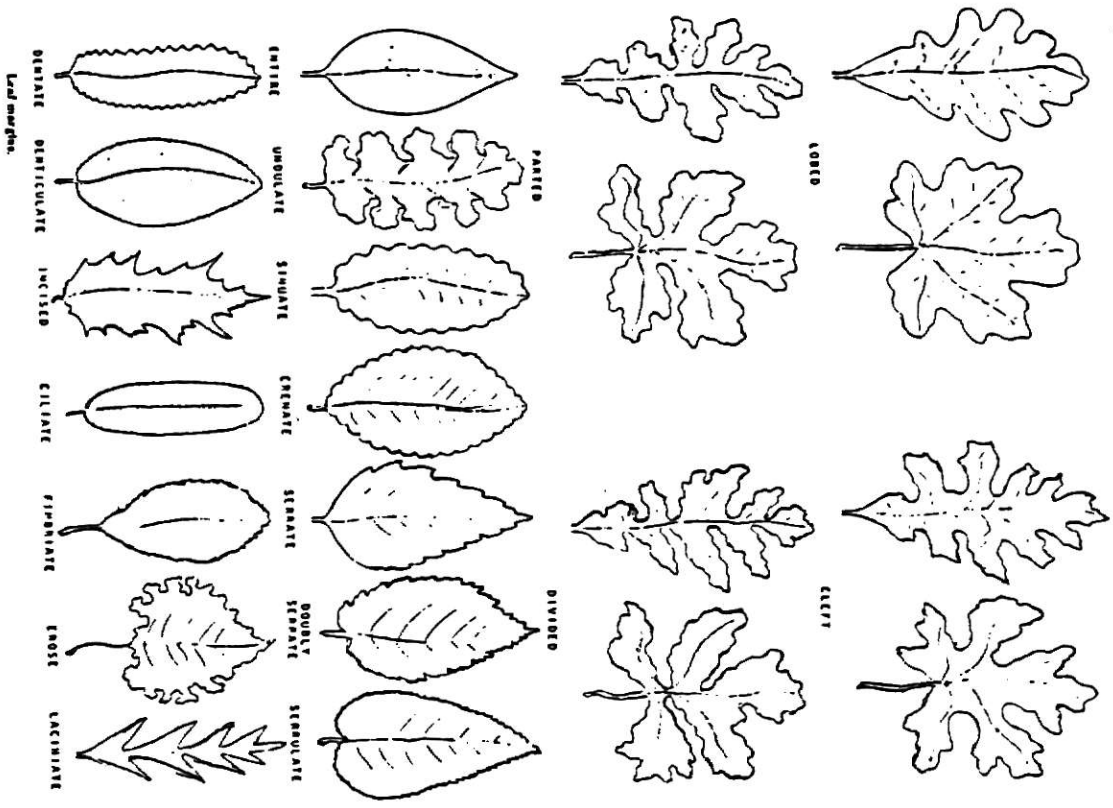

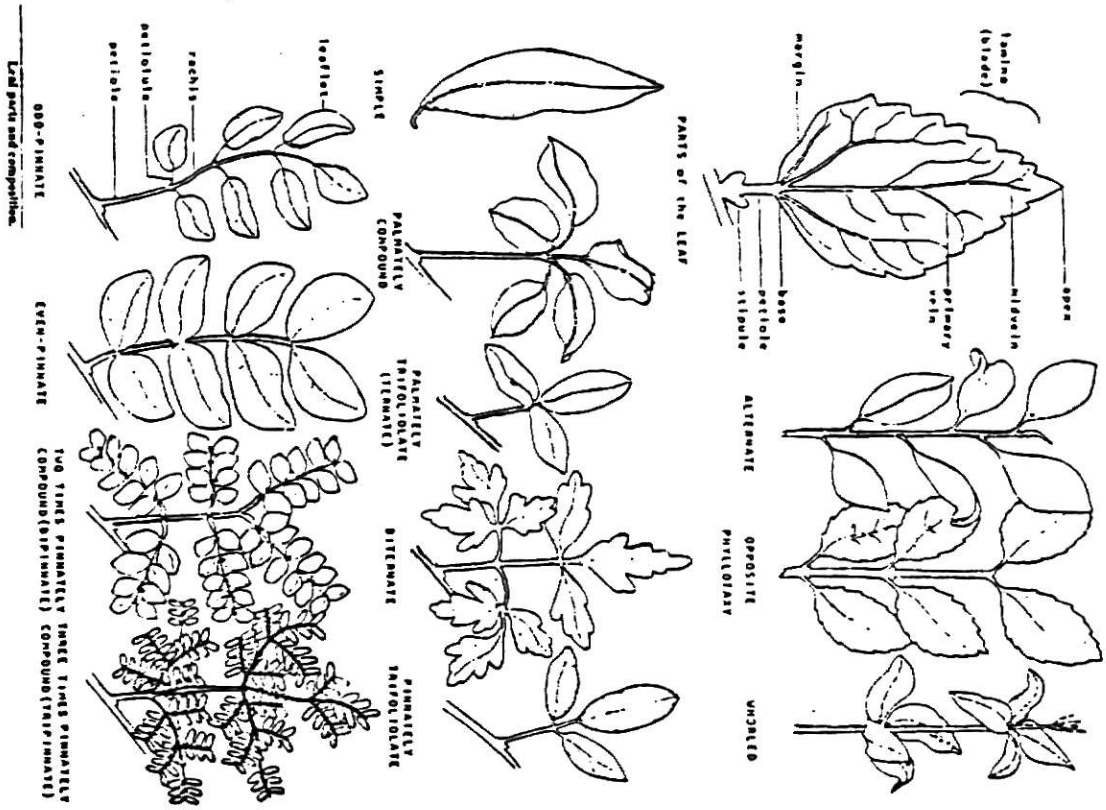

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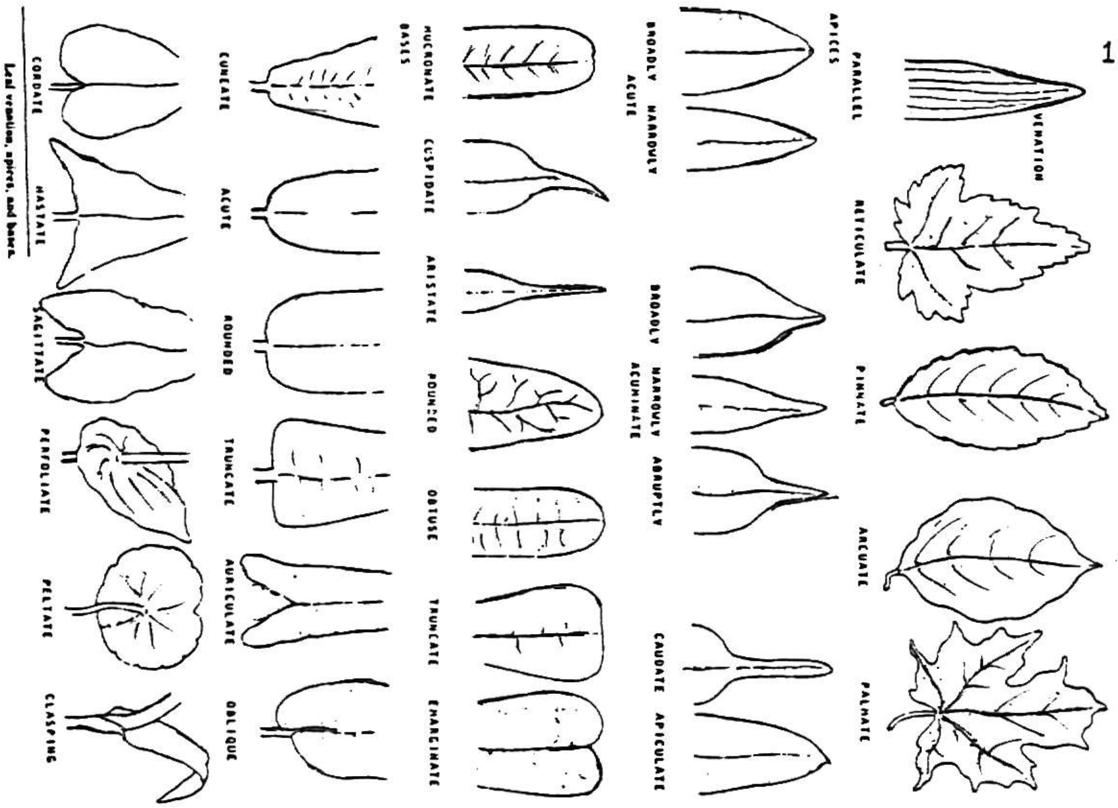

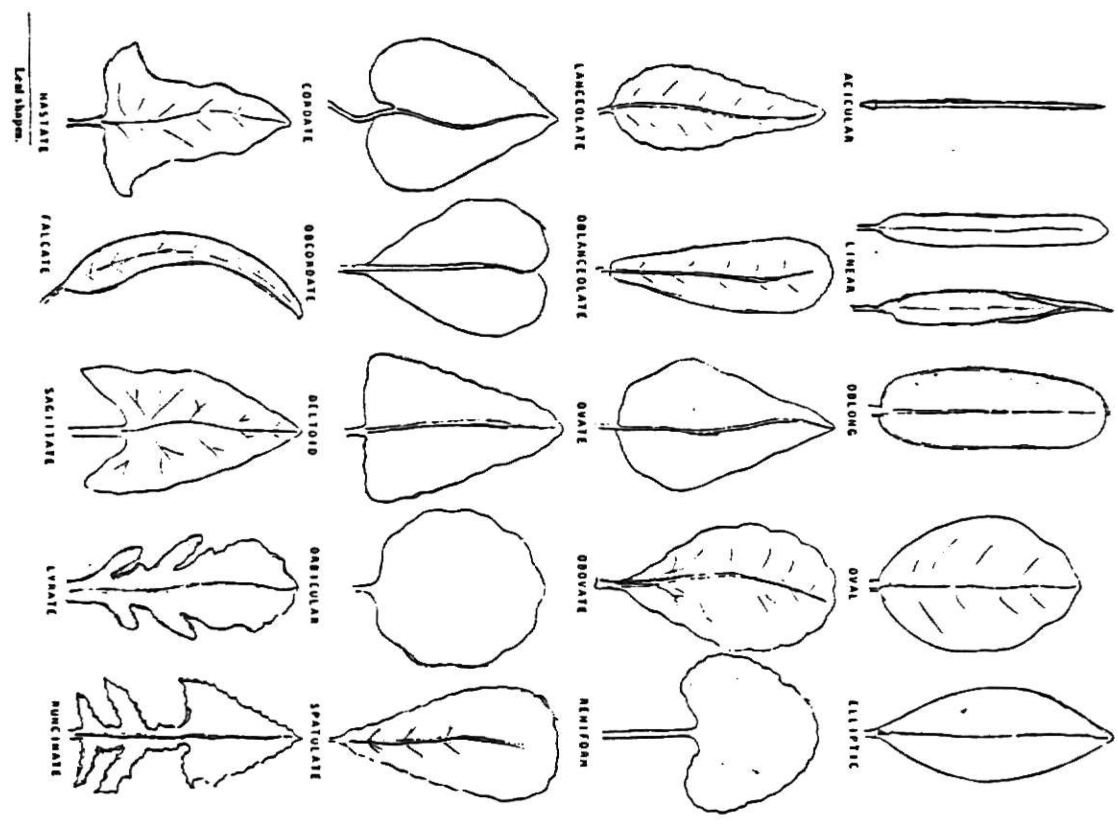

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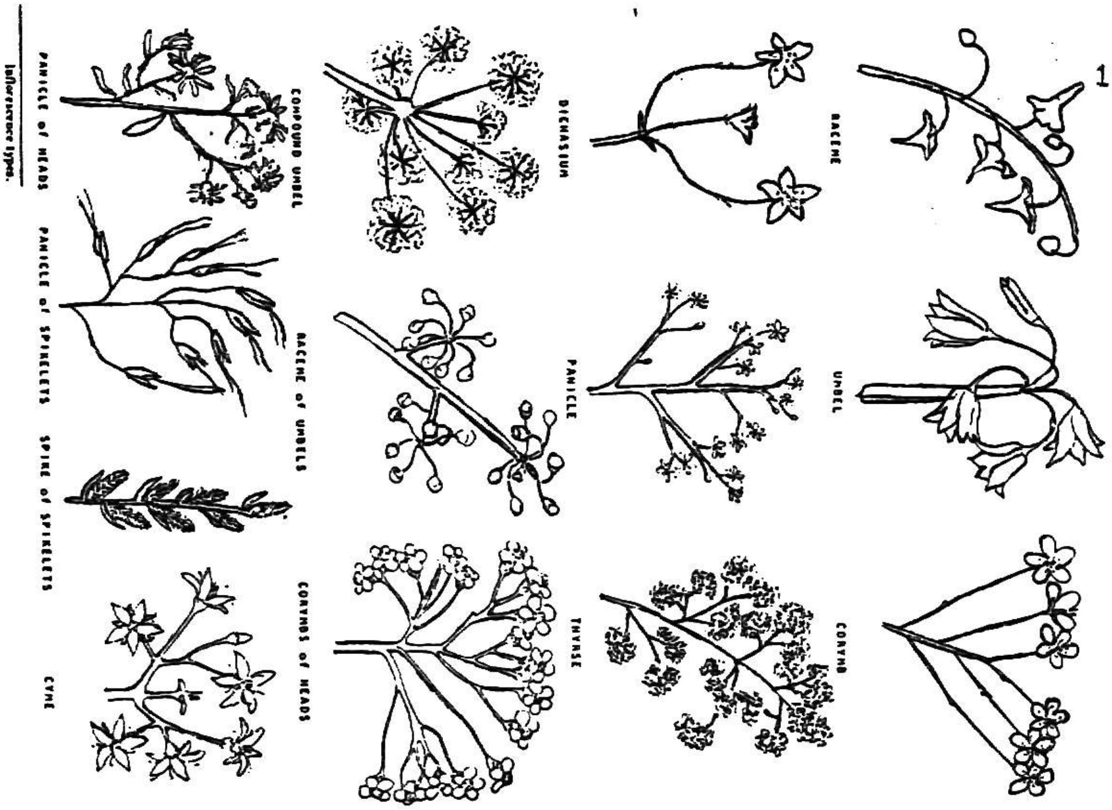

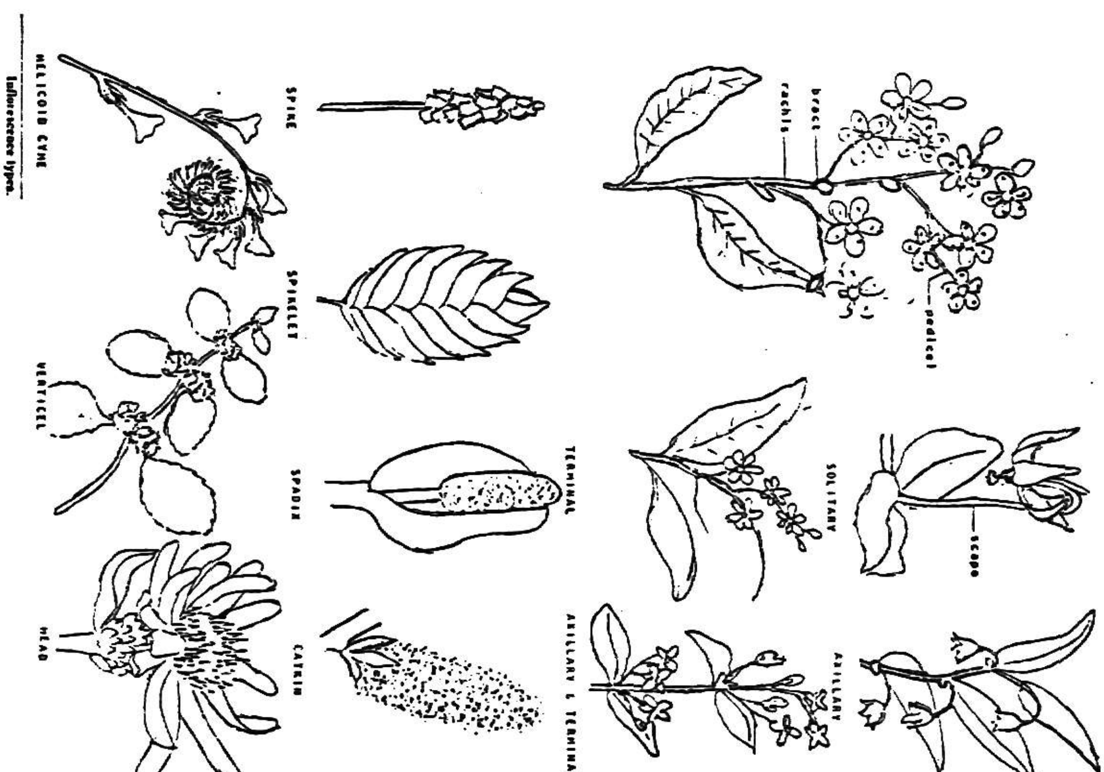

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Appendix C

Questionaire

Instructional Module Evaluation Form

PURPOSE: Below are listed the objectives set for instructional modules on field experiences in natural history developed to provide background information for secondary teachers on conducting natural history field studies. In an attempt to determine the validity of these modules this survey is being conducted to evaluate the usefullness of these materials.

Please fill in the following information.. Module_____

Check one: Practicing teacher_____ Potential teacher _____

For the following questions respond to each item by indicating agreement or disagreement with the statement by, circling 5 if there is strong agreement, 4 if there is agreement, 3 if there are neutral feelings, 2 if there is disagreement, and 1 if there is strong disagreement.

5	4	3	2	1
strong agreement	agreement	neutral	disagreement	strong disagreement

1.	Module rationale or purpose was expressed clearly?	5 4 3 2 1
2.	Terminology is appropriate for secondary teachers?	5 4 3 2 1
3.	Definitions are provided were needed?	5 4 3 2 1
4.	Goals and objectives are appropriate for subject matter?	5 4 3 2 1
5.	Performance levels are clearly defined and obtainable?	5 4 3 2 1
6.	Conditions for performance of activities are defined?	5 4 3 2 1
7.	Minimum acheivement levels are clearly outlined?	5 4 3 2 1
8.	Content is principally cognitive in nature?	5 4 3 2 1
9.	Sufficient information is provided to complete objectives?	5 4 3 2 1
10.	Sufficient information is provided to organize a field trip?	5 4 3 2 1
11.	Collection techniques are adequately explained?	5 4 3 2 1
12.	Proper use of equipment is thoroughly demonstrated?	5 4 3 2 1
13.	Locating or constructing equipment is demonstrated completely?	5 4 3 2 1
14.	Use of chemicals for killing and preservation is well defined?	5 4 3 2 1
15.	Aids for identifying local plants and animals are sufficient?	5 4 3 2 1
16.	The use of identification keys or field guides is well defined?	5 4 3 2 1
17.	Methods of observing and recording data outlined completely?	5 4 3 2 1

In order to obtain a broader range of comments regarding the usefullness of these modules your responses to the following questions with extended comments will be useful..

1. Is this module something you would use when preparing a field trip? Explain.

2. What part of this module would you be most likely to use? Why.

3. Is there one part that you would like to see expanded? How?

4. Is there any information you feel should be added to this module?

5. Are there other topics on field biology you feel should be added to this series?

ABSTRACT

DEVELOPMENT AND EVALUATION OF INSTRUCTIONAL MODULES ON FIELD BIOLOGY FOR PRESERVICE SECONDARY SCIENCE TEACHERS

by

RONALD R. KITTELSON

B.S., Pittsburg State University, 1979

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

College of Education

Department of Curriculum and Instruction

Kansas State University
Manhattan, Kansas

1981

ABSTRACT

This report contains comments from in-service teachers, pre-service teachers and graduate students in education on the quality of instructional modules in field biology. These modules were designed to provide basic information on conducting field trips, observation and data collection, collection and preservation of specimens and aids in identification for pre-service teachers. Modules evaluated covered the subjects of birds, fish, herps, insects, mammals and plants. The modules were found to contain all the information set forth by their objectives but were weak in two areas. One was in the selection of instructional objectives which were not necessarily valid for pre-service teachers. The second weak point was in providing identification keys to the common plants and animals of Kansas. Overall acceptance of these materials was high with nearly all persons surveyed indicating they would use this type of information, provided they are corrected and expanded to include keys to plants and animals of Kansas.