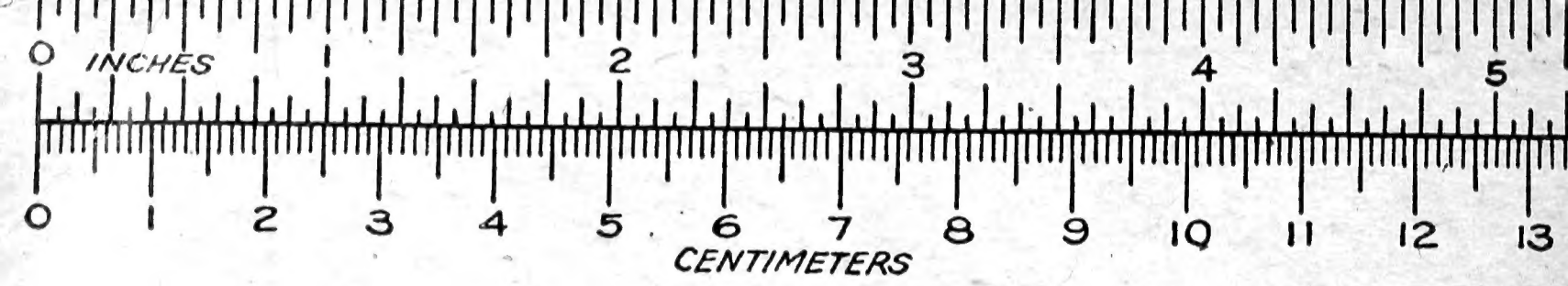
A COLLECTOR'S MANUAL IN NATURAL HISTORY

PREPARED BY MEMBERS OF THE STAFF
OF THE
SMITHSONIAN INSTITUTION

(PUBLICATION 3766)

PUBLISHED BY
THE SMITHSONIAN INSTITUTION
WASHINGTON, D. C.
1944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INTRODUCTION

Many of the men serving in our armed forces who have been sent to all parts of the world have a keen interest in the animals, plants, rocks, and other objects about them, and, as their duties permit, find recreation in examining them. It is normal for those who enjoy such activities to wish to know the names and kinds of the things they see. In order to keep specimens for identification and scientific study or for future display among friends, it is necessary to preserve them in some way. The brief instructions on procedure that follow have been prepared to this end.

In the wilder sections where our service men are stationed, the military and naval authorities have instituted commendable regulations against useless destruction of the native animal and plant life. It is wise that this has been done, as numerous species of birds, mammals, and other forms of life count but few living individuals at any one time, particularly when they are found on small islands, or have a limited range for other reasons. The mere presence of forces of men, with the attendant use of the land for housing facilities and installations concerned with war, in many cases seriously affects plants and animals native to the

area. Thoughtless shooting or useless destruction may result in the extermination of interesting and curious forms.

The naturalist in studying the life about him will never take specimens to the detriment of any species. No harmless mammal, bird, plant, or other form of life that is reduced in numbers until only a few individuals remain alive should be disturbed, and with others only those needed for preservation and future examination should be collected. It is believed that Commanding Officers will recognize the merit of those men who are seriously interested and will grant them the necessary permission to make small collections. The preparation of specimens requires time and patience, and the true naturalist will kill or take nothing that cannot be preserved.

Care should be used also to prevent needless disturbance of mounds, old ruins, or deposits in caves left by ancient men who now have disappeared. The remains of their pottery and their implements of stone, bone, wood, or metal found in such places are the main evidence of their manner of living. When road building or other excavations expose such things, they should be preserved for scientific examination. But do not dig in unopened deposits unless you are a trained archeologist who can do the work properly, as otherwise you will destroy valuable evidence relating to the early history of the human race. If you want curios and souvenirs, get them in some way that is not destructive to things of scientific value.

In many areas remote from battle zones there will be stations where routine duties will become monotonous. Here natural-history studies will provide welcome and valuable recreation for those interested, and may add to human knowledge. The United

States National Museum, a branch of the Smithsonian Institution, throughout its existence has received large and valuable additions to its collections from service men in many regions and stands ready always to identify and provide information on plants and animals of all kinds. Special arrangements are offered for such identifications in connection with that work of the Army and Navy Medical Corps which deals with insects, mollusks, mammals, and other creatures that may harbor or carry disease-bearing agents that affect man. These same arrangements may be utilized for specimens that have interest for themselves alone.

The collections of the United States National Museum are among the most extensive and valuable that exist anywhere in the world, but many gaps exist in its series of all kinds of materials. The collections grow steadily through the interest of friends of the Museum, and studies based on them add constantly to human knowledge. Specimens from any foreign regions make valuable additions, and there are still many places in the United States from which collections are desirable.

GENERAL INSTRUCTIONS

Specimens of various kinds are often wanted in series, but never collect more of any kind than can be properly preserved or used. To take more than needed is useless waste, particularly where specimens are killed. Such action, besides being needlessly destructive, may prevent others from obtaining specimens or may even cause disappearance of the supply.

Labels.—All specimens should be accompanied by labels giving the necessary information regarding the place, date, collector,

and other pertinent data. Specific instructions for labels are included under the various headings. The label should be written when the specimen is prepared. Do not trust to memory at a later date, as this will certainly lead to many errors. Specimens incorrectly labeled, or without data, lose much or all of their scientific value.

The matter of exact labeling may be difficult for service men who in wartime may be under orders not to send out information that will indicate to others the location of their units. This may be avoided by placing numbers on the specimen labels that refer to a catalog or memorandum where full data are set forth. The catalogs should be sent in as soon as practicable after the specimens have gone. Always keep a copy until you know that the original has arrived, and always take great care of such catalogs so that eventually, when the need for secrecy is past, the lists may be united with the specimens. Details relating to the preservation of these data will need to be worked out individually. Remember always that the data accompanying a specimen are as important as the specimen itself, if the latter is not to be considered merely as a curio.

The field label, when it can be prepared in full, is part of the permanent record that in many cases remains constantly with the specimen. Use as much care as practicable to write or print legibly on as good grade paper as may be available. Carbon ink is the most desirable but probably will not be at hand; next best is a fairly soft black pencil. Do not write with ordinary ink or indelible pencil, as such writing will run and become illegible if wet or even moist.

Packing.—Proper packing for safe transportation is as important

as care in collecting or preserving. Excellent specimens may be damaged or destroyed in transit unless properly protected. Specimens should always be firmly secured so that they will not shake or jostle about as this may break, wear, or destroy them. Never pack fragile objects with more durable ones. For shipment select containers that will not be broken or crushed. In packing miscellaneous materials small objects should be sorted out and put in small boxes or other containers that then can be placed in wooden boxes or otherwise protected. More detailed instructions are given in the sections that follow.

Shipping.—Shipments intended for the National Collections should be addressed to:

U. S. National Museum,
Smithsonian Institution,
Washington, D. C.

In some cases it may be possible to forward through the Quartermaster Corps. Small lots may be sent by parcel post. Shipments from foreign lands sent by other means should be addressed to the U. S. National Museum, Washington, D. C., care of U. S. Despatch Agent, New York, New Orleans, or San Francisco, according to the section of the world from which the material is forwarded. Such shipments are sent from the place of entry to Washington in bond and are cleared through customs there.

All specimens that merit permanent preservation will be recorded as gifts from the donor, who will be given due credit in the Museum's records.

MAMMALS

A scientific mammal specimen ordinarily consists of two items, the skin and the skull. Skins of small, and even of large mammals, may be removed with a small pocket knife if no other tool is available. The following equipment, however, is ordinarily used by preparators:

Small scalpel.
Large scalpel.
Small, pointed scissors.
Slender forceps or tweezers.
Small pliers with wire cutter.
Dividers for measuring specimens.
Steel tape or rule, marked in millimeters and inches.
Toothbrush for removing dirt, dried blood, and sawdust from skins.
File, three-cornered or flat.
Carborundum or oilstone.
Needle and thread.
Suitable tough paper for labels.
Pins.
Cotton, tow, and excelsior for stuffing.
Fine hardwood sawdust or corn meal for absorbent.
Arsenic.
Alum.
No. 23 wire for mouse legs; No. 23 or No. 20 wire for mouse tails.
No. 20 or No. 17 wire for legs of rats or small squirrels.
No. 17 wire for rat or squirrel tails.
No. 17 or No. 15 wire for legs of large squirrels, rabbits, or skunks.
No. 15 wire for tail of large squirrels, rabbits, or skunks.
A soft-rubber bulb syringe or a piston syringe is useful for removing brains from small skulls.

Prepare two labels, one for the skin, the other for the skull. The label data shown (fig. 4) are standard for mammal specimens.

Use black pencil or waterproof ink. On the label to be attached to the skin write: (1) The number assigned to the specimen; (2) sex (♂ = male; ♀ = female); (3) locality; (4) date; (5) name of collector; (6) total length of the animal, tip of nose to end of tail vertebrae, taken preferably with the animal stretched tight on its back (fig. 1); (7) length of tail taken by turning tail at right angles with back and measuring from base to tip (fig. 2); (8) length of hind foot, from heel to tip of most distant claw (fig. 3). These data should be entered in your catalog opposite the number of the specimen. On the label to be attached to the skull write the same number as on the skin label and the initials of the collector (fig. 4).

Mammals should be skinned as soon as possible after the blood has coagulated in death. After taking measurements, writing labels, and recording all data, lay the mammal on its back, hold the skin taut along midline of abdomen, and cut the skin from about hinder end of breastbone to a point in front of vent (fig. 5). Commence on one side to work the skin loose until the hind leg is visible. Push the leg from the outside toward the opening (fig. 6) and at the same time pull the knee joint inward, sever the knee joint, and then work the skin downward as far as the heel. Strip the meat from the bone left on the hind leg, and then repeat the operation on the other hind leg. The free use of fine hardwood sawdust or corn meal on the exposed flesh will keep the fur clean and prevent hair from sticking to the body while skinning. Fine dry earth may be used, lacking the others, but is not as good. Use the finger or the flat end of a scalpel to work the skin loose from the body. Cut the skin and the vent free from the body. Work the skin loose around the base of the

FIG. 1.—Measurement for total length.

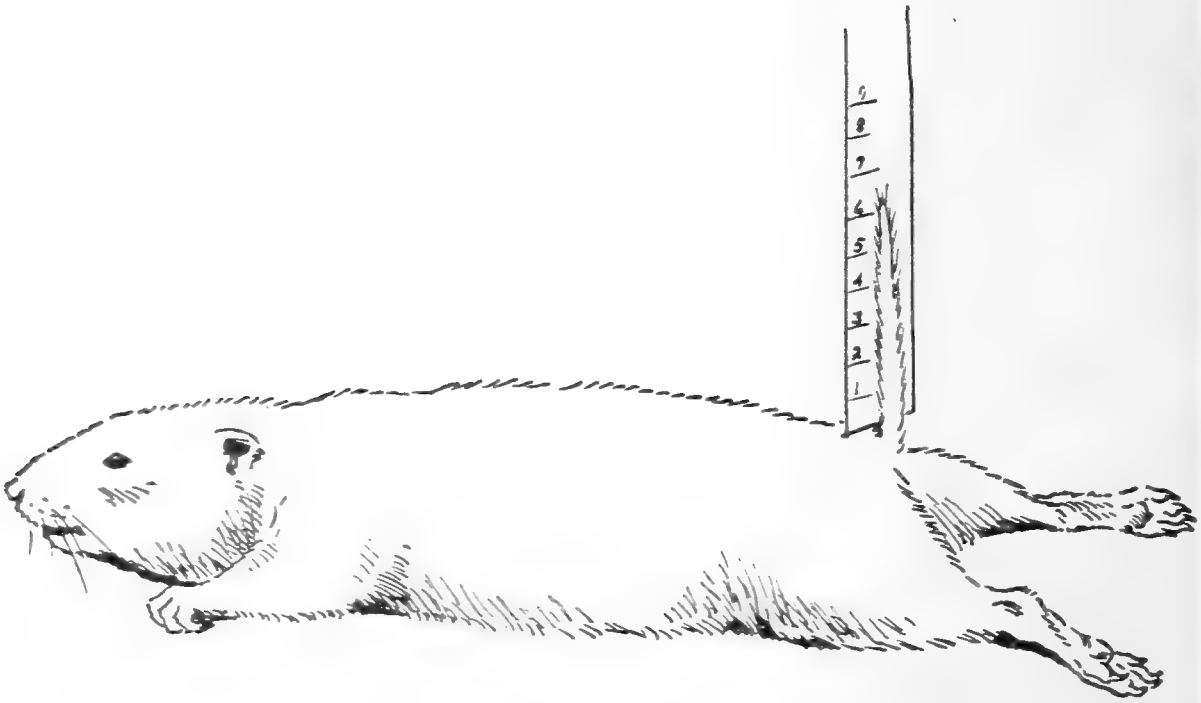


FIG. 2.—Measurement for tail.

tail. Then hold the skin at the base of the tail firmly with the thumb and fingers of one hand, and with the thumb and fingers of the other hand pull the tail vertebrae out of the tail skin, taking care not to tear off the tail skin from the body skin (fig. 7).

Hold the body by the hind quarters with one hand, and with the other work the skin forward free from the body until the fore limbs are exposed. Manipulate the skin gently, and do not pull so hard that it will be stretched. Free the forelegs from the skin in the manner described for hind legs.

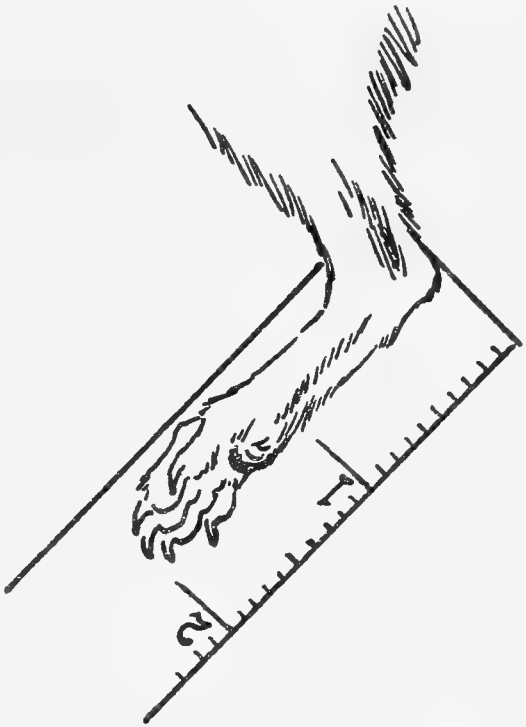


FIG. 3.—Measurement for hind foot.

Continue to work the skin forward until it binds at the base of the ears. Carefully cut through the cartilaginous ear bases so as not to injure either the skin or the skull. The eyes are next encountered. Work skin forward to behind the eyes and then cut as closely as possible to the skull. With care and practice the membrane holding the skin to the eye sockets will be cut without injury to the eyelids. Cut away the skin from the snout until the lips are free. The skin now hangs attached by the nose only. Cut through the cartilage at the end of the nose taking care not to injure the delicate nasal bones or the skin of the muzzle (fig. 8).

All noticeable fat, adherent flesh, and loose tissue should be removed from the raw side of the skin, taking care not to stretch it. Fat, when present, must be removed by scraping the inside of the skin with a knife or scraper. Loose scraps of fat and grease may be removed by applying corn meal or fine sawdust as an absorbent and then scraping them off.

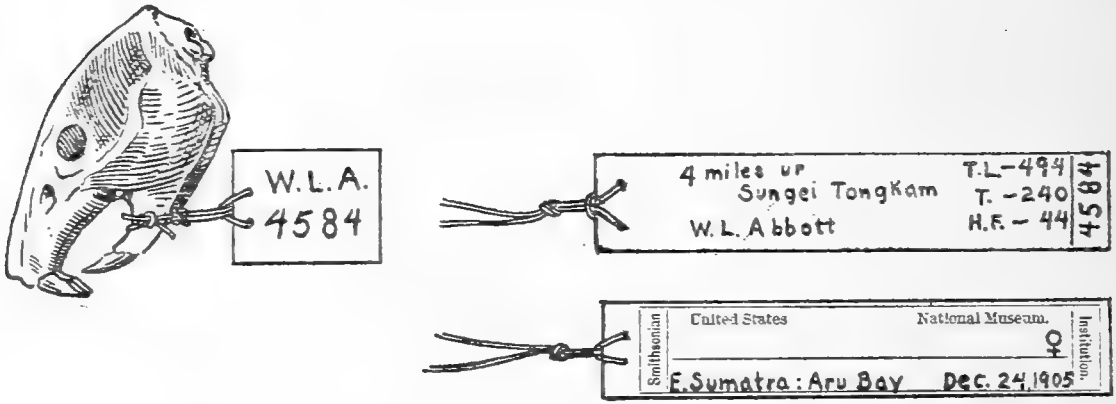


FIG. 4.—Sample skin and skull labels for mammals.

Large skins may be scraped more readily on the rounded surface of a smooth log than on a flat surface. For them a hack-saw blade makes a satisfactory scraping tool.

The tails of mammals with a hard shell (armadillos) or with a covering of scales (pangolins) should be split down the center of the under side to remove the vertebrae. South American spiny rats have tails that break off at the base with the slightest tug. It is therefore necessary to apply rolling pressure with the flat surface of a large knife to the entire length of the tail to loosen the attachment of the skin to the flesh and vertebrae before attempting to slip the tail vertebrae from the skin.

The preservative recommended as most satisfactory for the skins of small mammals is a mixture of powdered arsenic (dry white arsenic trioxide) and powdered alum (ammonium) in the

FIG. 5.—Opening cut on abdomen in small mammals.

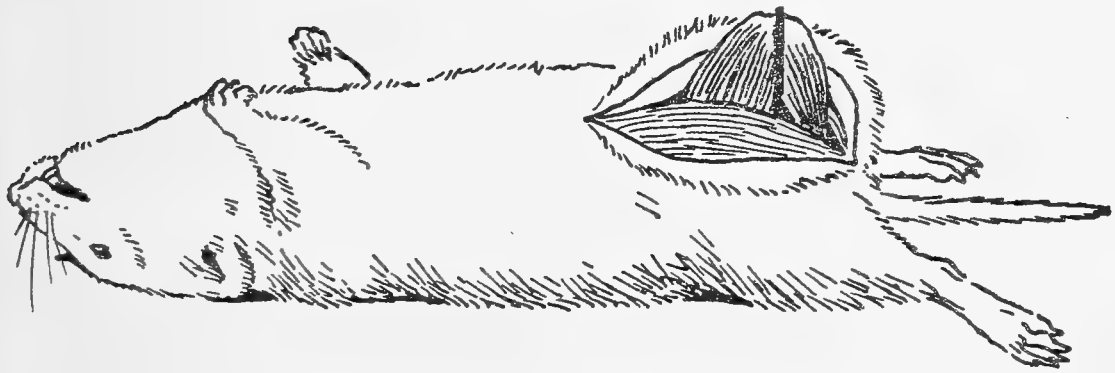


FIG. 6.—Skinning out hind leg.

proportion of half and half by volume. This mixture is especially good where the climate is very hot and moist. Arsenic may be used alone if alum is not available. The dry preservative mixture

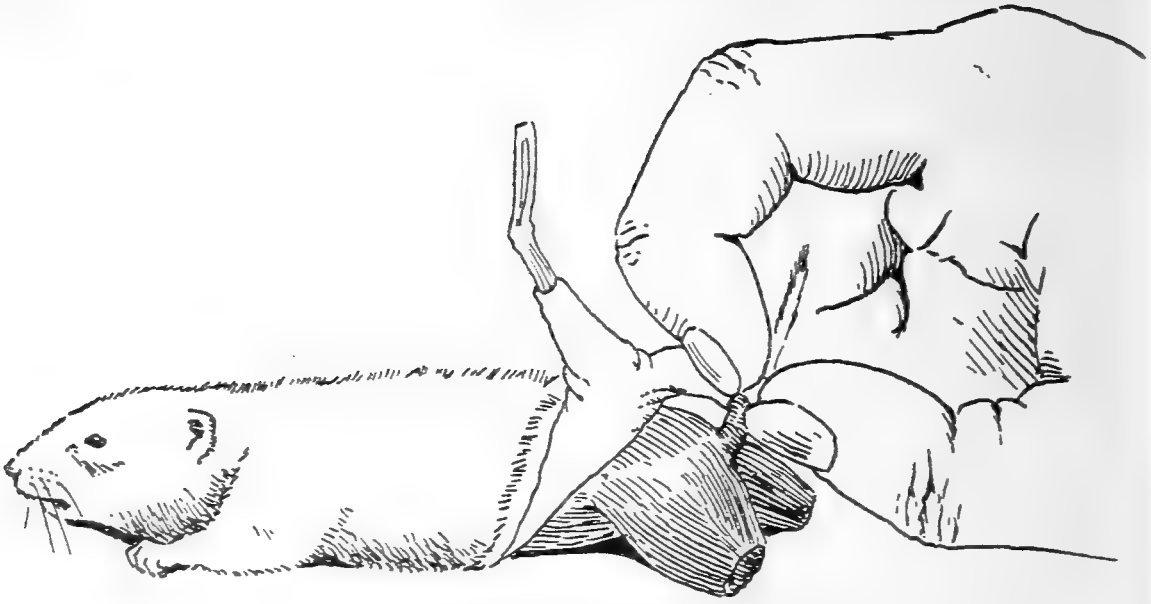


FIG. 7.—Removing tail from skin.

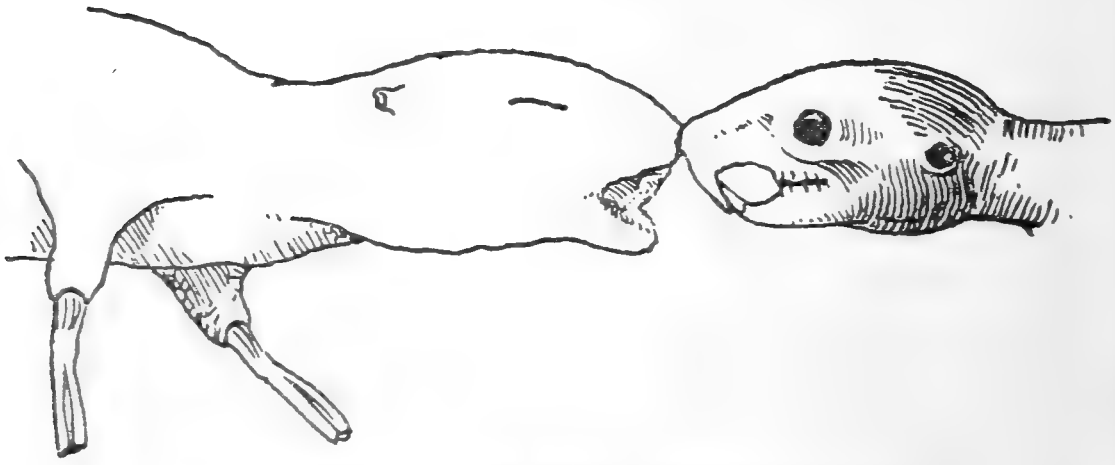


FIG. 8.—Skin and skull before latter is cut loose.

may be kept in wide-mouthed bottles, or wide-mouthed tins with friction or screw-top covers. Arsenic is a poison and should be conspicuously labeled.

Dust this preservative over the entire inner surface of the skin

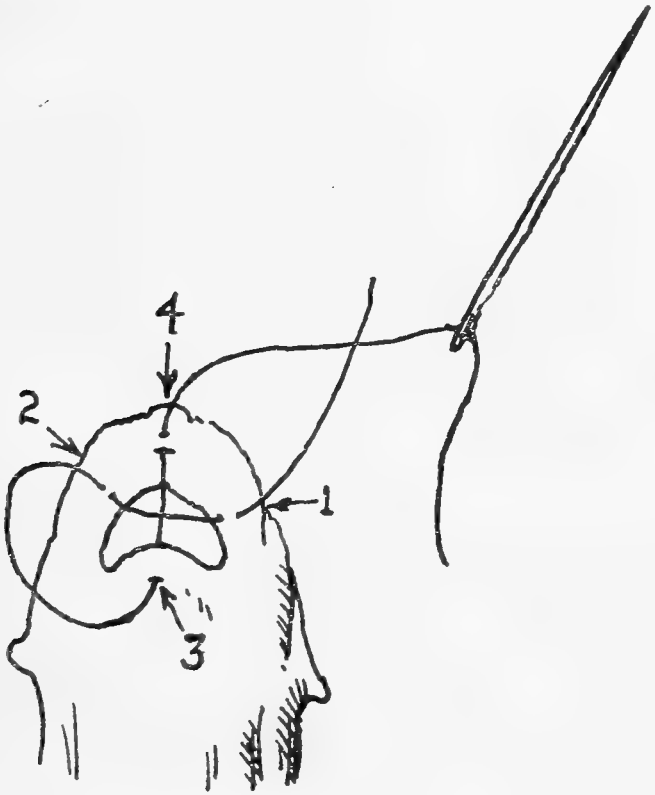


FIG. 9.—Method of sewing lips.

so that every part is covered. Shake surplus poison back into the container and then sew the lips together by passing the needle from side to side and then through the front of the two lips (fig. 9). Knot the ends of the thread after drawing it tight. Turn the skin right side out. If any blood or dirt still adheres, remove by

brushing. If this is not sufficient, wash carefully with clean, cold water and a bit of cotton, being careful not to wet a larger area than necessary. Then dry by dusting in fine sawdust or corn meal. This drying is hastened if the wet area is moistened with benzine or a good grade of straight gasoline.

The skin is now ready for stuffing. A properly made skin should have essentially the same length measurement as before

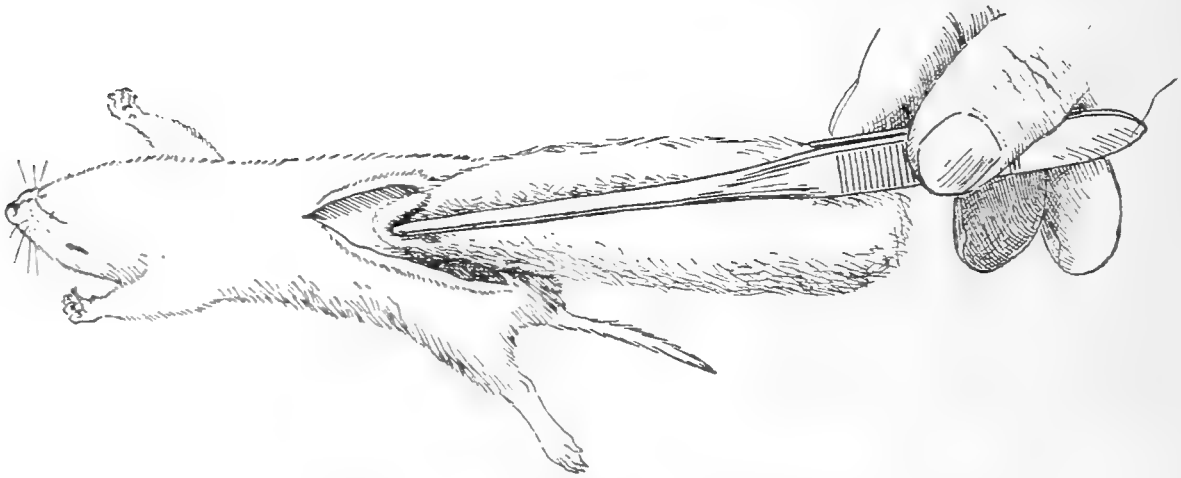


FIG. 10.—Inserting body filling.

skinning. Take a piece of cotton batting that when rolled will approximate the original size of the animal's body. With the forceps, grasp the rolled cotton at the end which is to go into the head, and insert it through the opening (fig. 10) cut in the abdominal region of the skin. With the other hand slip the skin over the roll of cotton until the end held by the forceps reaches the nose. Remove the forceps and work the skin backward over the hinder part of the rolled cotton.

Wires should now be inserted in the legs and tail. Insert the thin wire alongside the leg bone into the foot (taking care not to distort the heel). Now twirl or wrap a small piece of cotton

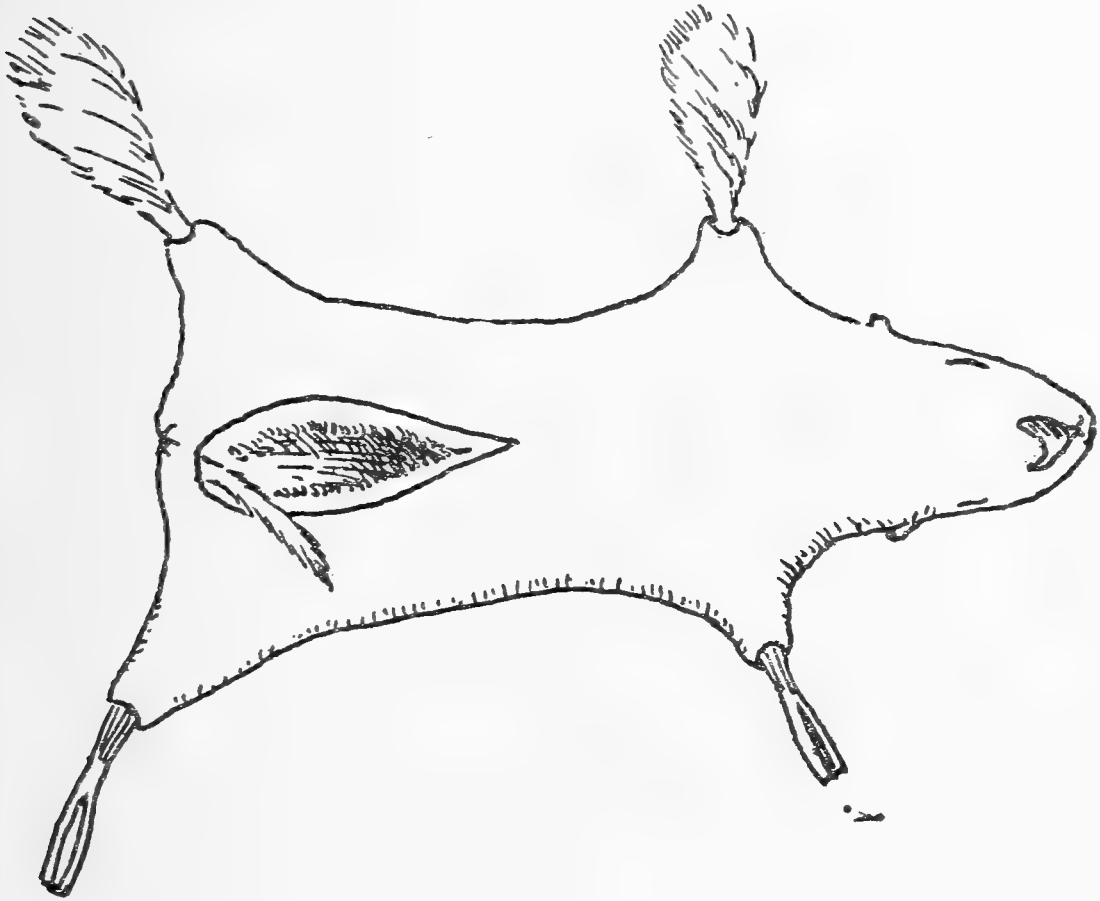


FIG. 11.—Method of twisting cotton around leg bones, when leg wires are not available.

around the inserted wire and leg-bone to fill out the skin of the leg. If wire is not available, wrap strips of cotton around the leg bones before the skin is reversed (fig. 11).

Considerable practice is required to wrap cotton satisfactorily around the tail wire (fig. 12A). Splinters of tough wood or of bamboo may be substituted when wire for the tail is not available. A long thin shred of cotton of satisfactory quality must be selected and this twisted or wound around the tail wire, tightly at the end that is to go to the tip of the tail, more loosely toward the

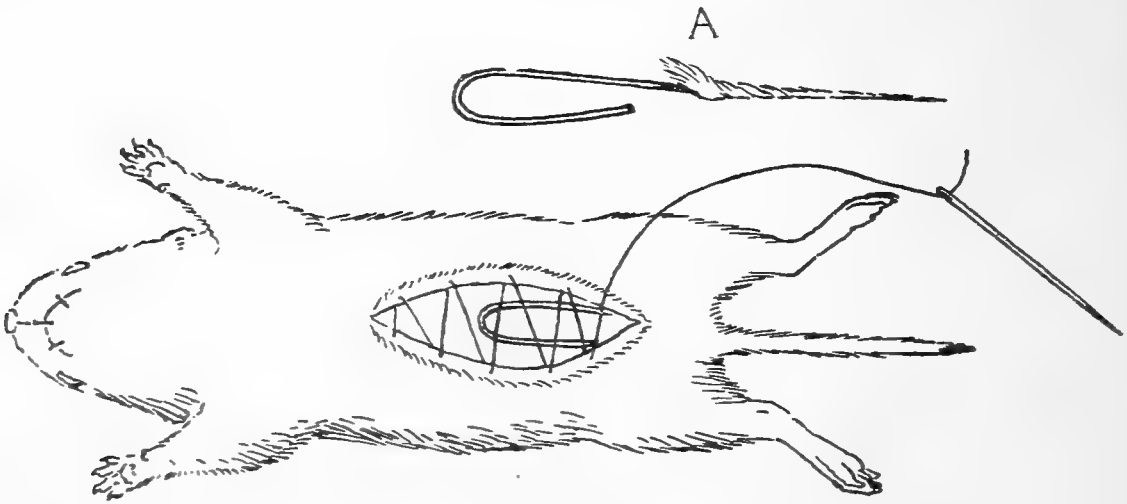


FIG. 12.—Sewing the finished skin. *A*, wrapped tail wire ready for insertion.

base, so as to resemble a tapering form like that of the tail bones. To accomplish this the straight tail wire should be rotated between the fingers of one hand while the thin shred of cotton that winds around the wire is played out with the other hand. The cotton must be wound smoothly on the tail wire, without lumps or loose strands. Before insertion, the wrapped tail wire should be dusted with arsenic. After inserting the tail wire, the free end of the wire should be bent into a loop which will lie

beneath the center of the artificial body to give support to the tail when the skin is sewed up (fig. 12). Uneven places in the stuffed skin should be filled in with pieces of cotton before the skin is sewed up. Insert forceps between lips and push the cotton body filling forward into the nose, molding it with the fingers to proper form. Sew as indicated in the illustration (fig.12), pulling the thread tight finally to bring the edges of the opening together. Make a loose knot in the thread and, with the point of the needle, slip it down tight against the skin. Then cut the thread.

When cotton batting or tow is not available, paper folded to the proper size may be used to advantage. The folded paper will separate the opposite raw surfaces while the skin is drying. Flat skins filled with folded paper should not exceed $\frac{1}{4}$ inch in thickness.

The skull is an important part of the specimen, and hence care should be taken not to damage the back of it when it is severed from the neck. Under ordinary conditions do not attempt to remove the eyes, tongue, or large muscles from the skull of any mammal smaller than a rat. Remove the brain by squirting water from a soft-rubber bulb syringe or a piston syringe into the opening for the spinal cord on the back of the skull, or carefully scoop the brain out with a wire loop of a size that will enter the opening and bent slightly at one end to form a hook. One end of the thread attached to the skull label can be forced with forceps through the flesh at the fork of the lower jaws and out of the side of the mouth and the two ends then securely tied. The skulls as they accumulate may be strung on a cord or wire passed through the loops of thread on the labels. Hang out of reach of prowling animals such as cats,

and where necessary dry by artificial heat or direct sunlight. Never put salt, alum, or formalin on a skull. If skulls are infested with maggots or are otherwise obnoxious because of disagreeable odor of decay, dip them briefly in boiling water.

Tie the skin label securely to the right hind foot close above the heel (fig. 13). The skin should now be pinned down on a board, preferably of soft wood. Pin the feet with the soles down placing the hind feet as close as possible to the tail (fig. 13).

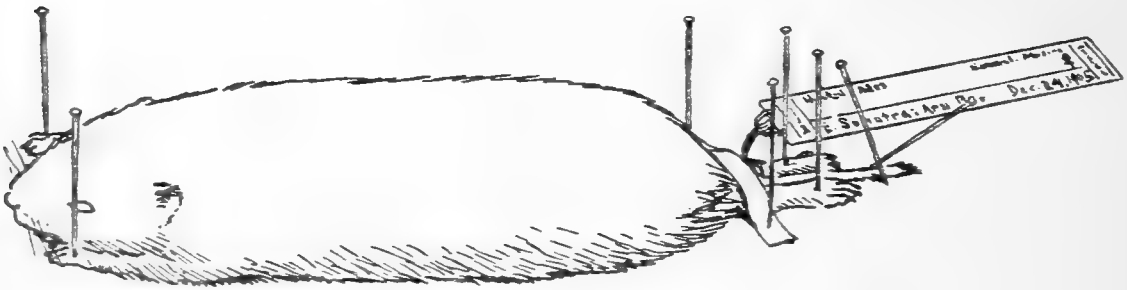


FIG. 13.—Finished skin labeled and pinned for drying.

The fore and hind feet when pinned down should not project outward beyond the sides of the body.

The final shaping is given as the stuffed skin is pinned down. Flatten the specimen somewhat for convenience in handling and storage. The specimen may now be set away in a safe place to dry. In very damp climates it may be necessary to dry in direct sunlight or by artificial heat. If exposed to sunlight for drying, the skins should be covered with paper.

Directions for large mammals.—Take the following measurements in millimeters or inches before skinning (fig. 14): (1) Total length of animal, in a straight line, from tip of nose to end of

tail vertebrae; (2) length of tail (from base to terminal tail vertebrae; (3) standing height at shoulder, from sole of foot to above shoulder blade; (4) length of hind foot.

The diagrams (figs. 15 and 16) indicate where cuts are made to remove the skin. Note that the cut for the legs in deer (fig. 16) and related animals is different from that in wolves (fig. 15) and

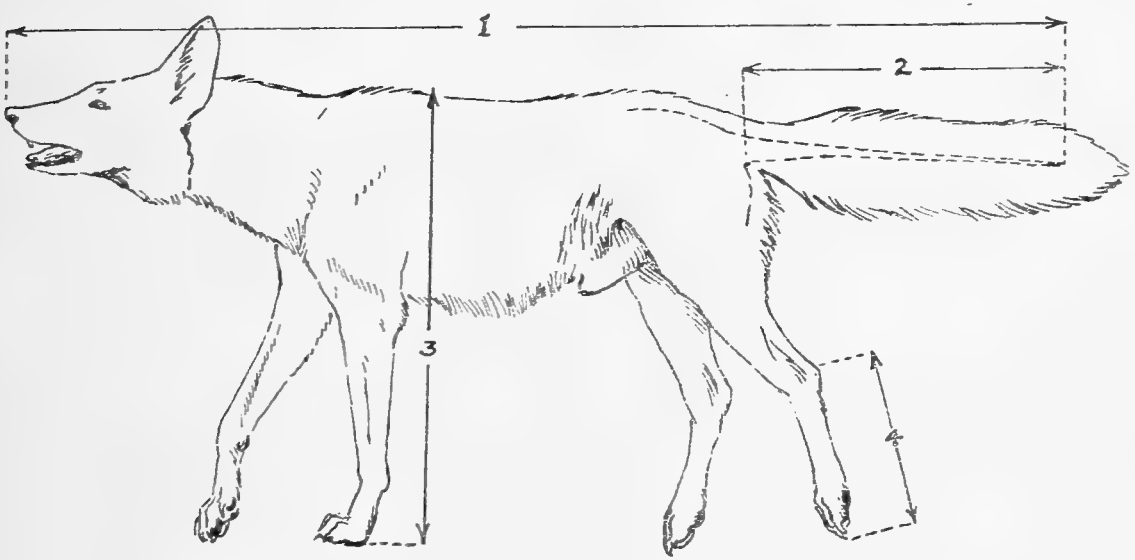


FIG. 14.—Measurement diagram for large mammals.

cats. The cuts should be made on the hinder side of the fore and hind limbs as indicated. The skin should be worked free of the body with the hands, and, where necessary, carefully cut loose with a knife. On species with horns or antlers remove the head (fig. 17) by a short cut down the back of the neck and a transverse cut between the bases of the horns. Carefully cut through the thick skin to the bone of the skull around the base of each horn. Sever the head from the neck and then free the skin from the

head. In large mammals, the ear cartilage has to be skinned out carefully, leaving it attached to the skin (fig. 18).

Common salt is the best preservative for fresh hides and scalps of large mammals. Salt should be applied plentifully to the raw

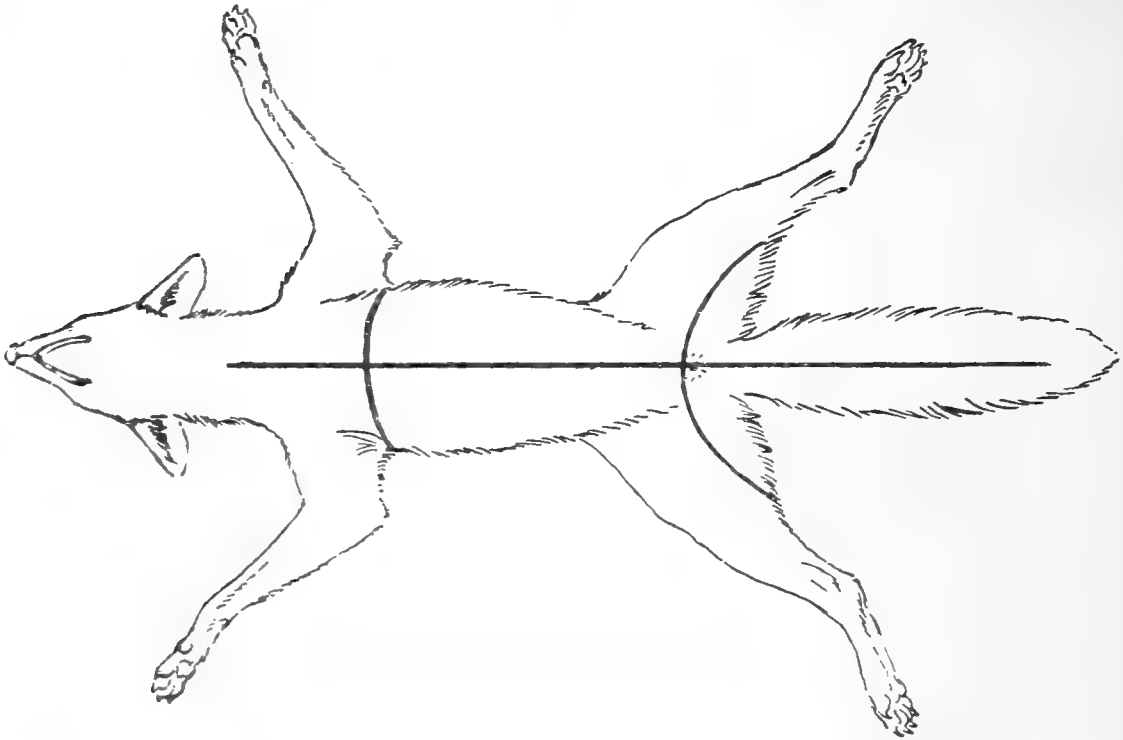


FIG. 15.—Opening cuts for skinning wolves, cats, and related species.

side of the hide as soon as possible after skinning. Care should be taken to work the salt in around the small bones left attached to the toenails in the feet, as well as around the cartilage and skin of the ear. When salt has been thoroughly applied to the skin, the head with the ears turned hair side out should be

folded over and laid in the center of the skin. Wet salt should then be placed in the ear cavities from the outside and laid over the ear tips. Feet and legs may then be folded over and

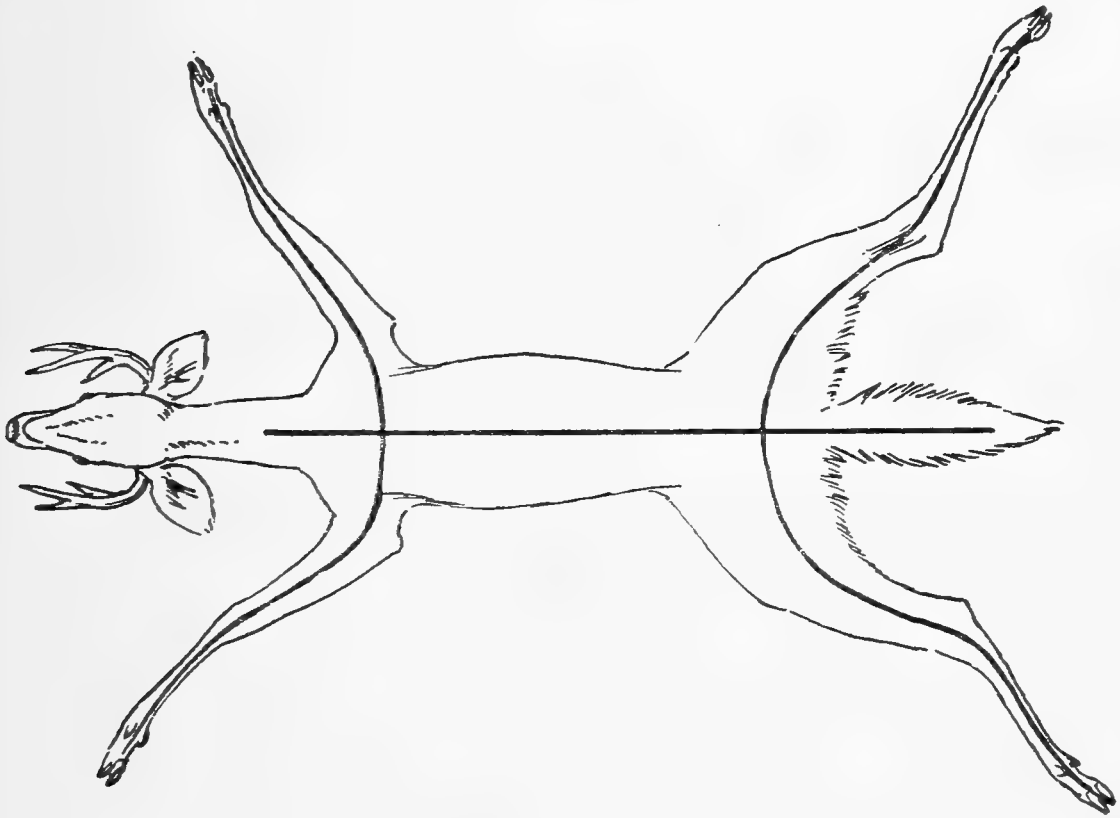


FIG. 16.—Opening cuts for skinning deer, sheep, antelope, and related species.

the skin rolled compactly together with the hair side out. Place folded skin in the shade where it can be kept as cool as possible for 24 hours. Then the skin should be unrolled and the loose salt and water shaken off. It should then be resalted, rolled,

and left in a cool place for another day if convenient. Then without shaking off the loose salt turn the skin flesh side out and hang over a line or a pole, in the shade, until partially dry, but not too dry to fold (hair side in) to a size convenient for packing and shipping. In damp climates it may be necessary to dry in the sun or by gentle artificial heat.

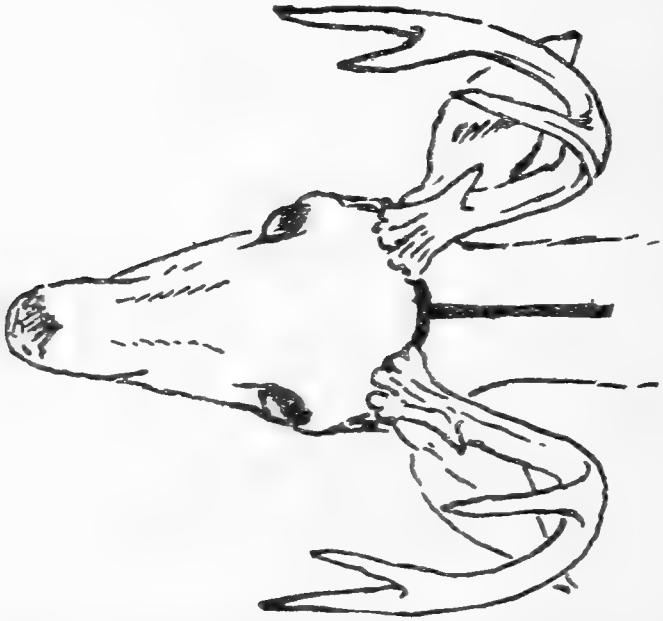


FIG. 17.—Opening cuts for skinning head in horned mammals.

With large salted skins make a label of a flat piece of wood marked with the number and tie this through the eye opening or fasten it otherwise securely. Send the paper label in separately, since, if attached to the skin, salt water and blood will make it illegible.

Skeletons.—Complete skeletons of mammals are valuable for

many studies. Specimens so decomposed in hot weather that the hair slips and the skin is valueless may be utilized advantageously in this way. To prepare skeletons remove the hide and the entrails. Cut the flesh away from legs and body, being careful not to mar the bones. Small skeletons may be left intact, but in the case of larger ones it is necessary to disarticulate the legs and the skull. Clean out the brain and cut away the cheek and head muscles on skulls larger than that of a squirrel. Do not attempt this on skulls of small species.

FIG. 18.—Skinning out cartilage in ear from inside in large mammals.

Larger skeletons should be tied in compact bundles for convenience in packing, and all should be thoroughly dried in the sun before they are shipped. Do not salt skeletons, but dry them without preservative, except that the smaller ones may be placed in alcohol if desired. Never use formalin. If the skeletons become infested with insect larvae, these will not harm the bones. Skeletons and skins should not be packed together for shipment, however, as the insect larvae will ruin the skins.

Be certain that data tags are securely tied to each skull and skeleton.

BIRDS

Birds generally are collected by shooting with small shot, the size depending on the size of the bird. Birds may also be obtained

from natives who trap them, though these are often in too mutilated a condition for specimens.

The tools for preparation are as follows:

Small scalpel or knife.
Small, pointed scissors.
Small, pointed forceps or tweezers.
Needle and thread.
Tough paper for labels.
Arsenic and alum mixed.
Hardwood sawdust or corn meal for absorbent.
Cotton, tow, and excelsior for stuffing.

In case of necessity birds may be skinned with no other instruments than a small sharp knife.

After shooting a bird, pick it up and handle it by the feet or bill, never by the tail, as some movement may pull out the feathers. Immediately sprinkle dry corn meal or dry earth as an absorbent on any blood that may be on the feathers. When this is absorbed scrape it off carefully with the point of a knife and apply more of the absorbent. Plug the mouth and throat with clean cotton to prevent bleeding. Keep the feathers as clean as possible as this will save work in washing them later. Put small birds head first in a paper cornucopia to keep the feathers from ruffling while carrying. Larger specimens may be wrapped in paper or carried by the feet, using care not to break the feathers of wings and tail. In hot weather unwrap specimens at once on reaching house or camp so that they will cool. Do not try to skin birds until the blood is thoroughly coagulated.

Prepare a label as indicated (fig. 19), giving locality, date, collector's name, and number, and color of eyes, bill, and feet

if these are peculiar. The same data are repeated in your catalog opposite the number of the specimen. The sex is added when the bird is skinned, as usually it cannot be ascertained externally.

When ready to skin, replace the cotton in the throat with a fresh plug. If an eye is damaged and leaking on the feathers, pull it out carefully with forceps or knife point, and sprinkle absorbent in the socket, putting in a small plug of cotton.

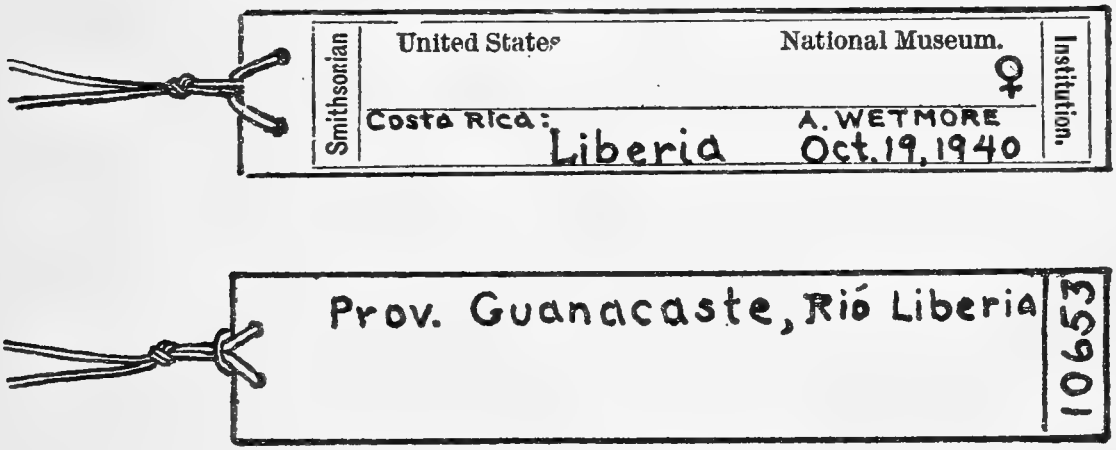


FIG. 19.—Sample label for birds.

The best preservative for birds is powdered arsenic (dry white arsenic trioxide) and powdered alum (ammonium) mixed in the proportion of half and half by volume. In using, dust this on the inside of the skin with a fluff of cotton held in the forceps. The hind foot of a rabbit with the claws clipped off makes an excellent brush for applying preservative.

Lay the bird on its back in front of you with its head to your left (if you are left-handed, reverse the position), and blow on the bird's belly to part the feathers. In most species this reveals

a bare space along the middle, but in ducks and other water birds the feather covering may be practically continuous. If the wings are in the way, break the large bone, the humerus, as near the body as possible, which allows the wings to be pushed aside. With a sharp knife cut the skin on the midline from the end of the breastbone (which you can easily feel) to the vent (fig. 20).

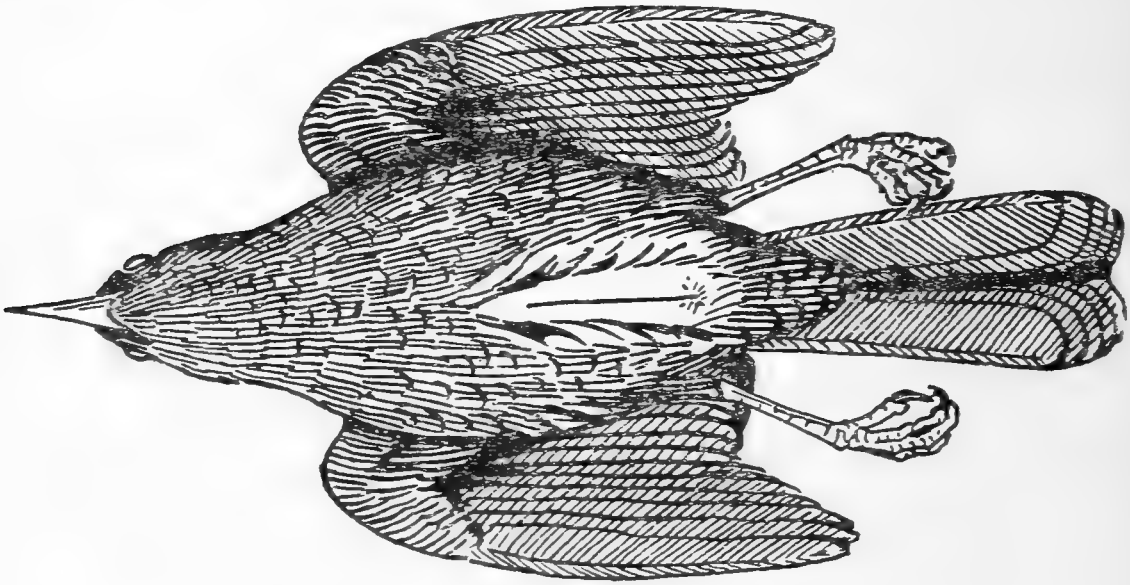


FIG. 20.—Line of opening cut on abdomen.

Try not to cut the abdominal membrane. Sprinkle some absorbent along the cut and, using the handle of the knife or your finger, separate the skin from the end of the breastbone. Continue this loosening as far as possible on either side of the cut down toward the vent, exposing the knees. Holding the foot, push the knee farther into view (fig. 21) and clip the leg at that point. Do this for both legs, thereby severing them from the body.

During the entire process of skinning, sprinkle corn meal or fine hardwood sawdust on the exposed surfaces to absorb blood and other fluids so that these will not soil the feathers. Keep the fingertips dry by dipping them in the absorbent for the same reason. If nothing else is available, fine, dry earth may be used.

Using your fingers rather than a knife, press the skin away from the body on either side of the rump until it is free all around, connected only at the tail. With scissors cut the body loose at

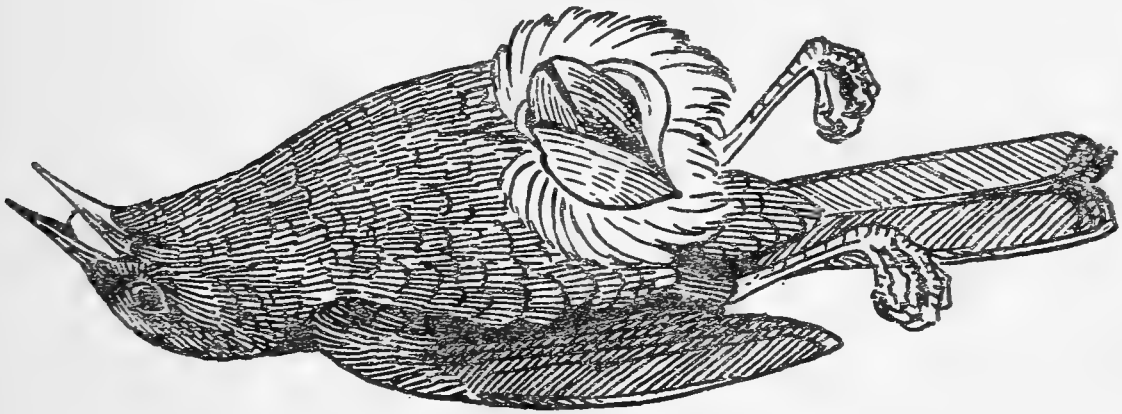


FIG. 21.—Exposing the knee.

the base of the tail (fig. 22) and sprinkle the cut with absorbent. Press the tail and rump skin over and off the body. Do the same with the under side until the skin, inside out, is free up to the wings (fig. 23), using absorbent freely.

Cut off the wings where they join the body, and continue the process of pushing the skin back over the neck. Press the skin carefully over the back and sides of the head. Soon a membranous piece of skin attached to the skull will appear on either side. This is the ear (fig. 24). Carefully pull the ear skin from its

attachment on the skull without tearing it. Press the skin forward until the membrane joining the eyelids with the skin appears. Cut this membrane in such a manner as to avoid injuring the

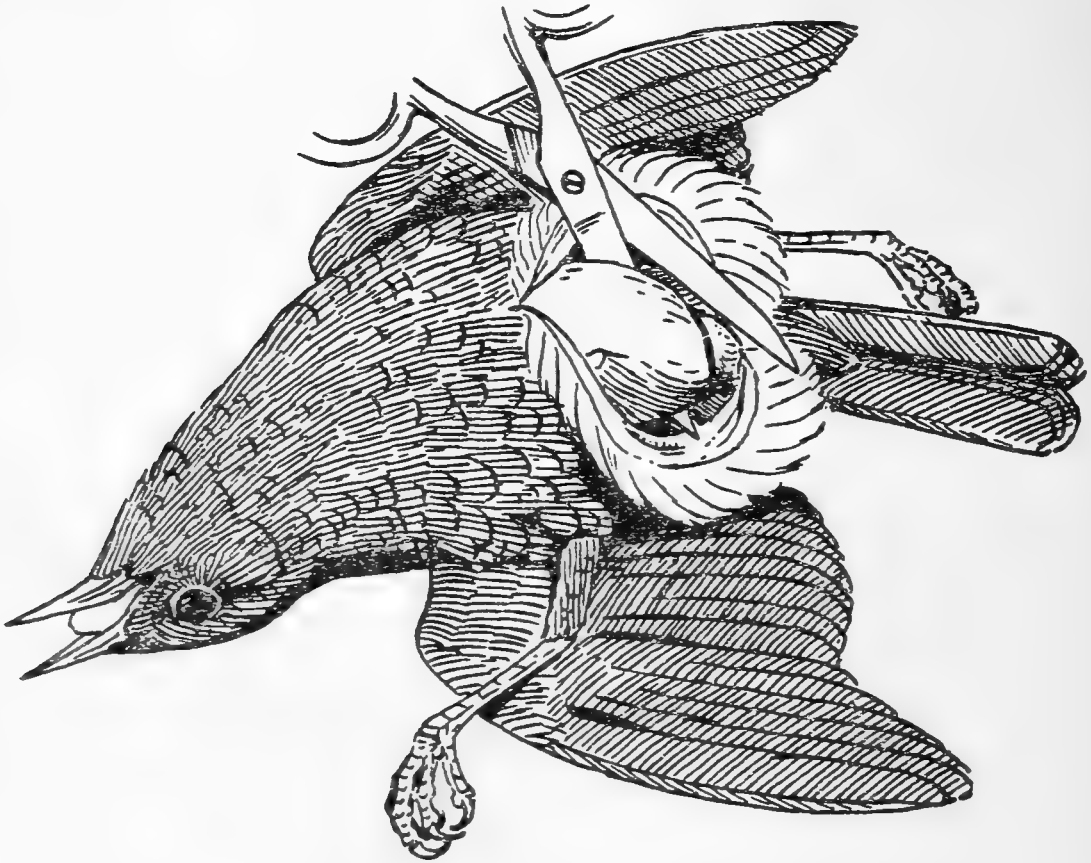


FIG. 22.—Severing the tail.

lids or the skin (fig. 25). Remove the eyes with forceps or knife. Free the skin from the skull clear to the base of the bill. On the lower side cut the membrane below the tongue so that the tongue and the plug of cotton in the throat are free.

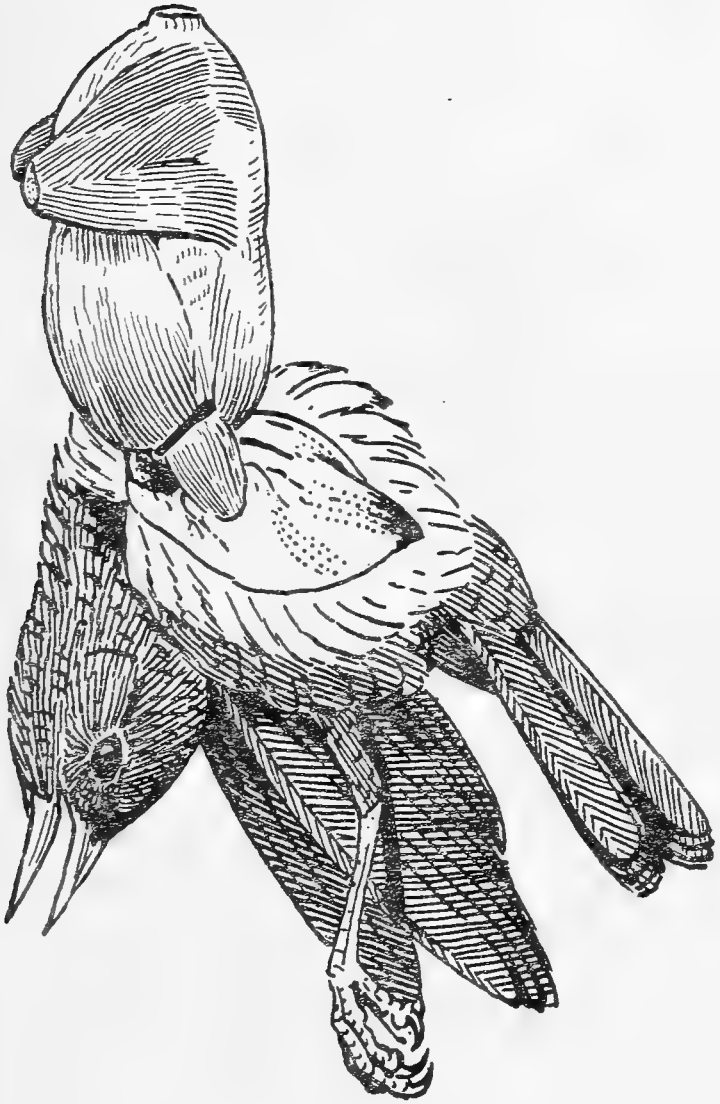


FIG. 23.—Skinning the body.

With scissors make a cut across the roof of the mouth, between the branches of the lower jaw below the eye sockets, so that it enters the forepart of the brain cavity (fig. 26). Then make

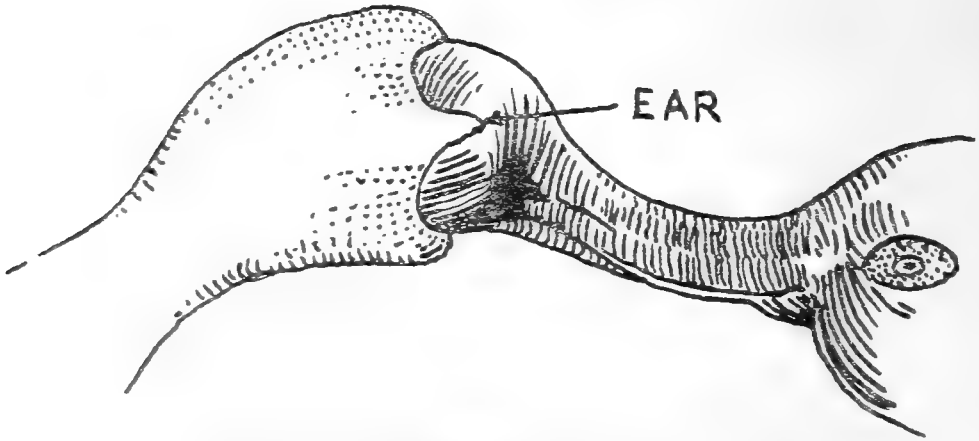


FIG. 24.—Attachment of ear to skull.

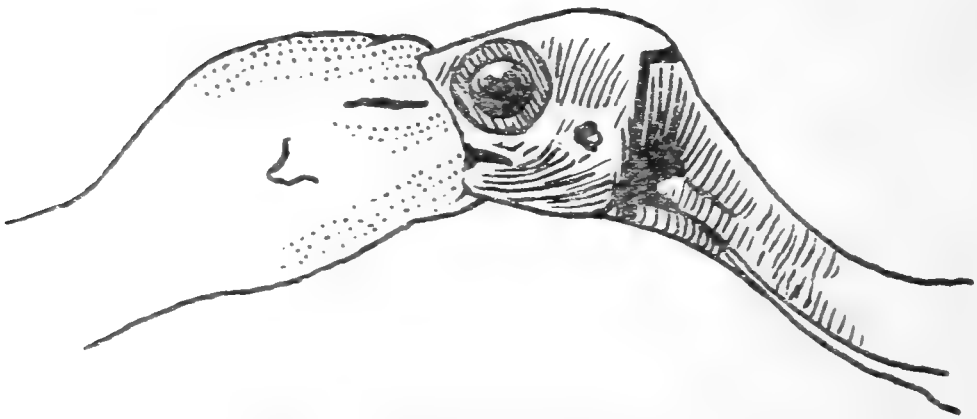


FIG. 25.—Side of head to show eye.

another cut on either side from the end of the first one to the upper base of the skull, and a fourth cut connecting the upper ends of these two. The base of the skull and all of the body,

now free of the skin, may be pulled loose and put to one side. Clean out the brain through the cut end of the skull. If there is much meat on the side of the skull, scrape it away. Dust the skull with the arsenic and alum preservative. Make smooth balls of clean cotton for eyes and put one in each eye socket. Dust the inside of the head and neck skin with arsenic and alum and work it back over the skull.

Large-headed birds like ducks, woodpeckers, and hornbills have heads too big to allow the skin of the neck to be worked

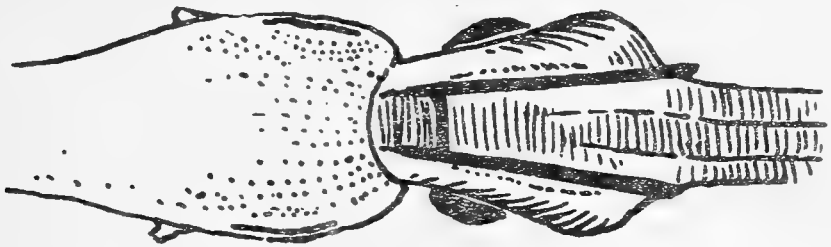


FIG. 26.—Line of cuts on skull.

over them. In such cases, when the base of the skull is reached, cut it loose from the bones and muscles of the neck. When you have finished the rest of the preparation of the skin, poison it and turn it right side out. Then make an incision down the back of the head (fig. 27) and loosen the skin around it until you can skin and prepare the head as directed above for ordinary birds. After the head skin is poisoned and the eyes are in place, sew up the cut in the back of the head with fine stitches.

Free the wing bones as far as the joint and clean off any meat. Skin along the top of the wing to expose the meat on the second joint and remove this also (fig. 28). In sandpipers, goatsuckers,

and large birds leave this process until the skin is turned right side out. Then make a cut on the under side along the second joint, free the skin, and then remove the meat (fig. 29). Poison carefully, and in large birds sew up the cut with a few stitches.

Remove the flesh from the legs. Cut off the surplus meat and fat from the base of the tail, making sure to remove the oil gland immediately above it, but using care not to weaken the

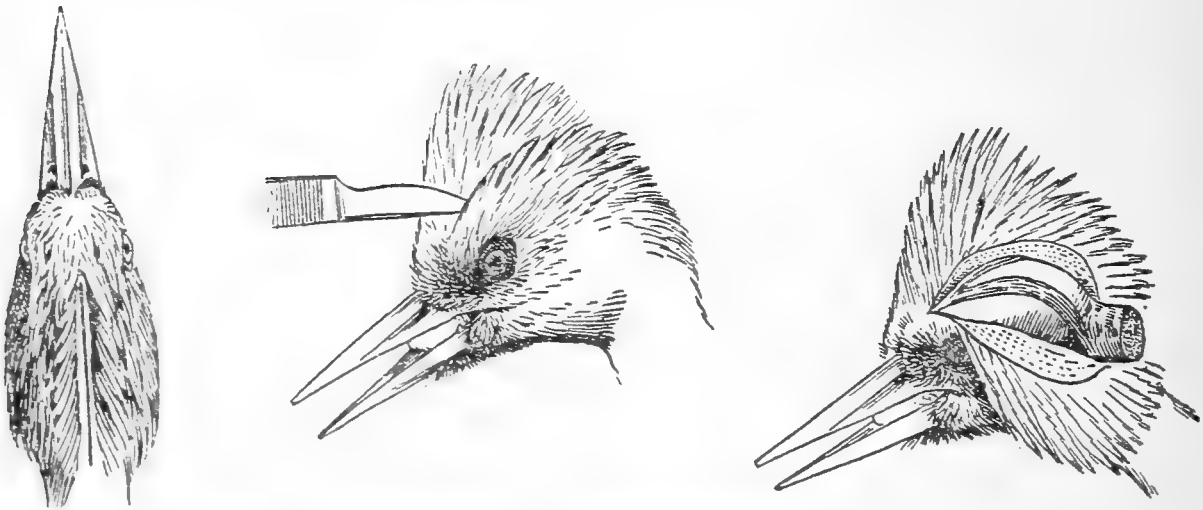


FIG. 27.—Line of cut on head for woodpeckers and some other birds.

attachment of the tail feathers. This operation requires much skill. Carefully remove any fat and flesh that adheres to the inside of the skin. Dust the inside of the skin with arsenic and alum and turn it back right side out. If the skinning process has taken long and the skin is dry, moisten the inside slightly with water to soften, then poison. Use the arsenic mixture in sufficient quantity to coat the inside of the skin without leaving any loose particles.

Holding the skin by the bill, shake it gently to aid in getting the feathers back in place.

In large birds and all water birds, including sandpipers and plovers, it is necessary to pull out the long tendons in the feet. Make a cut in the bottom of the foot (fig. 30) and you will see the cordlike tendons which can then be pulled out by pushing an awl or strong forceps under them. Cut them off at the point of attachment. Then make a cut on the under side of each toe at the outer end, pull out the tendon, and cut it off.

Make a cotton body the size of the bird's body on a small, dry stick, one end of which, only slightly covered with cotton, should protrude by the length of the bird's neck (figs. 31 and 32).

FIG. 28.—Method of skinning wing from inside.

In larger birds form the body of fine excelsior, pulling out the fibers until they make a smooth surface, and then wrap firmly, but not too tightly, with thread to the proper shape. Make the neck of cotton. In large birds and water birds it is necessary to

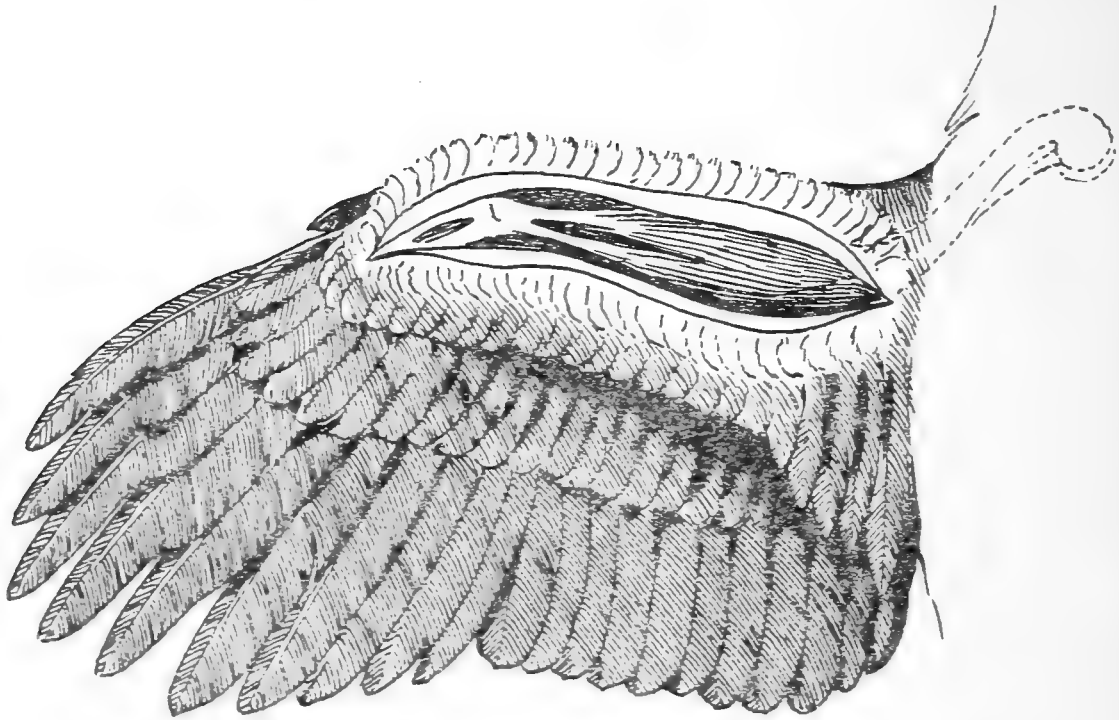


FIG. 29.—Cut for skinning wing in large birds from outside.

fasten the wings together inside the skin. Pass a strong thread or light string between the two bones of the forewing on one side, tie it, and then make another knot at a distance from the first one equal to the width of the back. Pass the cord between the two bones of the wing on the other side, draw it up to the second knot and tie it. When the skin is right side out, the

ends of the large bones of the wing, the humeri, after tying should lie at the same distance apart as when in position in the bird before skinning.

Lay the bird skin on its back and insert the protruding end of the stick into the body, through the neck, pressing it into the roof of the mouth so that the head fits on it firmly. The tip of the bill should be on a line with the body (see fig. 35). Carefully fit the skin into place around the body and sew it together across the belly with two or three stitches (fig. 33).

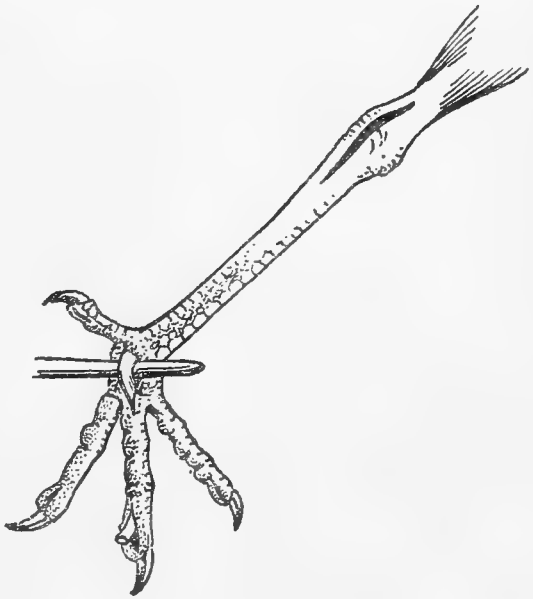
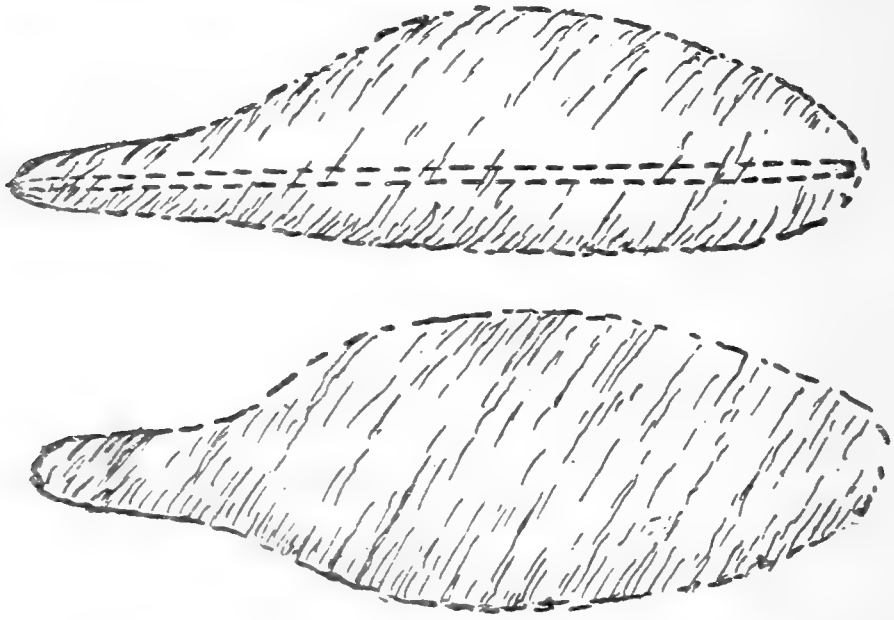


FIG. 30.—Removing tendons from foot and toes in large birds.

Make sure the bill is closed evenly, if necessary tying it shut. Arrange and smooth the feathers of head, neck, and body. Fold the wings as in a bird when at rest. With your fingers pinch the skin away from the body on the upper back and press together the wing bones there so that they are in place above the body. Holding the bird in your hand, make sure the two wing tips are even, then lay the specimen on a square sheet of cotton about the length of the bird (fig. 34).

Open the carcass by cutting it on the left side. Press the intestines to one side and look for the sex glands on the midwall of the lower back. If the bird is a male, there will be two testes,

whitish or blackish, narrow, bean-shaped bodies lying side by side. If it is a female, the ovary, normally on the left side (usually only one, but two present in some birds), will show as a mass or cluster of small round bodies. This is the only certain way of determining the sex of the specimen. The organs are large in the breeding season, very small at other times. If the body



FIGS. 31-32.—Form of body for stuffing.

cavity is bloody so that the organs are not readily seen, wipe it out with a fluff of cotton. Write the sex (male = ♂, female = ♀) on the label and in your catalog.

Cross the feet and tie them together. Tie the label to one of the feet above where it is fastened to its companion (fig. 35).

Arrange the feathers in place and carefully wrap the now completed skin in the cotton sheet to keep its shape while drying,

drawing the cotton from either side toward and over the bird, leaving only the tail feathers protruding. Arrange the tail feathers to insure their drying in place and shape the skin carefully. Large birds may be wrapped in paper or thin, soft cloth. Place wrapped

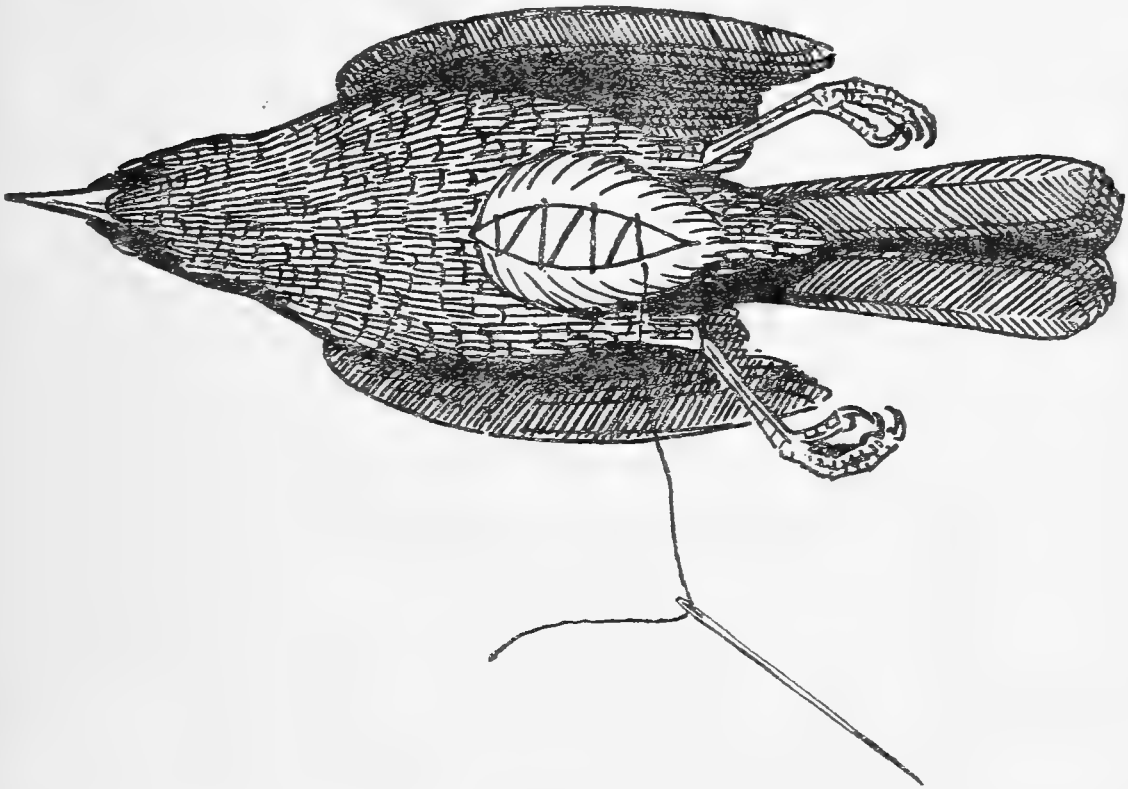


FIG. 33.—Closing the body cut by sewing.

bird skins carefully in a tray or other flat place to dry for a few days. Once dry, they can stand being moved without serious damage.

In skinning hummingbirds, after making the opening cut loosen the skin on the sides of the abdomen, cut off the tail as usual

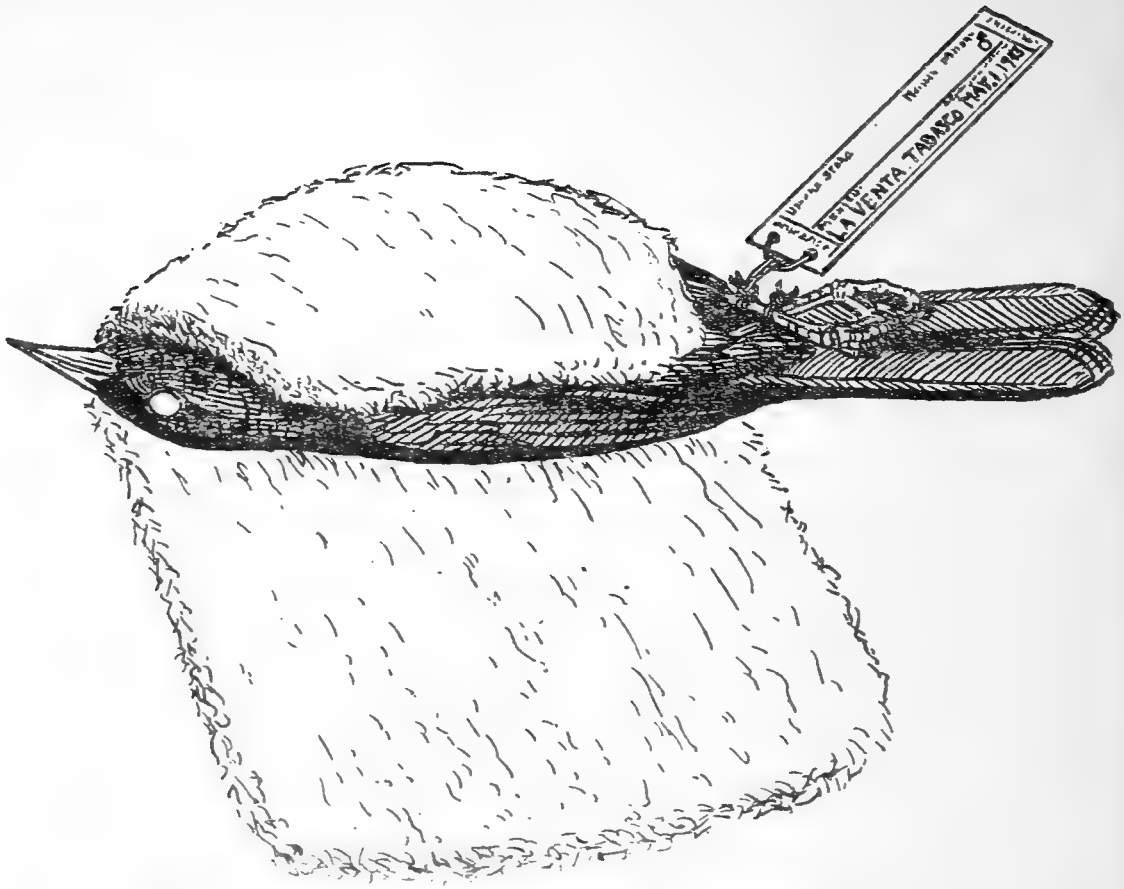


FIG. 34.—Wrapping specimen in cotton to dry.

FIG. 35.—Dry skin to show form and methods of tying feet and attaching label.

and work the skin up over the back. Continue this until the legs are fully exposed, cut them at the usual joint and clean them.

Fat left on skins will ruin them eventually, but care must be taken in removing it not to have grease run out on the feathers. It is necessary to use quantities of the very fine hardwood sawdust or corn meal to absorb it. In handling water birds that are very fat, where corn meal is available, heat the meal in a pan, apply it hot, and scrape the fat off with the meal. Apply more hot meal and repeat the scraping until all grease is absorbed.

It is often necessary to cut carefully with the point of a very sharp knife between the projecting bases of the feathers on the inside of the skin where these are buried in fat to get out all the grease. In doing this, follow the feather rows, using care not to cut through. The side of an ordinary tablespoon makes an excellent scraper for large skins. Hold it with the thumb against the back of the bowl to support it and scrape by pushing gently. In pelicans and some other species the inner surface of the skin is covered with air cells that penetrate between the bases of the feathers. It is necessary to cut carefully through all these, following the feather rows, to allow the arsenic to reach the skin.

Very large birds may be skinned out and not made up, but thoroughy salted and sent in from the field in that condition. This is especially desirable if the birds are greasy, as they can be cleaned more efficiently in the museum than in the field. Rub fine salt thoroughly into the flesh side of the skin, being sure to work it in around the base of the bill, into the wings, base of the tail, and into the openings in the feet from which the tendons have been drawn. Turn the skin right side out, smooth out the feathers and dry well, in the sun for a brief time if needed, and

pack separately from made-up skins. In large birds turn the head on the breast to make a more compact specimen. In damp climates where salted specimens will not dry, instead of salting, poison the inside of the skin with arsenic and alum and dry. Such specimens can be made up by the museum taxidermists.

If specimens are to be kept in the field for some time, they should be exposed to the air until thoroughly dried. If the weather is wet and drying is difficult, expose the wrapped skins to the sun or before a campfire on every occasion until they are really dry. Then pack in a box with naphthalene flakes to keep out insects. Specimens should be rolled in fairly stiff paper before shipping away and packed firmly enough so that they cannot shift about but not so tightly that they will be crushed. Many well-prepared skins have been ruined by careless packing. Large and small skins should be packed separately. The smaller kinds may be packed in cardboard boxes which may then be placed in a larger, wooden box.

Eggs.—Special drills and a blowpipe to be obtained only from dealers in natural-history supplies are necessary to prepare eggs. Eggs should be collected in sets, that is, all the eggs from one nest should be kept together.

Each set of eggs should be accompanied by a label giving name of the bird or the number of the skin of the parent, date, locality, and a note as to whether the eggs were fresh or much incubated. Eggs collected without seeing the parent bird at the nest are worthless, as they cannot be positively identified. If possible, collect the parent bird and send it in with the eggs. When numbers of eggs are collected, each set should be packed so that the labels will not be mixed. It may be necessary to use numbers

for each set. In placing small numbers on eggs with ink or very soft pencil, great care is necessary to avoid breaking them.

Eggs are prepared by blowing. A small hole is drilled into the side of the egg (not the end) with an egg drill, and into this is placed the small end of the blowpipe. Blow gently and steadily through the blowpipe and the contents of the egg will run out. Do this until the egg shell is entirely empty, then fill the mouth with water and blow it into the eggshell to rinse it. Then blow air in to get rid of all the water. Place the egg hole downward to let it drain. When corn meal is available, the eggs may be placed on this to dry. When they are dry, wrap carefully in cotton and pack in small boxes, placing the labels with the eggs.

Skeletons.—For preservation as skeletons select birds that are not badly broken by shot. Broken wings or legs do not matter, but do not skeletonize those with badly injured heads. It is often possible to preserve the skeletons of birds with injured or missing feathers or that are too bloody or dirty to skin. Prepare a label giving locality, date, collector, and number in the same form as for skins and tie to one foot.

Pull off the skin of the body and neck with the feathers, leaving the skin and feathers on the head, and the large feathers in the wings and tail. These will serve to identify the species later.

With a knife cut off the large muscles on the breast, legs, and wings, using great care not to injure the bones or to cut off delicate processes of bone. Remove the viscera, being sure to ascertain whether the bird is male (♂) or female (♀), and write this in your catalog and on the label. In this preparation corn meal, fine hardwood sawdust, or dry earth may be used to absorb excess blood.

Fold the wings and legs against the body, turn the head and neck on the back, and wrap with string or thread firmly, but not too tightly, and tie to make a compact bundle. Tie a string through the loop made by the neck vertebrae and hang up in the sun in a safe place to dry. Small skeletons may be preserved in alcohol, but never put formalin on skeletons. When they are completely dry, wrap skeletons in paper and pack in boxes that will not crush in shipping.

Always pack skeletons separate from skins as they may be attacked by insects. These will not injure bones but will destroy skins.

REPTILES

(Lizards, Snakes, Turtles, Crocodiles, Alligators)

Lizards and snakes are usually killed during capture, or they may be dispatched by striking a quick blow on the neck back of the head. Always use utmost care in handling snakes you do not know; they may be poisonous. In shooting lizards or snakes, use fine shot. Those captured alive may be drowned in 30 to 60 percent alcohol, a method that may serve for small turtles. Large turtles may be killed by cutting the spinal cord in the neck just before it joins the shell, while alligators and crocodiles may be shot through the heart or vertebral column. Do not injure the head.

Snakes may be captured alive by means of a slip noose of cord or fine wire on the end of a stick (fig. 36). They are carried best in small bags of heavy muslin or light-weight canvas, one animal to a bag. Always use great care in handling any that may be poisonous.

Small lizards and snakes are not difficult to preserve, requiring only a preserving solution made of 3 parts of full-strength alcohol to 1 of water, or of 4 or 5 percent formalin. With small specimens proceed as instructed for amphibians. Cut quarter- to half-inch slits at 1- to 2-inch intervals on the belly of snakes, with one or two under the tail, to insure preservation. Lizards over 5 inches long need one or two slits in the abdomen for the same reason. With large lizards make incisions along the under side of the legs also.

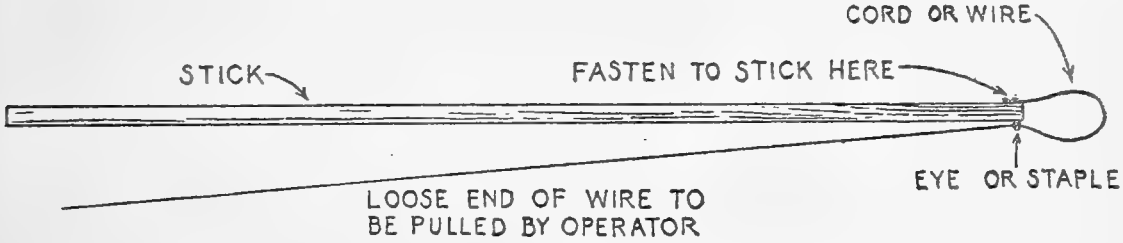


FIG. 36.—Stick for capturing or handling poisonous snakes.

Larger snakes present a more difficult problem. It is often advisable to skin out the body of a large snake by cutting along the midventral region from chin to anus, take that part of the body out entire, and leave the head with 2 or 3 inches of neck, and the entire tail, attached to the skin. This may be kept in preservative and will occupy much less space. Dried snake skins are not very desirable as museum specimens.

Turtles are hard to preserve. With a large hypodermic syringe inject pure alcohol or formalin at the base of each leg. If a hypodermic syringe is not available, jab a knife deep into the body between the foreleg and neck, and between the hind leg and the shell, to make fair-sized holes for the preservative to

enter. Prop the mouth open with a cork or stick, and pull the neck out of the shell as far as it will come. Then place in a container of 75 to 90 percent alcohol for curing. After a few days, if no "soft" (decayed) spots show on the specimen, it can be wrapped in a cloth wrung out in alcohol and placed, with label attached, in a tin shipping container, which should be soldered shut.

A larger turtle can best be made into a dried skin, that is, a shell with the flesh removed from inside the legs, tail, and neck, which remain attached to the shell by a part of their leathery skin. The skull should be dried inside the head skin, as its structure is rather delicate. If time is lacking, the shell alone can be "roughed out," that is, cleaned of flesh, the legs discarded, and only the head dried and saved with the shell. Labels for large dried specimens may be made of flat pieces of wood on which the data are printed with black pencil.

Alligators and crocodiles present the same difficulties. The ones preserved in alcohol undoubtedly are the best for later scientific study; hence those less than 2 feet in length should be so preserved. Many injections of pure alcohol or strong formalin into the fleshy parts of the body are necessary. The specimens may then be kept in 75 to 90 percent alcohol until ready for final packing.

Large lizards, alligators, and crocodiles should be skinned out, leaving the legs attached as well as the head and tail. Salt may be used as an additional preservative if the skins are slow in drying.

It is advisable to make measurements of any specimens intended for skinning and drying, as well as to weigh them, if that

is possible. The nature of the stomach contents should be noted. Packing, labeling, and shipping of alcoholic specimens of reptiles is the same as that noted below for amphibians. Too much emphasis cannot be placed upon the need for complete and legible labels, one for each specimen, or one for a group of specimens all collected on the same day at the same place.

Remember that the inconspicuous, secretive animals that are hardest to find are likely to be the rarest in museum collections. Well-preserved and accurately labeled material from any part of the world is of value.

AMPHIBIANS

(Frogs, Toads, Salamanders, Caecilians)

Frogs and toads are most common around water or in moist places. Marshes and ponds are attractive to many, while other kinds will be found on or around trees and stones in forests. Parasitic plants and mosses covering branches and trunks in tropical forests harbor many. Salamanders live under logs, beneath bark, in damp decayed wood, or under stones. A few kinds are found in water. Caecilians are wormlike, burrowing amphibians confined to the Tropics; they live in the mud of swamps, from which they emerge sometimes after rains. The more secretive the specimen, the rarer it usually is in collections, and hence the more desirable.

Night collecting is profitable, as many amphibians remain concealed by day. Use a flashlight, or a gasoline lantern that throws light in all directions.

The best means of killing all species is to drown them in a

20 to 40 percent solution of alcohol, as this kills quickly and they remain relaxed. A few drops of ether in water makes a good killing solution for frogs but does not serve for salamanders. Do not use chloroform, as it causes the muscles to tighten, making distorted specimens. Lacking alcohol or ether, use warm water which also leaves the animals relaxed. Take good series of each kind whenever possible, preserving large and small, light and dark specimens as they come, in order to get the full range of variation.

After killing, the best procedure is to arrange the animals in a natural position in a pan of 10 percent formalin for 3 or 4 hours until they are stiffened, when they may be removed for preservation to 60 percent alcohol, made by adding 4 parts of water to 6 parts of full-strength alcohol. If formalin is not at hand they may be placed directly in 60 percent alcohol. If alcohol is not available, preserve in 2 to 3 percent formalin.

With large toads and frogs—over 5 inches in length—make a short incision in the stomach and others in the fleshy part of the under side of the legs with a knife or scissors to allow the preservative to enter. Prop the mouth open with a cork or small piece of wood, so that the preserving fluid may penetrate the alimentary canal.

Specimens should not be packed tightly when first preserved—not more than three or four to a jar at first if possible—as the muscles set within the first few hours and distortion results when they are crowded. Leave them in the original preserving fluid for 2 or 3 days, then put them in a fresh solution of the same mixture for permanent storage. The original fluid discolors and weakens after freshly killed animals have been put in it. Keep

specimens from different localities in different jars, or wrap those from separate localities in thin cloth to avoid mixing them. Each specimen should be labeled with the locality, date, collector, and also any observations on food, habitat preferences, or breeding.

The best labels are small rectangles of pure sheet tin or sheet lead on which a number corresponding to that in a catalog is scratched deeply so that it will remain legible. Metal stamps for making numbers are better if these are available. Thread this label through a hole punched in one end and tie securely to the specimen. In the catalog opposite the number write locality, date, collector, and other circumstances under which the specimen was found. If metal labels are not available, use a slip of tough paper that will not dissolve in the fluid, and write the data on it in soft black pencil. Place this in the jar with the specimen. Be sure to make a label that will be legible when the specimen finally arrives at its destination, as this is of the greatest importance to those who will later study your collections. Do not use ordinary ink, as it will dissolve in the preserving fluid. If specimens are carried about before packing for final shipment, wrap in cloth so that the label will not rub and become illegible.

It is possible to ship very small specimens in vials or small bottles filled with fluid, packed in boxes in straw or other packing material. In such cases ink may be used on labels pasted on the outside of the bottle, but experience has taught that soft pencil is better, as fluid from a broken bottle may render ink labels illegible.

Keep the jars of preserved specimens in a dark place, as light bleaches the original skin colors very quickly. Hot weather delays thorough preservation of specimens. The jars should be inspected

once a day for the first few days after the specimens are put into them, and if any soft spots develop—usually greenish sunken areas above the stomach or intestines—a deep puncture of the skin above the soft places should be made, and a little fresh preserving fluid added. In the Tropics it is necessary to put a freshly killed animal into preservative almost as soon as it has been killed, to prevent drying out and decaying.

For shipping, specimens should be loosely wrapped and tied in a piece of white cheesecloth or other light-weight cloth, with the label attached to each specimen or group of specimens coming from a single locality. Saturate the cloth with preserving fluid and lay the bundles of specimens in a clean gasoline tin, the top of which may be soldered shut when it is full. Do not let the skin of any specimen come directly in contact with the tin, for it will rust, especially if the preserving fluid is formalin. Do not crowd the specimens too tightly, but use packing material—excelsior, cotton, or cloth—if necessary to keep the bundles from shaking around in the can. Be sure that packing material is white or light-colored, as dark-colored material may discolor the specimens and labels.

FISHES

Fish may be collected by ordinary hook-and-line fishing, or with small nets. A tow net is useful for obtaining fish at sea, especially at night, as oceanic fishes come closer to the surface at night than in the daytime. A submarine light placed over the side of a ship or boat will attract fishes so that they can be caught in dip nets or a throw net. Fishing over the side of a ship when at anchor, and trolling off the stern while the ship

is in motion if the speed is not too great, often result in fine captures of oceanic fishes. Seining along the beaches of islands and bays, especially at night, is a highly successful method of obtaining specimens.

Small fish, even half an inch or less in length, should not be rejected, for some of the most valuable specimens are the small ones. It is desirable to obtain series of specimens of each species. With common species of small size that are found in large numbers, collect the same species in different localities, and take series in all localities. In general, preserve all fish that are collected as far as available containers and preservative will permit.

Small fish should be placed alive, if possible, in a solution of formalin made by mixing 1 part of commercial formalin with 9 parts of water. This is of sufficient strength to preserve specimens up to 5 inches in length in about 3 days. Larger ones should be left for a greater length of time, depending on their size. In all specimens over 3 inches in length make a small slit in the side of the abdomen, or inject formalin with a large hypodermic syringe into the abdomen and also at intervals of 2 inches in the muscle tissue. They should be left in the formalin solution for 5 to 7 days or more. At the close of the periods indicated, fish of all sizes may, if desired, be transferred to water, and the formalin soaked out for 1 or 2 days, when they are placed in 75 percent alcohol for preservation.

One precaution should be observed—never crowd the fish in the containers. Crowding hardens them in distorted shapes, and they may spoil for lack of preservative. If it is necessary to leave the specimens in formalin indefinitely, they may be trans-

ferred to a weaker solution made up as follows: 1 part formalin to 15 or 18 parts of water, to which there should be added 2 teaspoonfuls of borax to each gallon of preservative. This weaker solution is usually of sufficient strength to preserve the fish indefinitely if the container is closed tightly. Always fill the containers full of liquid.

If alcohol is used, specimens should be placed while alive, if possible, in 35 percent alcohol and after about 6 hours removed to 75 percent alcohol. If the specimens are at all crowded, the fluid should be poured off and fresh 75 percent alcohol added the next day. If specimens become soft, another change of alcohol should be made, again using 75 percent.

In general, formalin preservation is best at the start, and should be used instead of alcohol because the formalin hardens the specimens. However, after the fish have been in formalin a week, they should be transferred, if possible, to 75 percent alcohol, after thoroughly washing out the formalin, because the acid in the formalin has a tendency to soften the bones unless it is neutralized.

Either fresh water or salt water is practicable in preparing formalin solutions, but with alcohol only fresh water may be used.

Labels giving locality, date, collector, depth, and any other information that seems pertinent, such as method of capture and ecological data, should be placed in the jar with the fish when collected. The labels may be written in pencil on any good grade of linen paper. Do not use paper that will disintegrate in the liquid, and do not write with ordinary ink, as this will wash off the label. Large fish may have tags tied onto them, preferably through the lower jaw, with all essential data written on the

tag, or a number may be used and the data recorded under the same number in a notebook.

Be sure that all containers are completely filled with preservative so that there is a minimum of air space in the container. If the fish are allowed to shake around with air in the jar, their fins will become frayed, and the rays and scales worn.

As a rule, fish should be left in the preservative for 1 or 2 weeks, depending on their size, before being wrapped for shipment.

When preservation is complete, proceed as follows: Stack the small fish in rows (as wood is piled) with the heads outward on both sides and the tails toward the center so that the tails are protected, and then wrap in white cheesecloth or other thin cloth. Sew the ends together firmly or tie with string to make a package. Larger specimens should be wrapped individually in cloth to prevent rubbing. Be sure to protect all the fins when wrapping. Clean gasoline cans make good shipping containers if a considerable collection has been made. They should be completely filled with packages of fish, or the excess space filled with excelsior or clean, dry grass. Do not use paper, as it softens and dissolves and does not fill the spaces. After the container is completely filled any excess liquid may be poured off; enough of the preservative should remain so that the contents are wet. Be sure the container is sealed to prevent evaporation. In the case of metal cans, the top should be soldered.

If neither formalin nor alcohol is available, fishes may be preserved in salt. They should be soaked first in a saturated brine solution, and when thoroughly impregnated, packed in dry salt for shipment. As in the case of other methods of preservation, the abdominal cavity should be opened to allow the salt

solution to enter freely. It may be necessary in the case of fishes that feed on vegetation to open the intestinal tract and remove the accumulated vegetable matter.

Fish too large for preservation in the containers available should be skinned. Make a slit along the abdomen and remove from beneath the skin the flesh from both sides of the body, but leave all the fins in place. The head and tail should be left attached to the skin. This skin can then be placed in formalin or alcohol, or it may be salted. It is best to remove most of the fat and all flesh from the skin. In case of moderately large fish, it may be well to cut away the flesh so as to leave the vertebral column intact.

ACORN WORMS (BALANOGLOSSIDS)

The acorn worms or balanoglossids (fig. 37) are unfamiliar even to most experienced collectors, but their importance as the lowest forms definitely related to the vertebrates makes them valuable finds. They are soft, slimy, wormlike burrowers, from 1 to 20 mm. in diameter, and from 2 to 100 cm. in length. The distinctive feature is the collar with projecting proboscis and elongate trunk. The proboscis may be 3 to 10 times longer than the collar, or there may be a single great fold on each side of the trunk; otherwise all species look much like figure 37.

Acorn worms are sluggish creatures that live in sand or mud, occasionally under rocks or among seaweed roots. Black mud, if the sea water is not too brackish or stagnant, and clean coral sand are equally likely habitats, but wave-washed beaches are not. Sand flats exposed at low tide and coral-sand tide pools are typical situations. They are found in all latitudes.

These animals, rarely found exposed on the surface, are usually obtained by digging or turning over rocks. Some species may be located by the coiled casting of sand thrown up in a cone at one end of the burrow, but many are encountered only by chance when digging in appropriate situations. They usually break and are obtained as pieces. These fragments are valuable and should not be discarded in the hope of finding whole specimens. But

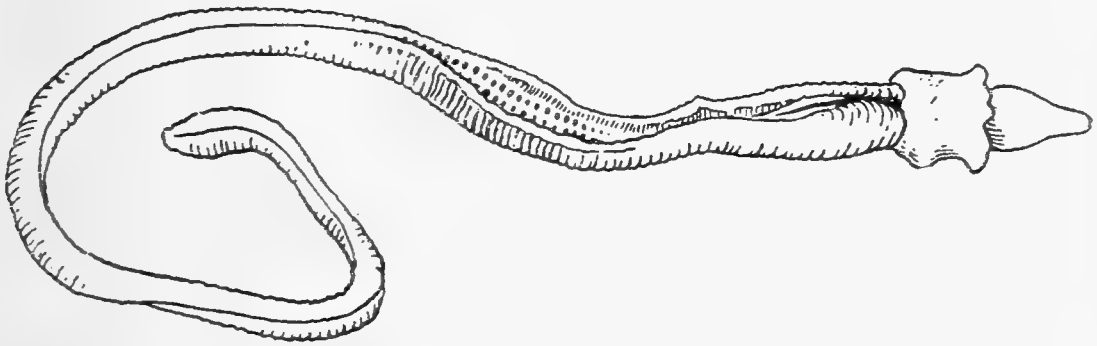


FIG. 37.—An acorn worm.

if one fragment is recognized as a balanoglossid, efforts to find others should be made. Balanoglossids should be carried back to the working quarters in containers separate from any other material collected at the same time, as they often give off great quantities of mucus.

They should be preserved within a few hours of capture. All serious study of balanoglossids depends on their subsequent cutting into thin sections, so that careful preservation is necessary. If possible, place them in a tray of clean sea water and allow evacuation of sand from the gut for an hour or so. Then slip

off the mucus sheath with all the sand grains and drop the animals into fixative. This may be 10 percent formalin, which is made up of 1 part of the commercial article in 10 parts of sea or fresh water. Alcohol may serve if nothing else is available. If alcohol is used, kill in 50 percent solution; after 3 to 4 hours transfer to 70 percent and on the following day to fresh 70 percent solution.

In any case change the fluid, preferably twice in the first 24 hours, and again after several days. The label should give the locality, date, color, method of preservation, and name of collector.

Some technicians may have facilities available for preparing Bouin's Picro-formol fluid for a fixative. This is made as follows: Picric acid, saturated aqueous solution, 75 parts; formol 25 parts; acetic acid 5 parts. Place the specimens in Bouin's Picro-formol, change to 50 percent alcohol after first day, and to 70 percent alcohol on third day for preservation.

MOLLUSKS

Mollusks may be found almost everywhere. Some live in the tops of tropical forest trees, others in shrubbery, and still others on the ground, in lakes and streams, and in the sea, where they range from the shore line to great depths. Full-grown mollusks vary in size from that of a pin head to a weight of 700 pounds. The smaller species are the least known and therefore the most interesting.

The group is divided into five classes: bivalves (fig. 38), snails (fig. 39), tooth shells (fig. 40), coat-of-mail shells (fig. 41), and cephalopods (fig. 42).

Mollusks are easily prepared for museum specimens. In small kinds the animal can be allowed to dry up without harming the shell or causing a smell. Larger specimens should be dipped in boiling water for a couple of minutes, when the animal can be extracted with a bent pin or piece of wire.

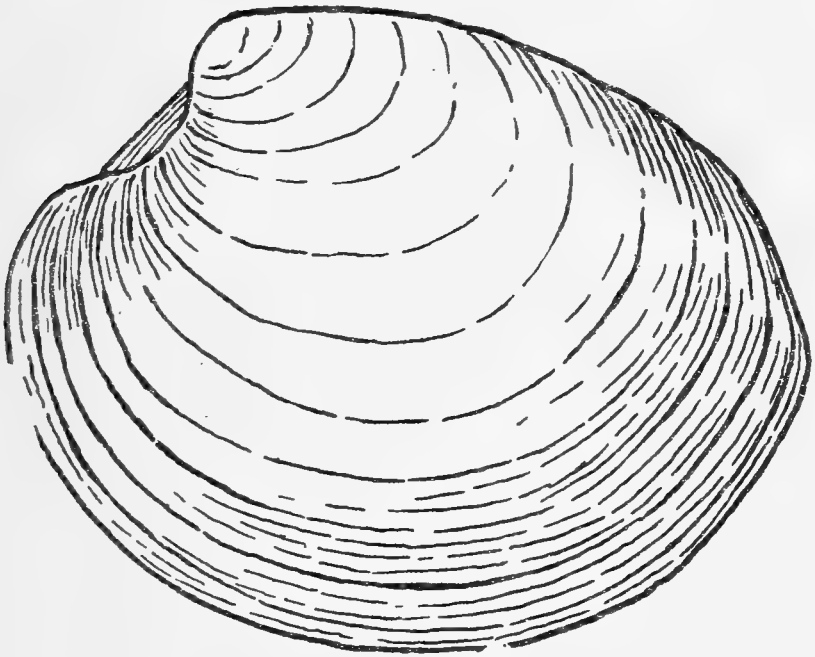


FIG. 38.—A clam.

Most cephalopods and slugs are mollusks without shells, and should be preserved in 80 percent alcohol. It is well to change this two or three times so that it may not become too diluted by the extraction of water from the specimen, which might cause it to spoil. In these changes, 10 times as much alcohol should be used as the bulk of the specimen. After the changes indicated

have been made, the mollusks can be preserved in as small a quantity of alcohol as the bulk of the animal.

Care should be taken in preparing shells of mollusks for shipment to avoid injury or breakage. Delicate specimens should be wrapped in paper or other soft material. Place a label written in pencil with each lot, giving locality, date, and collector.

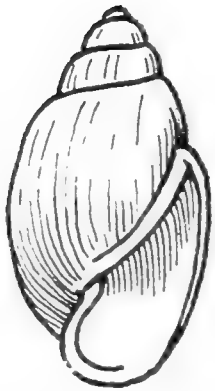


FIG. 39.—A snail.

FIG. 40.—A tooth shell.

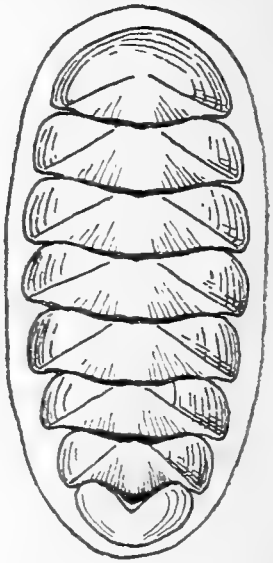


FIG. 41.—A coat-of-mail shell.

When packing small living mollusks, wrap the label in cloth to prevent the animals from eating it.

For shipping, all should be packed in wooden boxes with paper, excelsior, clean, dry grass, or other packing to keep them from jostling. In tropical countries fragile specimens may be packed in joints of dry bamboo (which make excellent mailing tubes). Empty cartridge shells also make good containers.

For shipping cephalopods and slugs preserved in alcohol, pack the containers carefully to prevent breakage. With these specimens use labels of a good grade paper that will not disintegrate when wet.

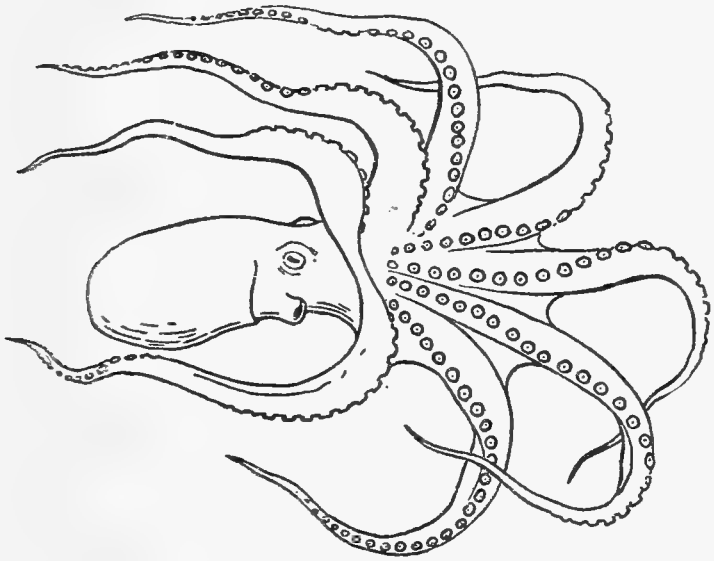


FIG. 42.—An octopus.

INSECTS

The collector of insects must have, first and most important, a good killing bottle, and second, some sort of a net. Any wide-mouth bottle, such as a pickle bottle, will do for the first. If it has no stopper, whittle one from a piece of wood. If cyanide is available (it can sometimes be had at a drug store or photographic supply house), wrap a piece the size of a lima bean in damp, soft paper and ram it tightly in the bottom of the bottle. In handling cyanide remember that it is a *deadly poison*. Cut a piece of blotting paper to fit tightly over the plug

of cyanide and seat that firmly. The cyanide will immediately produce enough gas to kill insects, but not enough to be a danger to the collector. However, do not stick your nose into a killing bottle to find out whether it is still strong. If cyanide is not available, plug the bottom of the bottle with soft, wadded paper and moisten the paper each time you go collecting with carbon tetrachloride (Carbona), chloroform, or ether. The cyanide-type bottle will last for months and, when necessary, may be easily cleaned out and recharged.

A net frame, similar to a fisherman's landing net, can be made from flexible branches and string. If you are where the rattan palm grows, a few yards of rattan will make an excellent frame. A torn mosquito bar that is no longer good enough to sleep under will provide the netting.

Carry also a small bottle or two partly filled with strong alcohol if available. Many kinds of insects are better killed in fluid than in cyanide. Carbon tetrachloride (Carbona) can be substituted for the alcohol.

For extensive collecting a beating net and cloth are desirable. The beating net is made with a frame of heavy wire 12 inches in diameter fastened to a strong handle. The net bag is of strong white cloth. This is used to sweep grass and other vegetation, gathering whatever insects may be present. The beating cloth is a 3-foot square of strong white cloth with a narrow pocket sewed in each corner. Light, flexible sticks of the proper length are thrust crosswise into the corner pockets to extend the cloth like a sheet. Hold the cloth with the sticks uppermost beneath branches and beat the leaves and trunks with a stick so that insects will fall on the sheet.

At night a light set behind a white sheet or thrown on a white wall will attract many insects.

Insects live in all sorts of places. Hunt for them on leaves of trees and bushes, on flowers of all kinds, on and under rotten fruits, under loose bark of dead trees, in rotten stumps and logs, under stones, and in water. About the only place where you will not find living insects is in the sea, but after a few days of off-shore breeze plenty of dead ones will wash ashore at high

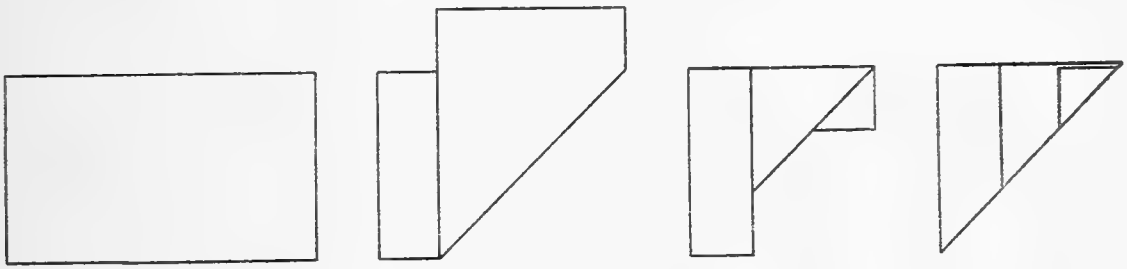


FIG. 43.—Folding a triangle to preserve insects.

tide in a neat row on the beach. Collecting is often good under the ridge of seaweed usually found at this line.

Kill fragile insects (butterflies, moths, and mosquitoes) and hairy kinds (bumblebees and flies) in cyanide; others are best put directly in fluid.

Remove specimens killed in cyanide from the killing bottle soon after they are dead. Place them then in paper triangles for storage and shipping (see fig. 43 for method of making triangles). For the larger butterflies and moths put only one in a triangle; other less fragile kinds may be placed several together.

Write on the triangle before folding where and when each specimen was collected, the date, and the collector's name. Do

not put specimens from different places in the same triangle. Do not write on triangles after the insects are in them as this may injure the specimen. If, because of military regulations, these data cannot be sent out with the specimens, keep a notebook, number the lots to correspond with entries in the notebook, and send these data separately. Be sure to keep a copy of the data yourself in case that sent is lost. Specimens without data have practically no scientific value.

When ready to ship specimens, find a small wooden box if possible, or a tin box such as is used for English-type biscuits. Make sure that the insects cannot shake about by putting a small plug of cotton or white cloth tightly on top of them. A bubble of air plowing back and forth through a mass of insects preserved in fluid can do much harm in the journey to the Museum. Wrap the bottles separately and pack the box full, using crumpled paper to fill all extra space.

Pack specimens in paper triangles in a box separate from those in alcohol, always making sure that the contents of the box cannot shake about. Never pack heavy objects of any kind in the same box with paper insects.

SPIDERS

Spiders occur in the same situations as insects. In the popular mind all spiders are poisonous, but actually only the species of black widows are really dangerous, and even these rarely bite unless cornered. However, if one prefers, spiders may be handled by means of tweezers which can be made from two wood splints.

All spiders should be preserved in alcohol and labeled and handled as described above for insects.

CRUSTACEANS AND MISCELLANEOUS INVERTEBRATES

The larger species are usually readily observed and captured, but not the smaller, rarely seen forms, which are often more important than the larger ones. They need to be specially sought.

On land, along sea, lake, or stream shores, turn over stones, logs, and debris and examine the ground beneath, as many small crab- or shrimp-like animals, as well as spiders, snails, beetles, and other creatures find protection in such habitats. A most fertile field is the seashore at low tide, where the receding water leaves the bottom exposed. Small crustaceans, marine worms, and other forms seek protection beneath stones and rocks, and also burrow into the mud or gravel. If clumps of seaweed, other marine growths, or encrusted rocks are vigorously rinsed in a bucket of fresh or sea water to which about half a pint of formalin has been added, many small creatures become detached. The water may then be poured off carefully, or run through a fine-mesh strainer, and the small animals put into alcohol.

Many small inhabitants of sea beaches are nocturnal and may be trapped, sometimes in considerable numbers, by placing a shallow pan containing 2 inches of weak alcohol, or even sea water, upon the beach above high-tide mark, and leaving it overnight.

For the capture of small specimens seen moving in water, a small, fine-mesh, hand dip net is necessary. Such a net may be made with a stout wire bent into a loop, covered with a piece of fine-mesh cloth or, better, fine wire screening soldered in place, fastened to a short handle. The mesh should be one-half or one-fourth the size of fly screen. A small strainer such as is used in cooking, if not too coarse-meshed, may be used. Nets

made for museum collectors are about 4 inches in diameter, with a 5- or 6-inch handle.

For handling larger and, to the collector, more questionable animals, a pair of long forceps is useful. These can be improvised from light bar-iron, wire, or pieces of wood and a spring. A crab slapped down with the flat of the hand does not get a chance to use his pincers, and can be picked up by taking hold of the shell near the hind end, or grasping the two legs of the last pair with one hand. If one leg is seized, the crab usually parts with it and so escapes.

Whenever possible, a number of specimens of each kind should be preserved.

Proper labeling of material is most important, as ordinarily an animal without locality label is not worth saving. Field labels should be plainly and legibly written in soft pencil, giving the place, date, depth at which taken in the case of aquatic animals, and name of the collector. These data may be supplemented usefully with notes regarding the conditions under which the material was taken, environment, other organisms with which the specimens were associated, host in the case of parasites, and notes on color. A good grade, heavy bond paper should be used if it can be obtained. Shipping tags or the usual tablet or writing papers go to pieces in any kind of liquid. Formalin is particularly hard on paper. If possible, the label should be protected against abrasion by wrapping or tying it in a piece of cloth, especially if there is any doubt about the quality of paper used. The label should be placed in the bottle or container with the specimens in all cases. It may be supplemented by a label pasted or tied to the outside, but never omit the inside label as the outside one may become detached.

Most invertebrates are best preserved in alcohol. For permanent preservation a 70 percent solution is used. Certain animals become too rigid or brittle and others excessively contracted when killed in solutions that are too strong. Therefore all animals should be killed in 30 or 40 percent alcohol. Marine crustaceans, shrimps and crabs, that spend their lives in the sea, may be killed by placing them in containers of fresh water. Those that live on land or in fresh water must be killed in the weak alcohol. As far as practicable, animals should be killed in individual containers. This is especially important with larger specimens, such as crabs, as if placed together they often fight and tear each other. Tin cans are useful as killing containers.

Immediately after death, time and materials permitting, the killed specimens should be put into a 60 per cent solution of alcohol overnight before being transferred to the final 70 percent solution for permanent preservation. If there is no time for this, they may be placed directly in a 70 percent solution from the weak killing solution. In lieu of other preservatives, strong spirits, such as whisky or rum, will usually preserve invertebrates until they can be given further attention. Since the alcohol is diluted by the extracted body fluids of the animals, it is advisable either to change it or to bring it up to 70 percent strength by adding undiluted alcohol after a day or two. Use fresh water to dilute alcohol.

Formalin makes a good pickling solution for all types of animals if alcohol is not available, and is the best preservative for jellyfish. The commercial article, formaldehyde, is usually labeled as being a 37 percent solution of formic acid in water. This is mixed in proportion of 1 part of formalin to 20 parts of

water. Either sea water or fresh water may be used for mixing. Formalin, unlike alcohol, does not need to be brought up to strength subsequently. At all times crowding of specimens in containers should be avoided; see also the remarks under alcohol with respect to brittleness and killing. When killing animals with formalin a little of the prepared solution should be added from time to time to the water in which the animals are killed. After killing, the specimens should be transferred to a fresh solution of formalin.

Soft-bodied animals such as worms are preferably killed in an expanded condition. A very gradual addition of alcohol to fresh water, or formalin to either fresh or salt water, will serve to put them to sleep if no other narcotizing agents are at hand. For marine animals one of the best and most easily obtained narcotizing agents is magnesium sulphate, to be used in the proportion of 154 grams to the liter of water (5.5 oz. to 2.1 pints). The animals may be placed directly in this solution at sea temperature or preferably cooler. When insensitive to being touched, they can be transferred first to weak alcohol or formalin for killing, and then to the strong solution for permanent preservation. In the Tropics narcotizing must not be too prolonged, as unless the process is carried out in a refrigerator, the animals will macerate because of the high temperature.

Containers, if not otherwise provided, can usually be obtained from the camp or ship's cook. Pickle, preserve, and mayonnaise jars with screw caps are good. In place of gaskets, waxed paper over the mouth of the bottle under the lid is usually satisfactory, if not broken when the lid is screwed down tight. Tin cans with spring tops are excellent containers. Tin cans with slip-over

tops can be sealed by means of adhesive tape so that evaporation will not occur.

In order that there will be room enough for sufficient preserving liquid properly to pickle the collected animals, the bottle or container in which they are preserved or stored should not be filled more than two-thirds full of specimens, except in extreme cases when they will not remain crowded for long periods of time. This caution is especially to be observed in the Tropics or other regions where high temperatures obtain. Moreover, in such situations, if tightly sealed or clamp-top containers are used, the tops must be opened from time to time during the first few days, to allow accumulated gases to escape; otherwise, the container may blow up or the specimens be ruined.

Ordinarily, for shipment a bottle or can full of liquid provides sufficient cushion for the contents against shock or breakage en route. Under no circumstances should raw cotton be put in any bottle to take up vacant space as these specimens become hopelessly entangled in it. If packing material is deemed necessary, soft paper or thin cloth should be used. Where weight of shipments becomes an important factor, as in air transport, the specimens may be shipped without any liquid whatsoever, provided that they are shipped in liquid-tight containers which will keep the contents from evaporation. A well-preserved animal, guarded against desiccation, will keep indefinitely. At the same time, the containers can be packed brimful. Where convenient, tins may be lined with cloth, preferably light cotton, to prevent the animals from becoming rust-stained, particularly if old cans are used. The cloth should be moistened with some of the liquid in which the animals are preserved. Shipment of moist

specimens without liquid should not be attempted unless the animals have remained in the full-strength pickling solution 10 days or 2 weeks. Only in emergency cases should incompletely preserved animals be shipped moist, for the chances are that they will spoil before they reach their destination, and so be of little or no value.

EARTHWORMS

Earthworms are of considerable scientific interest; several specimens should be preserved from every locality in which they are found.

The animals are best killed in 8 to 10 percent alcohol in a flat dish. This solution should straighten out the animals; those that do not straighten out can be manipulated by hand. As soon as the worms are dead, they should be placed in about 10 percent formalin composed of 1 part of the commercial article in 10 parts of water. When time suffices, it is well before killing to allow the earthworms to clear the alimentary tract of ingested material. This often contains soil and sand and therefore interferes with later sectioning of the animals, which may be desirable for purposes of study. The clearing is best accomplished by permitting them to feed overnight on soft, moist paper.

Narcotized specimens tend to shrink less on preservation. Narcotization can be accomplished by suspending a rag saturated with chloroform in a jar containing the worms. After they are insensible to touch, they can be placed in the 10 percent formalin solution.

Label as directed for other invertebrates.

LEECHES

Leeches are of considerable medical importance and form valuable museum materials. Their collection requires considerable care. The methods used for their preservation are applicable to other soft-bodied worms.

Study of leeches is greatly facilitated by properly prepared material and is equally hampered by faulty preparations. The preserved leeches should be straight, moderately extended, and undistorted. They should be well fixed and preserved in fluids strong enough to prevent maceration or softening, but not so strong as to render them overhard and brittle. They are completely ruined by drying, which often happens when collectors are busy with other things.

As leeches contract excessively and irregularly on contact with irritating preserving fluids, the first step in good preparation is to stupefy or anesthetize them. Many narcotic drugs will accomplish this, but the best one, if available, is carbon dioxide, found in soda water in siphons or other carbonated waters. Chloroform or ether fumes, chloral, chlorotone, cocaine hypochlorate (of about 1-1000 strength), a very weak nicotine or tobacco decoction, magnesium sulphate, alcohol, or very weak acid like lemon juice, added very gradually to water in which the leeches are confined are satisfactory narcotizing agents, and the animals will usually die in them extended. Place the leeches in a small covered vessel or stoppered bottle nearly filled with clean water to prevent escape from the stupefying agent. Leeches are very sensitive to nicotine, and in the field one of the best and simplest methods is to drop a few shreds of smoking tobacco into the

water with them, just enough to give the water a very faint tint. The leeches will usually be completely narcotized and relaxed in 30 to 60 minutes. If the decoction is made too strong they will die quickly, contracted.

When the leeches no longer respond to pinching with a forceps or similar stimulation they are rapidly drawn between the thumb and fingers to remove the excess mucus and then are laid extended side by side in contact in a flat dish. To keep them in place and to prevent distortion when the fixing fluid is poured on, a piece of muslin or other thin cloth, or of tissue or filter paper moistened with the fluid, may be placed on them. The fixing fluid is then gently poured on, usually at first not quite enough to cover them. This avoids floating and disarrangement. After allowing 10 minutes, or longer for large leeches, for them to harden partially, sufficient fluid is added to immerse them completely, care being taken to prevent floating. For ordinary museum or taxonomic purposes 50 percent alcohol or 2 percent formaldehyde, which can be made by diluting the formalin solution described above (page 63) with an equal quantity of water, will answer perfectly, the latter being preferable as less likely to cause the cuticle to separate. After the fluid has thoroughly penetrated and the leeches have fully stiffened, they are transferred to stronger solutions and finally preserved in 85 percent alcohol or 5 percent formaldehyde (the formalin solution described on page 63). They should be placed in wide-mouthed bottles or vials of sufficient length and diameter to keep them straight and to avoid crowding and distortion. Wads of surgical gauze or cheesecloth may be used to hold them in place if necessary.

The label, written in pencil or carbon ink on good grade paper that will not dissolve in the preservative, should record place and date of capture and the name of the collector. As some of the coloring matters of leeches are freely dissolved or altered by the fixing and preserving fluids, it is desirable also, if practicable, to record the living colors on the label. Every additional ecological or other fact added to the record increases the value of the specimens. A number of specimens of each kind should be collected.

ECHINODERMS

This group includes the sea urchins, starfishes, brittlestars, crinoids or featherstars, and holothurians or sea cucumbers. Take samples of the larger ones but direct attention mainly to collecting the smaller and less conspicuous kinds, which are less well known. They are also easier to preserve and occupy less space in shipping.

Sea urchins.—These are more or less common everywhere, from between tide marks down to great depths. There are three main types: Globular, with more or less long and numerous spines; oval, with short, or mixed short and long spines; and flat, solid ones with very short spines, usually called sand dollars. The globular ones live on rocky or hard bottom, or among seaweeds, and are often common in tide pools. Some bore holes in rock, in which they live. A few hide in holes or dark places during the day, coming out at night. The oval ones live either exposed on soft or hard bottom or, like the sand dollars, burrow beneath the surface of sandy mud.

Specimens preserved in alcohol are preferable, but because of

the large amount of water in them strong alcohol, over 70 percent, must be used and changed at least twice, which may not be practicable in the field except in the case of very small individuals.

All sea urchins may be preserved dry. After capture they should be placed in fresh water for a few hours; this will cause them to straighten out their spines. They should then be boiled for a quarter to half an hour to harden the tissues, after which they may be dried, either in the sun or by artificial heat. In the Tropics artificial heat is usually necessary for thorough drying. Where facilities are limited, they may be dried directly after their removal from the sea.

In the Indo-Pacific region is a type of sea urchin that it is well to leave alone. It is low and flattened, 4 to 6 inches in diameter, and has a very soft, parchmentlike shell, with short and widely scattered spines which are fine and exceedingly sharp; many of these spines are provided with poison glands which are capable of inflicting dangerous wounds. It lives mostly in rather deep water and is not likely to be met with along the shore. It is well known to native divers.

It is well, also, to avoid the common dark-colored urchins with very long, slender spines which may be 15 inches in length. These spines can inflict painful wounds. One of these needle-urchins, found in the Indo-Pacific region, has short, fine poison spines among the long ones.

Starfishes.—Starfishes occur along all coasts, some kinds on reefs, rocks, or hard bottom, others buried just beneath the surface of sandy mud. They should be placed in fresh water for a few hours, which will cause them to straighten out their arms, then boiled and thoroughly dried, by artificial heat if possible. All starfishes are harmless.

Brittlestars.—Brittlestars are found everywhere, usually under stones, in the interior of coral heads or sponges, about the roots of seaweeds, clinging to gorgonians or other plantlike animals, or buried in mud. Some live only among the spines of sea urchins, especially on the under side, or on crinoids or sea lilies. Many may be found by breaking up coral heads or cutting up large sponges. They should be dropped at once into 70 percent alcohol. The larger, tougher kinds may be dried after a few days in alcohol. The arms of the larger ones may usually be manipulated under alcohol so that they all point in one direction, which saves space in packing them for shipment.

Crinoids or featherstars.—Featherstars are often common on reefs, particularly below low-water mark on the windward side, or clinging to fringing gorgonians or other growths. They are usually found under large stones or in shaded situations. They should be placed at once in strong alcohol (75 percent solution). They almost always become more or less broken, but this does not prevent their being studied.

Some crinoids, known as sea lilies, grow up from the bottom on long stalks. These are especially desirable, as very little is known about the species occurring in relatively shallow water. It is possible that some of these may be obtained from divers.

Holothurians or sea cucumbers.—Sea cucumbers are found on rocks between tide marks on reefs, under fragments of rock, among seaweeds, or buried in mud. They vary in length from less than an inch to about 4 feet. Small ones may be dropped into 70 percent alcohol. It is scarcely practicable to attempt to preserve any over a few inches in length without abundant facilities, as they must be narcotized and then injected and carefully hardened because of the great amount of water in their tissues.

Note.—In packing dried echinoderms it is important to avoid any contact with cotton or other finely fibrous material, which will become hopelessly entangled in the fine serrations and other processes on their spines. They should be protected from the packing material by newspaper or some similar material.

Use alcohol to preserve all echinoderms, as formalin destroys their delicate skeletal structures.

CORALS

Along the shores and in shallow waters of tropical islands many beautiful corals may be found. These are desirable as museum specimens.

If material thrown up on the beaches is collected, care should be taken to select specimens that have not been worn by being rolled about by the waves. Living corals form the best specimens. When removed from the water the flesh disintegrates and produces an offensive odor. Before shipping they should be sun dried.

The main difficulty in coral collecting lies in packing the delicate specimens for shipment. They require individual wrapping and secure packing to keep them from rubbing each other and breaking in transit, and must be shipped in strong containers. For each lot note on the label the place and date of collection and the name of the collector.

PLANTS

The preparation of plant specimens for botanical study is a simple matter and does not require previous experience. The most important points are: To make complete specimens, to dry

them under pressure quickly and thoroughly, to label them properly, and to pack the specimens for shipment with care.

For digging plants of ordinary size a small pick is best, and for cutting branches from trees and shrubs a sharp knife is essential. A collecting portfolio of some sort must be provided also, to keep the specimens from wilting before being placed in the press. The simplest kind is one made of two pieces of rather stiff cardboard measuring 12 by 17 inches, each with slits near top and bottom toward either end, through which a pair of stout cords are passed. The bottom of the portfolio is thus readily adjustable to the number of specimens obtained, and the top can be kept closed by tying together the free ends of the cords. For convenience in carrying, a shoulder strap may be placed beneath the cords. If so desired, a more elaborate lattice-like portfolio may be made out of thin, slightly flexible wooden slats about an inch wide, criss-crossed at right angles and made fast by small nails properly clinched. Within the portfolio place sheets of newspaper, folded once so as to measure 11 by 16 inches.

Probably most of the material to be collected will consist of flowering plants. These are classed as herbaceous or woody. Of the former, which include many plants that do not have showy blossoms, collect only those having flowers or fruit, in addition to leaves; if you can obtain both, so much the better. Except in very special cases, do not collect plants bearing leaves only, for such material is hard to classify and is mostly of little value. Plants 3 feet high or less should be collected entire—roots, stem, foliage, flowers, and fruit, and if too long for the folder, they may be bent sharply in the form of a narrow V or N, to accommodate them to the collecting sheet, a free space always

being left at the right-hand lower corner for the label, when the specimen is mounted in the museum.

Ferns of moderate size may be prepared similarly. In all cases, dirt should be shaken from the roots, or, if necessary, washed out. Fine-leaved plants growing in water ordinarily collapse in a tangled mass when taken bodily from water, but usually they may be floated out gently on paper, if time permits.

In the case of woody plants, a branch about a foot long (or several shorter branches) bearing flowers or fruit (preferably both), besides leaves, should be collected, care being taken to place loose fruits in envelopes within the folder, or, if bulky, to wrap them in separate packages, carefully labeled.

The coarser seaweeds may be dried like flowering plants, but the delicate kinds with fine threadlike divisions must be patiently floated out on paper in sea water. Lichens and mosses should be taken only when in fruiting condition, and dried under much less pressure than flowering plants and ferns.

The usual plant press consists of (1) two slightly flexible lattice-like frames measuring 12 by 17 inches, made from slats of ash or some other tough wood, (2) driers (thick blotting papers) of the same size, and (3) a pair of strong web trunk straps.

On return to base from a collecting trip the specimens must be transferred from portfolio to press as speedily as possible, especially during hot weather. Begin with the specimen first collected. Transfer it to a dry newspaper folder like your collecting sheet, at the same time straightening the leaves or flowers if necessary, possibly removing portions so that all parts may be seen. Give the specimen a serial number; write this on the outside of the folder and on any other folders containing additional

specimens of the same plant collected at the same time and place. Under this number—and this is important—enter full data in your notebook, as explained in a later paragraph. The specimens next in order will be handled similarly, a new serial number being given to each different kind in turn. Now alternate with driers the folders containing specimens, place the pile between the press ends, and cinch the press tightly by means of the trunk straps.

The drying operation has now begun. After 12 hours, and at least once every 24 hours thereafter, fresh driers must be substituted for the wet ones, which then should be dried for further use. The process of changing driers at regular intervals is highly important if good specimens are to result, and it must be continued daily until the plants are dry. Grasses and ferns will dry quickly; most other specimens will require only a few days if plenty of warm, dry driers can be used. Fleshy plants dry slowly, of course, and some of them make better specimens if dipped in boiling water for a few seconds before being placed in the press.

The drying of all specimens can be greatly hastened by using stiff corrugated cardboards alternately with the driers. If this is done, the press should be placed in direct sunshine or over some source of artificial heat, such as a stove, furnace, or engine, so that there may be a continuous passage of hot air through the hundreds of flues formed by the corrugations. However, only strong corrugated cardboards, faced on both sides, should be used; weak ones will prove a nuisance, as the corrugations are bound to collapse under pressure and moisture. When dry, the specimens (still in their numbered folders) should be sprinkled

lightly with flake naphthalene and tied snugly in bundles of about 50 each between tough flexible cardboards, ready for shipment. It is essential that the packages be securely wrapped and stored in a dry place. The naphthalene serves not only to keep out destructive insects but to prevent injury from mildew and bacteria as well.

When none or only a part of the equipment just mentioned is available, makeshift apparatus must serve the purpose. If a portfolio cannot be made, a closed container of some sort, such as a rigid cardboard box, will serve admirably to carry plants for short collecting trips. Press ends and straps may be dispensed with also, if in their place a piece of strong board (12 by 17 inches) and a flat rock or other weight of 30 to 40 pounds are available. In fact, if the specimens are not too bulky, the follow-up pressure of the heavy weight may be better than the slackening pressure exerted by straps. Blotting papers for use as driers are, however, nearly essential. To a limited extent newspapers (several thicknesses placed together) can be used instead; but they do not absorb or give off moisture readily. Old newspapers, cut neatly to folders measuring 11 by 16 inches, make excellent collecting and specimen sheets. Incidentally, place the folded edge at the left and write the serial number in heavy lead pencil at the lower right-hand corner.

At the time a specimen is put in the press, all essential data regarding it should be recorded in the collector's notebook under the same number. Of first importance, naturally, are the locality, general region or country, altitude above sea level, date of collection, and name of collector. But many facts that will not be apparent when the specimen is received at the museum are

known to the collector, and these should be set down; for example, the height of the plant, whether a tree, shrub, or woody vine, its relative abundance, the kind of place in which it grows—swamp, forest, open brushy slope, grassy plain, or beach—its common name, the color of its flowers, and the like. Is the plant poisonous? Has it medicinal uses? Do the natives use it as a stupefying fish poison (suggesting that it may prove to be a valuable insecticide)? Is the fruit edible? Any information of this sort should be entered under each number and should cover such points as cannot be made out by examining the specimen itself.

One point more: Collection numbers should run from 1 upward in a single continuous series, no matter how many years and countries are concerned. Do not start with number 1 each year or at each new locality. Failure to observe this rule has resulted in great confusion.

Finally, remember that a few well-prepared ample specimens accompanied by full data and special information are worth dozens of poor specimens with scant or faulty data; and make your specimens as nearly complete as possible. The botanist needs complete specimens, but very often he does not get them, even from professional collectors.

WOODS

Wood specimens to have the greatest scientific value must be accompanied by mature leafy twigs and fruit or flowers from the same tree, this material being prepared according to the directions for collecting plants given above. All specimens from one tree should bear the same collection number.

Collection is speeded by the use of loggers' tools, an ax, cross-

cut saw, and steel wedges. A set of steel dies numbered 1 to 0, at least ¾ of an inch high, is the best means of marking specimens.

Trees selected for felling should be sound, without visible defects, and in fairly adult stage of growth. Make a horizontal saw cut at the side on which the tree is to fall, as near the ground as possible, continuing the cut to about one-fourth of the diameter of the trunk. With the ax make a notch above to meet this saw cut, the angle of the notch being about 45 degrees. Next make a saw cut on the opposite side of the tree on the same level as the first one. As soon as this is deep enough, insert wedges behind the saw and drive them progressively until the tree falls.

When saws are not available, trees may be felled and trunk sections cut with axes alone or with native cutting tools. Hard wood wedges may replace the steel ones. If a tree may not be felled, sections from a large limb may be taken.

After the tree has been felled, a trunk section must be cut from the butt. The length of this section may have to depend somewhat on transportation facilities, but in no case should it be less than 1 foot. With the metal dies, stamp on both ends the number assigned to the herbarium material from this tree, or if this means is lacking, mark otherwise in as permanent a manner as possible. Enter in a catalog opposite the number given the specimen the locality, date, name of collector, and altitude above sea level as for ordinary plant specimens. In addition record the type of forest association, as "hemlock-hardwood," "rain forest," etc.; soil type, as "sandy," "clay," "sandy-loam," "clay-loam," etc.; the diameter of the trunk breast-high, 4½ feet above ground

(usually written D.B.H.); age of tree (if possible); and color and other description of bark.

As soon as woods reach camp or base, provision must be made to air-dry them partially by proper stacking. Avoid damp places, and do not place any specimen in contact with the soil. If possible stack them away from direct sunlight, with the ends toward prevailing winds so that air currents can pass through the piles. Lay two poles on the ground and pile the blocks on them, with the larger pieces at the bottom to prevent the pile from becoming top-heavy. Separators made of small saplings should be placed on top of each row in the stack to assist further the passage of air. When collections are made during rainy seasons, it is also necessary to erect some kind of shelter over the stacks.

When only a few specimens are collected, simpler drying methods may be substituted, the main idea being not to dry them so rapidly as to cause undue checking, nor so slowly as to induce sap stain or fungus discolorations.

For shipping, pack the sections of logs in crates or boxes, wedging them in with packing material so that they cannot rub or move so as to be damaged.

LIVING ANIMALS

Members of the armed services and other travelers returning from abroad frequently bring back as pets or mascots living birds or other animals. Some of these come eventually to zoological gardens, so that the National Zoological Park in

Washington, a branch of the Smithsonian Institution, looks forward regularly to receiving interesting kinds after they cease to be pets, which, in the usual course, often happens. Species that may be common in a foreign country, even some of those considered pests, are usually desirable creatures for zoos here at home.

In connection with any plans for shipping living animals, the following points must be remembered: All members of the parrot family, and all hoofed animals, including deer and wild pigs, come under severe quarantine restrictions and except in very special cases cannot be brought into the United States. With so many other things available, it is not worth while to collect such animals. All mammals, birds, reptiles, and amphibians enter the United States under permits from the Fish and Wildlife Service, United States Department of the Interior, Chicago, Ill. In the case of specimens destined for the National Zoological Park at Washington, send notice by telegraph or letter in advance of arrival so that the necessary permits may be sent to the port of entry.

With the thousands of interesting live things available, it is not possible to give instructions for the care of all of them, but the following notes will be of assistance.

While animals may be kept as pets loose or on leash, for shipping they must be crated. The simplest and best crates are made of wooden boxes (fig. 44). A door in front about one-third the width of the box gives the animal behind it some privacy. The rest of the front can be of wire mesh, or of wooden slats fastened to a footboard raised a little distance from the bottom so that food and water may be put in and the cage cleaned

without opening the door. Place hay, straw, sawdust, or other litter on the cage floor for bedding to facilitate cleaning.

Perching birds should have perches provided in their cages, the size of the perch to be regulated to fit the foot of the bird.

Snakes and frogs can be kept for long periods without food. Snakes may be carried in cloth bags, which should be moistened

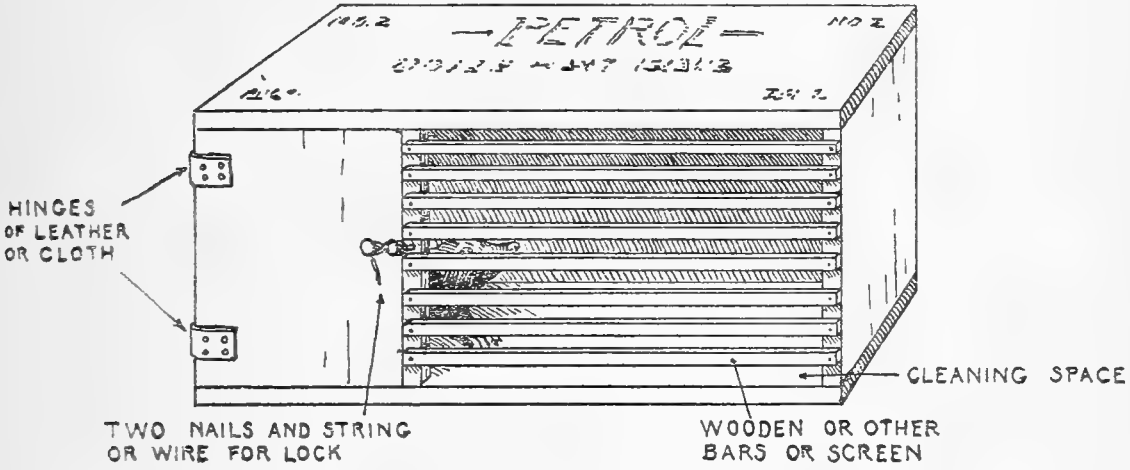


FIG. 44.—Shipping crate for living animals. For birds inside perches are added.

from time to time. Frogs should be kept in damp grass, moss, or other vegetable matter, which must be moistened regularly. Large lizards, common in North Africa, the East Indies, Australia, and the South Seas, thrive on a diet of ground meat, sometimes with raw egg or milk added to it. Ship them in cages.

Mammals, birds, and lizards should be kept moderately warm, dry, and free from draft, and given enough room in their crates to move about comfortably. Do not put them into excessively

large quarters, as they may be injured when the crate is shifted. In the lands where they are acquired you will doubtless be told something of the feeding habits of the various species, but some people, even natives, often seem to know a lot of things about animals that are not so. In the East Indies where rice is the main article of human diet, the natives have a tendency to feed everything else as they do themselves. So, be careful that they do not persuade you to keep a flesh eater on rice.

Animals like to eat what is good for them, and if given a variety of foods will select their own diet. Great quantities of concentrated sweets such as candies or jams are detrimental.

Very young mammals require milk. Diluted tinned milk is usually satisfactory. Small species of cats require milk when young, and should be weaned on raw meat—chicken, beef, or other flesh. Monkeys eat as humans do, but most of them require very little meat. Heavy-billed birds require seeds or small grain. Others, including birds of paradise, will eat insects (cockroaches are obtainable even on shipboard), chopped meat, and fruits or vegetables. Eggs, either raw or cooked, are relished by many creatures.

Aboard ship all the variety of foods necessary to maintain almost any animal or bird may be found. Carnivorous mammals or birds can be fed with scrap meat from the galley, preferably raw; vegetarian species may be supplied the same way from scrap vegetables, and the seed eaters with various dry cereals. Returning home aboard ship from many collecting trips, we have found that boiled rice, ripe bananas, and sweet potatoes raw or cooked, are good staples for many vegetarian species.

Specimens intended for the National Zoo may be forwarded

express collect addressed to the National Zoological Park, Washington, D. C. They should be accompanied by a letter giving the place where the animal was obtained and the name and address of the donor.

ANTHROPOLOGICAL MATERIALS

Anthropology, the science of man, is commonly divided into four parts: Archeology—the study of prehistoric man and his culture; ethnology—the study of living primitive peoples; physical anthropology—the study of man's body; and linguistics—the study of man's language. Since this section is limited primarily to the collecting of objects made by man, it will describe the care, precautions, and, most important, the record which must accompany the collection of such specimens.

The tools and utensils used by primitive people in their daily life are all of interest. These include such things as axes, arrows, pottery, stone, bone, and shell implements, objects associated with religion and art, and those used for hunting, fishing, agricultural pursuits, house furnishing, and body adornment. These should be things made by the natives themselves, and not those that they obtain from foreign traders.

The service man who is a prospective collector of archeological specimens should limit his activities to the preservation of objects that may be uncovered incidental to war activities. Much important scientific material from graves, kitchen middens, and ancient structures has been destroyed by the enthusiasm of unskilled investigators. Two important facts should be established regarding the area in which you may be located: (1) legal

restrictions on the collecting of specimens or their removal from the country, and (2) feeling of the native peoples regarding such matters, so as not to arouse antagonism through activities that possibly may be viewed as disrespectful to the spirits of their dead. Disregard of these local taboos may result in serious difficulties with local populations, particularly where specimens are deliberately excavated and carried away.

The scientific usefulness of any specimen, and frequently its desirability as a museum piece, is determined by the completeness of the accompanying record. This record must include at the very least the precise locality (country, state, city, subdivision, river, island), the circumstances under which each piece was recovered, the nature of the deposit, native name and use if possible, the date, and the name and home address of the collector. No detail should be left to memory; all data should be recorded at once and tied to the specimen.

Many archeological specimens are sufficiently well preserved so that they may be easily cleaned with water, brush, or cloth; others may be so soft or fragile that only excess dirt can be removed safely, and final cleaning should be left for the receiving institution.

Ideally, in preparing for shipment, specimens should be packed in substantial wooden boxes or paper cartons, with plenty of excelsior, dried moss or grass, or other similar cushioning materials. Cotton batting or shredded paper are suitable for light, fragile objects. In the field it may be necessary to substitute whatever materials are at hand, leaving final packing until arrival at a base.

Ethnological specimens collected from primitive tribes, es-

pecially those in out-of-the-way places where foreign cultural influence has had little or no effect on their behavior or cultural objects, may require considerable care to remove them to a base camp, and to protect them in transit by expert packing to guard against damage or destruction by such agencies as moths, beetles, borers, dampness, and warping.

Here again we must emphasize the fact that except in rare cases the specimens have little scientific merit unless accompanied by a detailed record. Such record must include the locality, in sufficient detail so that it can be located on modern, large-scale maps, the name of the tribe, and the function and use of the specimen in relation to the culture.

Collections of human remains of use to physical anthropology, and which are readily transportable, include the skull and other parts of the skeleton, the brain, and hair samples. When such remains are encountered, and there are neither local taboos against their removal nor official prohibitions against their collection and shipment, it is highly desirable that they be saved for scientific study. Bones should be packed in stout containers, using dry grass, excelsior, or shredded paper as packing material. Brains can be collected ordinarily only by those with medical training. They may be preserved in 10 percent formalin solution, surrounded with cotton or cloth, and sealed in metal containers. Hair samples should be placed in separate envelopes.

The scientific usefulness of these again depends largely upon the record obtained by the collector, which should include as many as possible of the following items (listed in the order of their importance): Locality, tribe, sex and age if available, weight of brain upon removal, and region of body from which

hair was obtained. To avoid the possibility of the record becoming separated from the specimens, it is advisable to number the lots with waterproof ink or black pencil, and to duplicate the key to these numbers in a catalog.

FOSSIL VERTEBRATES

Successful fossil hunting requires persistence, concentration, ingenuity, and keen powers of observation. Each specimen is a problem in itself, and each collector will have his own way of working out its details. Whether it be a skull, a few bones, or a complete skeleton, the aim should be to remove the specimen from its resting place in the field to the work table in the laboratory with the least possible injury. An experienced collector may spend hours or even days in taking up a valuable specimen that would be ruined by haste. Months of laboratory work may be required to piece together shattered fragments where the work of removal is done carelessly.

Vertebrate fossils are most common in the finer-grained, sedimentary or stratified rocks that have been deposited by wind and water. Limestones, calcareous shales, and clays are often fossiliferous; coarse sandstones and conglomerates seldom so. Yet it may be found that rocks which ought to contain fossils are barren, while coarse conglomerates may yield teeth and bones. The possibilities of each area must be discovered by careful scrutiny.

Fossils may appear unexpectedly in drill cores from hundreds of feet below the surface, in dredging and hydraulic operations, road work, quarries, mining, tunneling, gravel pits, wells, railway

cuts, and in caves. Examination of the refuse rock from such workings and of newly cut banks will often be rewarded. As a rule fossils not found in place, whether they have been transported by human or other agencies, are much less desirable than those collected undisturbed in the original beds.

Deeply eroded "badland" areas are particularly promising collecting ground. The usual absence of soil or vegetation on their sloping surfaces contributes to the ease of detecting any protruding or broken pieces of fossil bone.

Fossil bones can usually be distinguished from recent deposits of remains of living animals by their heavier weight, darker color, and the way they crack apart in weathering. A fossil bone breaks at right angles to the length, a recent bone into lengthwise splinters and flakes. These observations apply only to fossil bones that are mineralized, not to those found in caves and deposits of little age that may not have changed from their original condition.

Never dig hastily into a sorry-looking prospect, but always work with care, for many an unpromising pile of surface fragments has led to a good specimen. Carelessness may result in the destruction of a fossil, or cause hours of unnecessary labor in recovering pieces that have been needlessly broken.

The collector should have a stout leather or canvas knapsack, with separate compartments for wrapping materials and small tools. In this bag carry stout string, wrapping and tissue paper, labels, awls (fig. 45), brushes, a small trowel, or similar tool, and a small quantity of gum arabic with a receptacle in which to mix it. A small hammer and two or three light chisels are

often useful. The outfit also should include either a geologist's hammer or a short-handled pick (fig. 46) usually carried in the hand. Always keep the collecting outfit down to a minimum.

Upon discovery of a specimen it is important to gather from the surface and loose dirt all pieces of teeth and bones that may have been broken off. These pieces should be carefully wrapped and each package marked to indicate whether it contains scattered surface fragments (float) or tooth or bone pieces broken off by the collector. This procedure will prove of great aid in the laboratory in restoring the fragments to their proper places.

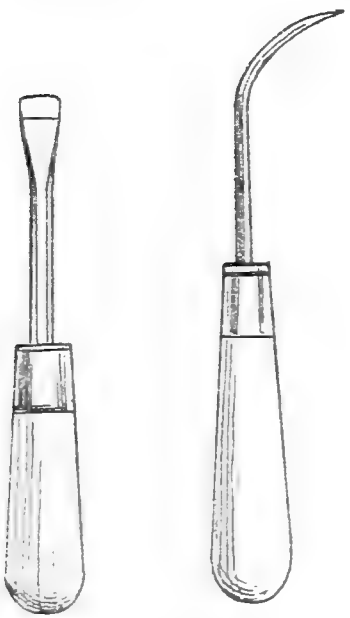


FIG. 45.—Awl and scraper.

The next step is the removal of the overlying burden of rock and soil. In general the work of excavating should begin from above and not from the side of a specimen. When you have dug to within a few inches of the bone, proceed with caution, using small tools and at the same time keeping the work surface clean by brushing so as to avoid the loss of projecting processes or loose pieces. Continue the removal of the rock or soil until the whole specimen, whether it be skull or skeleton, stands out in faint outline (see fig. 47). Harden soft or shattered places in the bone, as the work progresses, by saturating them with a thin solution of shellac or gum arabic, preferably the latter, which is allowed to dry. The best solution is made by dissolving crystals of commercial gum arabic

in an equal amount of water. Apply with a small, soft brush either by sprinkling or directly brushing the surface to be hardened.

When fossils occur in sandstone, limestone, or other consolidated rocks they can often be quarried out in blocks, following the bedding planes and natural seams, and then reduced in size by chipping off the excess rock. In using this method only the broken ends or exposed sides of the fossil need protection. A strip of burlap dipped in paste, made by mixing flour in water, placed over the exposed surfaces usually gives ample protection. Often layers of tissue paper pasted on with gum arabic solution serve the same purpose.

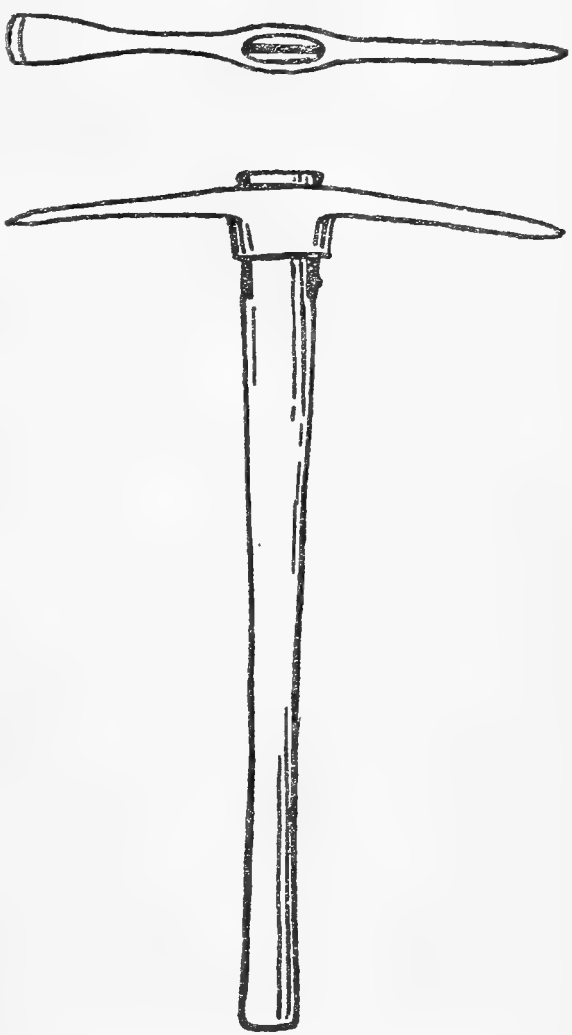


FIG. 46.—Short-handled pick.

Where the fossils occur in marls, sand, or soil, they are often checked and broken into innumerable pieces. To keep these pieces in their natural relationships, and thus avoid permanent damage to the specimen, as well as unnecessary labor in the museum laboratory, such fragile specimens usually

should be taken up in blocks, preferably encased in a jacket of plaster of paris and burlap.

In preparing a specimen for jacketing continue excavating downward all around the fossil, but with as little exposure of the bones as possible, until the whole stands on a pedestal of earth

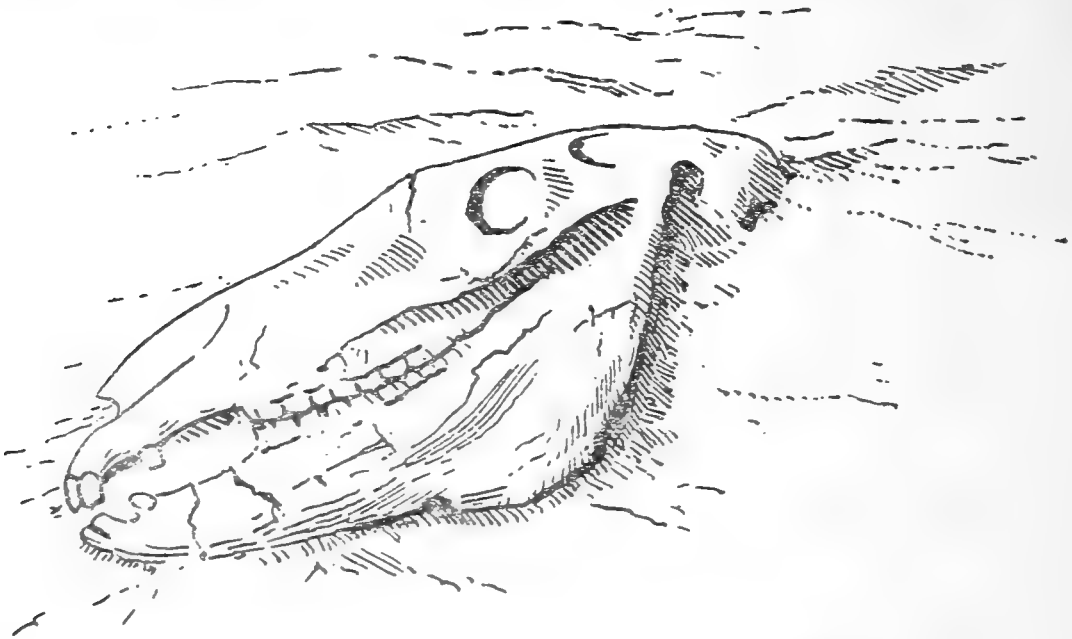


FIG. 47.—Fossil skull exposed by removal of surface cover.

(fig. 48) with the sides overhanging and with rounded corners. Next cover all exposed parts of the fossil with tissue or rice paper painted smooth with gum arabic solution (fig. 49). This will protect the bone surfaces from the plaster when the bandages are applied. For bandages use loosely woven burlap, or gunny sacking. Most old sacks are sewn with a chain stitch that will ravel easily if properly started. Cut the pieces of sacking into

strips 2 to 4 inches in width and 1 to 3 feet in length and place in a pail of water to soak. Next sprinkle plaster of paris slowly and evenly into a pail half filled with water until the dry plaster begins to rise above the surface of the water. Allow the plaster

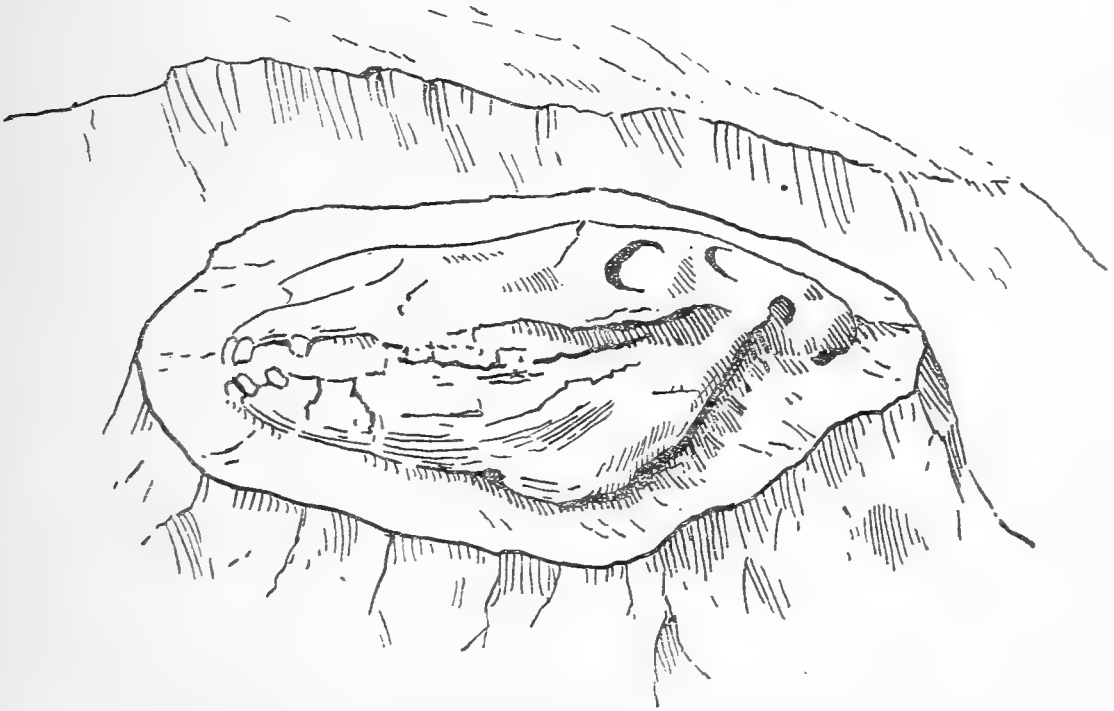


FIG. 48.—Second stage in removal of fossil skull.

to settle slowly without much stirring, which will prevent lumps from forming in the mixture.

Wring out a burlap strip and immerse it in the fluid plaster, taking care that both surfaces are fully covered. As the burlap is removed strip off the excess plaster with the fingers of the free hand. Apply the strip across the top and sides of the block

being particular to press it into all inequalities of the surface. Continue to apply similar bandages, first in one direction then in another, until all of the top and sides are completely covered (fig. 50). To complete the jacket apply strips low down on the pedestal so that their overlapping ends form a continuous collar that ties all together (fig. 51). Much of the success of the whole

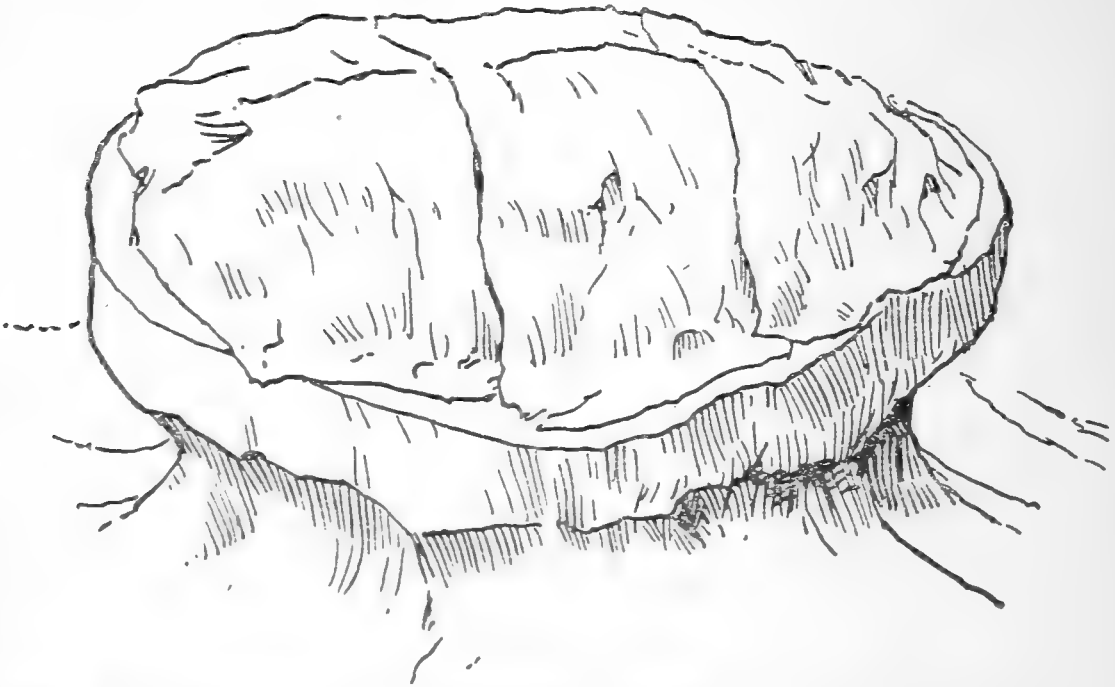


FIG. 49.—Fossil skull protected by tissue paper before bandaging.

operation depends on the strength and proper placing of the collar, for it is this bandage that prevents the spreading of the jacket when the block is being turned over. Should it not hold, the whole jacket may collapse and the specimen fall out. Often it is necessary to strengthen the collar by additional layers. When

the plaster has fully set, the block may be cut or broken loose and turned over. Trim off the excess matrix and bandage the newly exposed side. It is good practice to leave an inch or more of matrix adhering to the bone rather than to clear the surface entirely on the lower side.

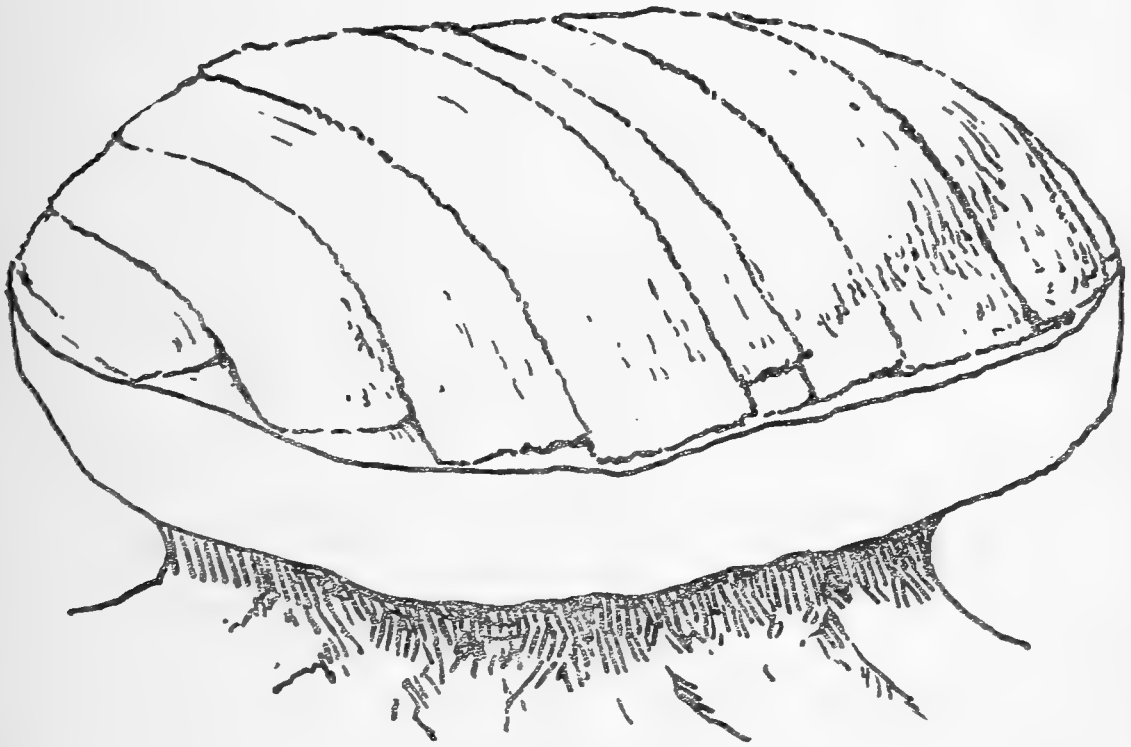


FIG. 50.—Bandages of plaster and burlap.

The block should now be plainly marked with its field or other identifying number. When thoroughly dry it is ready for packing.

In collecting large blocks by the method described certain modifications of the process are necessary. First, the block should

be reinforced by binding strong sticks or splints into the jacket (fig. 51). Second, with wide blocks, after the jacket has been applied to the top and upper part of the sides, dig a number of

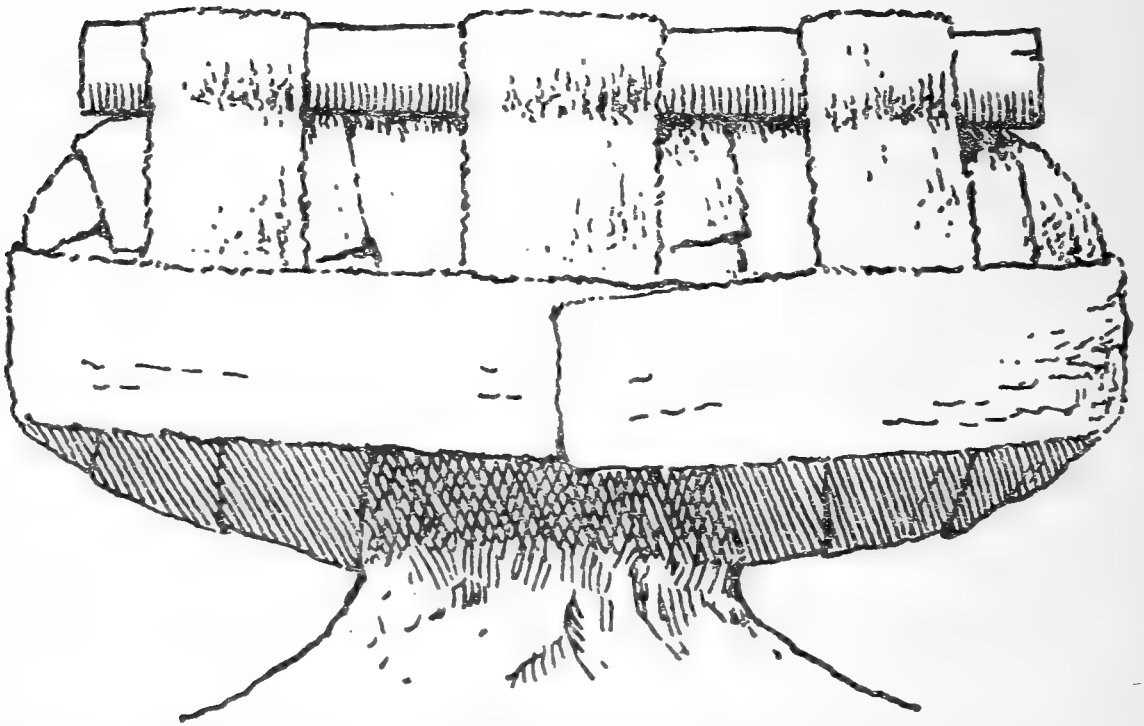


FIG. 51.—Side view of wrapped skull showing stick in place to give greater rigidity to the block.

parallel tunnels through the pedestal from side to side. Then pull strips of plastered burlap through the tunnels, tying their ends into the top of the jacket. Sometimes it is desirable to strengthen the bandages by the use of tightly twisted wire. The whole purpose is to tie the open side of the jacket together, thus

preventing the contents from falling out when the block is being turned over.

In the absence of plaster of paris, ordinary flour paste may be used for bandaging. It sets well in warm weather but cannot be used on wet specimens or in rainy weather. Specimens prepared with paste bandages are also subject to mold and to the attack of rats and mice. It is therefore necessary to keep the blocks dry and to use packing boxes free from knotholes. On account of the easy removal of paste bandages in the laboratory their use is especially recommended in the collection of many delicate fossils. Paste bandages can sometimes be used to advantage in collecting wide, thin bones by applying the strips directly to the surface of the bone. When dry, and after loosening around the edges, the specimen may be picked up without further ado. After removal apply bandages to the lower side.

Small, well-preserved specimens, after the surface has been hardened may be readily collected by the application of successive layers of tissue paper and gum arabic solution. When dry, turn the specimen over and continue the process over the lower side. When this method is used it is well to wrap the specimen in strong paper.

Fragments of a specimen, including float, should be wrapped in old newspapers or, if delicate, in cotton or tissue paper. When the pieces are small, several can be wrapped together, taking care to separate them so that their surfaces cannot rub. Add others as the package is rolled up. Where there are many of these packages it is often advantageous to tie them loosely together in bundles. These can be packed readily, and the connecting strings clearly indicate their relationship.

In addition to the written labels that should always be enclosed in wrapped packages, it is desirable to keep a notebook in which the data are duplicated under the proper number with supplemental information. With jacketed specimens, for obvious reasons, the data concerning them is entered in a notebook and should always include the exact map locality, range, township, and section. Be sure to number all specimens. If working in an unsurveyed area, indicate the locality in relation to some prominent local landmark or stream. Note the formation and position in the geological section, name of collector, and date of collection. A detailed statement of the observed parts of the skeleton present in the block, and any other observations that will be of assistance to the preparator in the laboratory are useful. Include reference to field photographs made of the specimen. Field notes should be written on the spot while the information is freshly in mind.

Small shipments of wrapped materials may be packed in light wooden boxes or heavy cartons. Heavy specimens require strong wooden boxes made specially for them. Wrapped specimens should be packed tightly so that they will not settle and shift about during shipment. Unless separated by strong partitions heavy specimens should not be placed in the same box with fragile materials. Specimens may be packed in hay, straw, excelsior, crumpled newspaper, or even leaves or small twigs and brushwood, if nothing better is available. Press the packing materials down firmly between and around the individual blocks. A tamping stick in the form of a narrow piece of board will be found useful in forcing the hay or straw in tight. Nail on the top, one board at a time, and cram the packing material in

solidly between it and the specimens. When a specimen has been collected in several blocks, pack in as few boxes as possible. Each box should be numbered, and under that number there should be a complete inventory of its contents. When a skeleton has been packed in several boxes, cross references to that fact should be entered in your notes. In shipping the prepared fossils, especially in the United States, they should be billed as "fossils in rock" as a special freight rate applies to this category of materials.

FOSSIL INVERTEBRATES AND PLANTS

Invertebrate fossils include remains of such ancient animals as protozoa, sponges, corals, echinoderms (starfishes, crinoids, sea urchins), worms, bryozoa, brachiopods, mollusks (clams, snails, cephalopods) and arthropods (ostracods, insects, crabs, trilobites). Fossilized remains of plants also often occur in rock formations. These two groups of fossils, animals and plants, therefore, may be considered together. The beginner may gather specimens of importance, and even after a century of collecting many new fossils of scientific interest can be discovered. Indeed, finding the good new things is often the fortune of the amateur and beginner.

Although fossils generally have little money value they do have scientific and economic importance in the information that they furnish on past life. They are links in the chain of evolution, which, when it is completely forged, may yield biological laws of inestimable value to mankind. From the economic viewpoint fossils are important in mapping rock layers and in locating oil

and mineral-bearing strata. The United States National Museum in Washington maintains a large collection of such reference fossils to help geologists identify their fossil specimens and thus classify and map rock formations.

Speaking in general terms, fossils are found in sedimentary rocks, that is, rocks that have been laid down in bodies of water such as seas or lakes. Flood deposits of rivers and wind-laid deposits such as sand dunes often contain invertebrate fossils or plants although the specimens are likely not to be well preserved. Searching for fossils in igneous rocks—those formed from molten magmas or lavas—obviously would be a waste of time. The same is generally true of metamorphic rocks which are composed of sediments or other materials more or less profoundly changed during times of mountain-building.

Limestone, sandstone, and shale constitute by far the greatest percentage of sedimentary rocks. Generally, ancient sediments can be recognized by their arrangement in layers or strata of different kinds of rock of varying colors. These layers are often flat as originally laid down, but in mountain-building they may be much folded so that their edges protrude from the surface at various angles. No specific rules can be given as to what kind of rock will contain the most fossils. In general the finer-grained rocks, such as the limestones and calcareous shales, contain more and better-preserved fossils than the coarser sandstones. Nevertheless some coarse sands contain numerous fine fossils. The best rule is to examine any exposure of sediments for fossils.

Fossils are preserved in many ways, varying from the entire animal to traces such as a footprint or burrow. Most fossils consist of the hard parts or skeletal portions only, preserved

with more or less mineralization. Many occur as replacements of the original skeletal substance or hard parts by several minerals, the most important of which is silica (quartz). Mineralizations of wood are found in which the cellular structure is faithfully preserved. Here the cells have been filled and much of the wood replaced by silica, lime, or other minerals. A few animals (graptolites) and many plants are preserved by carbonization. In this process some of the volatile hydrocarbons of the animal or plant have been drawn off leaving only a black film. Through such processes, acting on accumulations of plants, our great coal beds have been produced.

One of the commonest occurrences of fossils, particularly in sandy rocks, is in the form of impressions (molds and casts). In such examples the limy, shelly, or skeletal material has been dissolved by percolating water, thus leaving an impression of the exterior of the fossil along with an inner cast representing the mud that filled the interior. Many plants and parts of plants, such as leaves, occur as imprints.

The following are common fossils:

Protozoa—usually single-chambered, very tiny shells of infinite variety (fig. 52).

Sponges—branching, conical, subspherical, or cupshaped, often indefinitely-shaped bodies, having a skeleton composed of fibers or spicules (fig. 53).

Graptolites—black, lustrous skeletons of colonial polyps usually flattened and suggesting pencil markings on rocks (fig. 54). They are most common in slaty rock.

Corals—solitary corals are shaped like a goat's horn, while some colonial corals suggest honeycomb (fig. 55). Some more

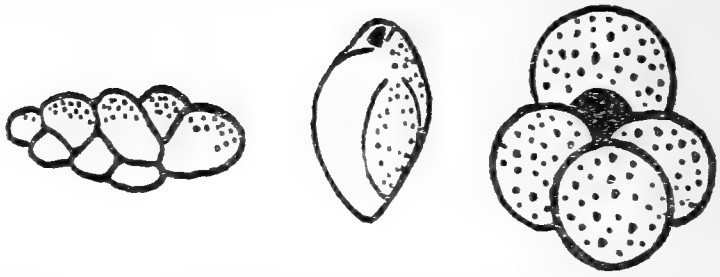


FIG. 52.—Fossil protozoans (much enlarged).

FIG. 53.—A fossil sponge.

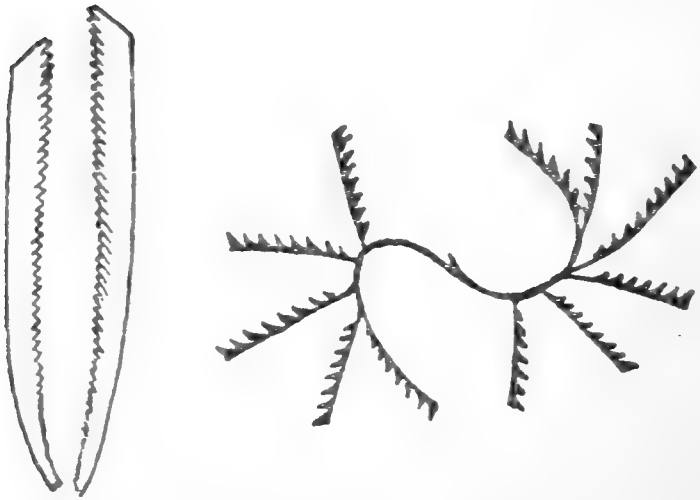


FIG. 54.—Examples of graptolites.

modern corals have skeletons of varying form, shaped like a brain, staghorn, or flower.

Echinoderms—star-shaped (starfishes), liliform (crinoids) (figs. 56 and 57), bun- or biscuit-shaped (sea urchin) (fig. 58) covered by a skeleton of calcite plates or ossicles that show the cleavage of the mineral calcite when broken.

Worms—seldom found as actual fossils but as traces in the form of burrows, tubular shells, or tracks.

Bryozoa—branching, lacy, or massive coralline skeletons containing tiny pores in which the colonial animals lodged (fig. 59).

Brachiopods (fig. 60)—with two smooth or ribbed shells of unequal size, the larger one with a hole at the beak. Right and left sides of the shells are identical (bilaterally symmetrical).

Mollusks—clams (fig. 61) have two nearly equal shells in each of which the right and left sides are unequal. Snails (fig. 62) have a single shell commonly coiled spirally, rarely coiled in one plane. Cephalopod shells coil in a plane (rarely spiral) or are straight and are divided into many chambers by transverse partitions or septa. Cephalopods in which the trace of the septa on the side wall is a simple curve are called nautiloids (fig. 63) and those with complicated septa, ammonoids (fig. 64).

Arthropods—invertebrates with jointed legs such as insects, crabs, lobsters, and spiders. The commonest fossil arthropods are trilobites (fig. 65) which have a segmented body, head, and tail, characterized by a more or less elevated central axis.

Locating fossil-bearing ledges.—The accurate location of the exact layer from which a collection of fossils is taken is most important. Loose or drift fossils, or specimens lacking essential information as to their locality, may have biological importance but will be

of little value to the geologist. Prospecting for fossils is not unlike a search for minerals or metals. If working along a stream or hillside, the collector should locate loose specimens or search for any indication of fossils in rock debris. Such indications should be traced to their source bed. When the fossil-bearing stratum is

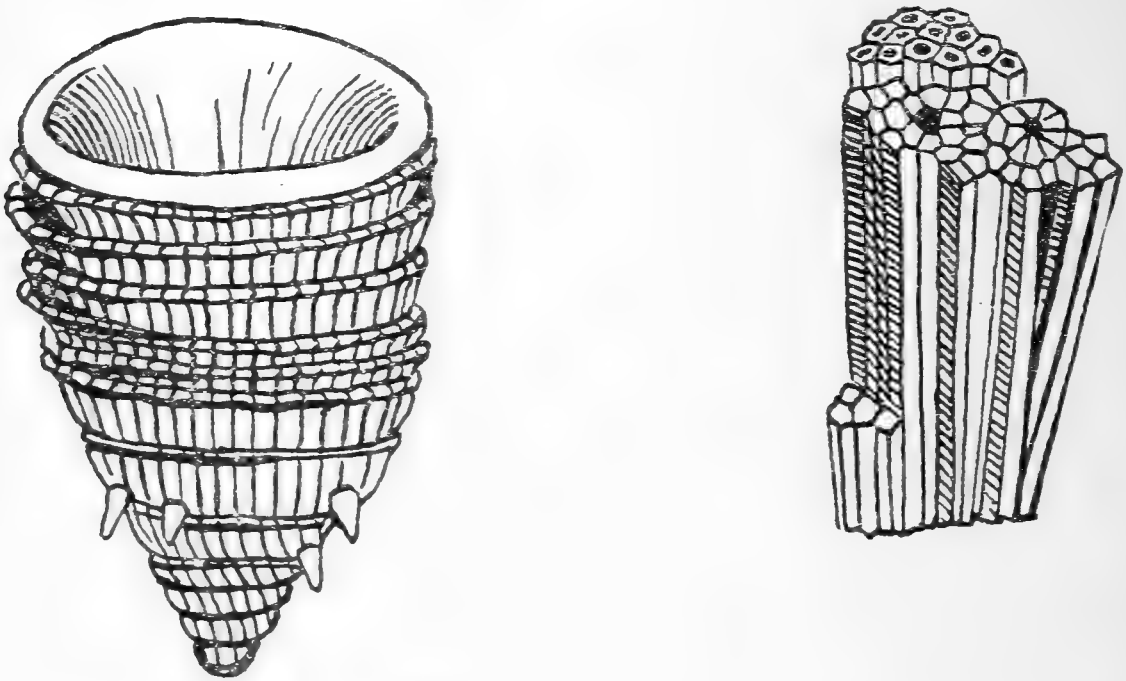


FIG. 55.—Fossil corals.

discovered, the collector can decide on the best means of attack depending on such conditions as the hardness of rock, the ease with which it can be split, accessibility, and amount of overburden (see under fossil plants, p. 107). The important item in every case is to determine the exact layer from which the collection is to be made, and to locate this layer with reference to harder or

softer beds, conspicuously colored layers, or other permanent natural features.

When collecting loose fossils on a slope derived from two or more soft, fossil-bearing layers, it may be necessary to dig away some of the surface debris in order to locate and collect specimens from the underlying beds that yielded them.

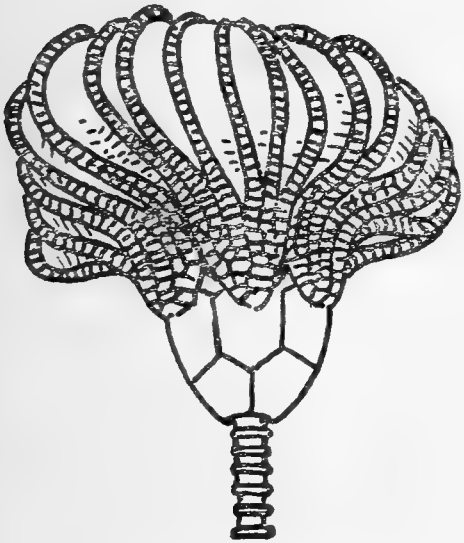


FIG. 56.—A crinoid head.

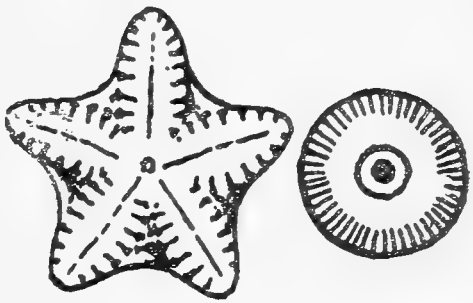


FIG. 57.—Segments of crinoid stems.

Collecting invertebrate fossils.—Fossils may occur embedded in hard rock or loose on the surface. When they are found in a hard matrix, it is necessary to break the rock to free the specimens. For this purpose a hammer is necessary, preferably one with a square face but, opposite to it, a chisel edge at right angles to the shaft for splitting slaty rocks. In addition one or more cold chisels or sharp points are desirable. A hand lens of 6 or 8 power is an indispensable item of equipment. Where the rock

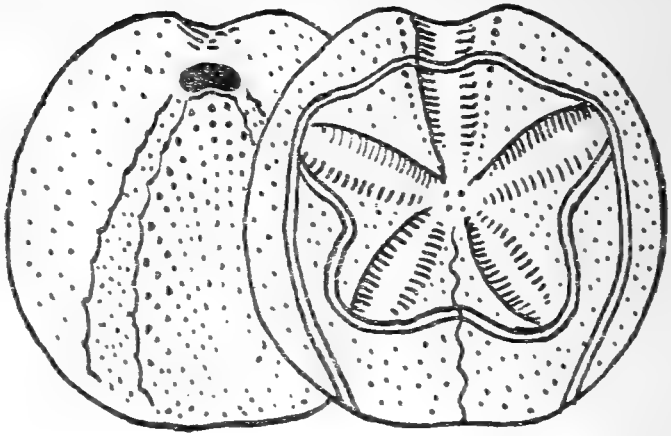


FIG. 58.—A fossil sea urchin.

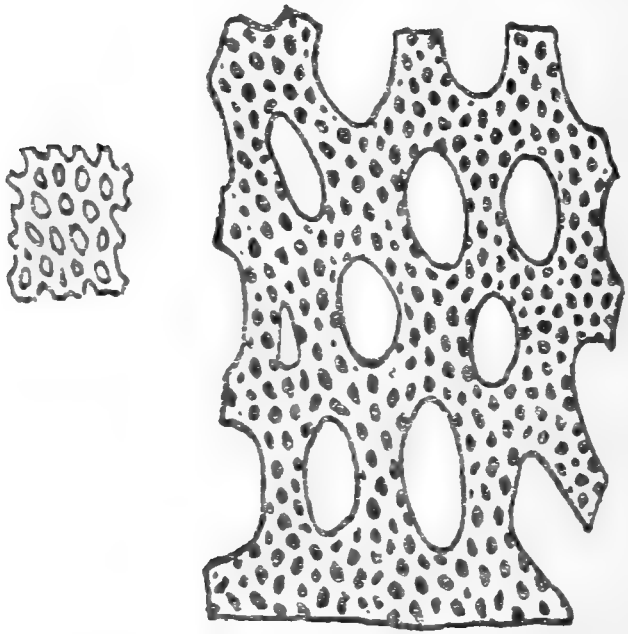


FIG. 59.—A bryozoan, shown natural size at left and enlarged at right.

is massive, a light bar and small (4-pound) sledge hammer are helpful to pry out and break up chunks. If fossils are numerous and easily removed from the rock, a good collection may be made by breaking up the larger chunks on the spot. Generally however, removal of a fossil from its matrix requires more time and facilities than are available in the field. It is best, therefore, to

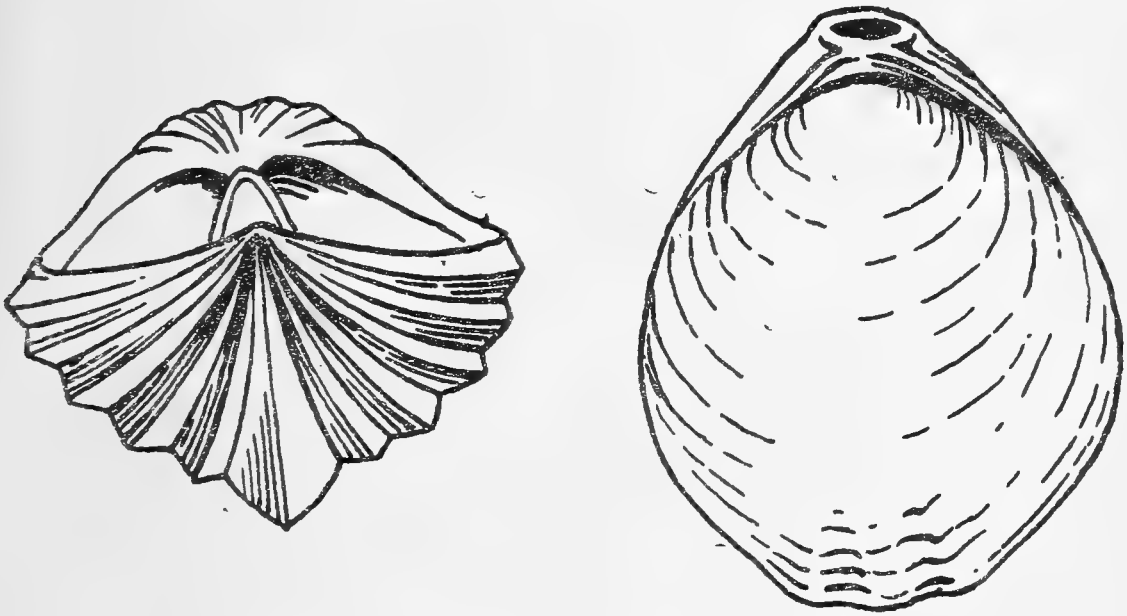


FIG. 60.—Views of two brachiopods.

bring in chunks of fossiliferous rock for more careful breaking in the laboratory. Do not attempt to clean fossils of any kind in the field.

Fossils usually occur on bedding planes along which the rock cleaves naturally. Fossil impressions will then usually occur on each side of a split piece, hence it is essential that both sides be saved because each impression represents a different part of the animal.

When broken open, fossil clams, brachiopods, and some other fossils found as impressions often yield an inner kernel or lump representing the ancient mud-filling of the inside of the shell. Inexperienced collectors often preserve only this inner filling, which is nearly worthless without the accompanying outer im-

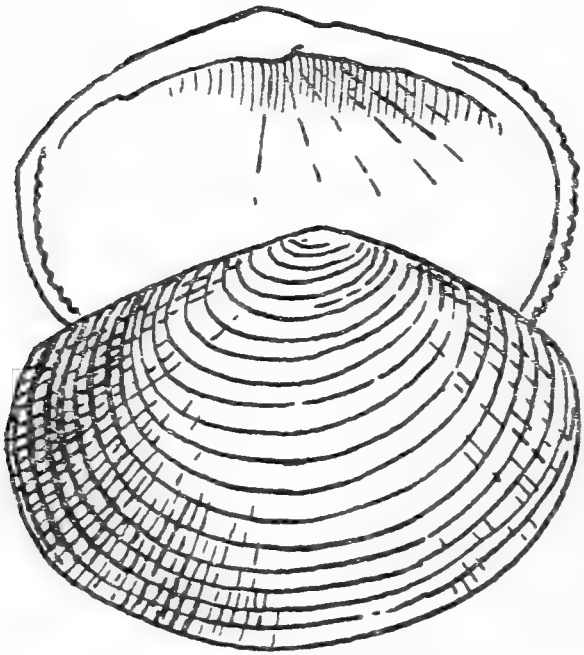


FIG. 61.—A fossil clam.

FIG. 62.—A fossil snail.

pressions. Both kernel and outer impressions must be saved, the latter to determine shape and ornament, the former because of impressions of internal organs and muscular marks.

In areas where the rocks have disintegrated, leaving fossils free, be sure to use the lens to detect microscopic species such as protozoa or young stages of the larger fossils. If microfossils are noted, brush debris and possible contaminating material from

a small area, then collect a small sack of the shale for washing and sorting in the laboratory.

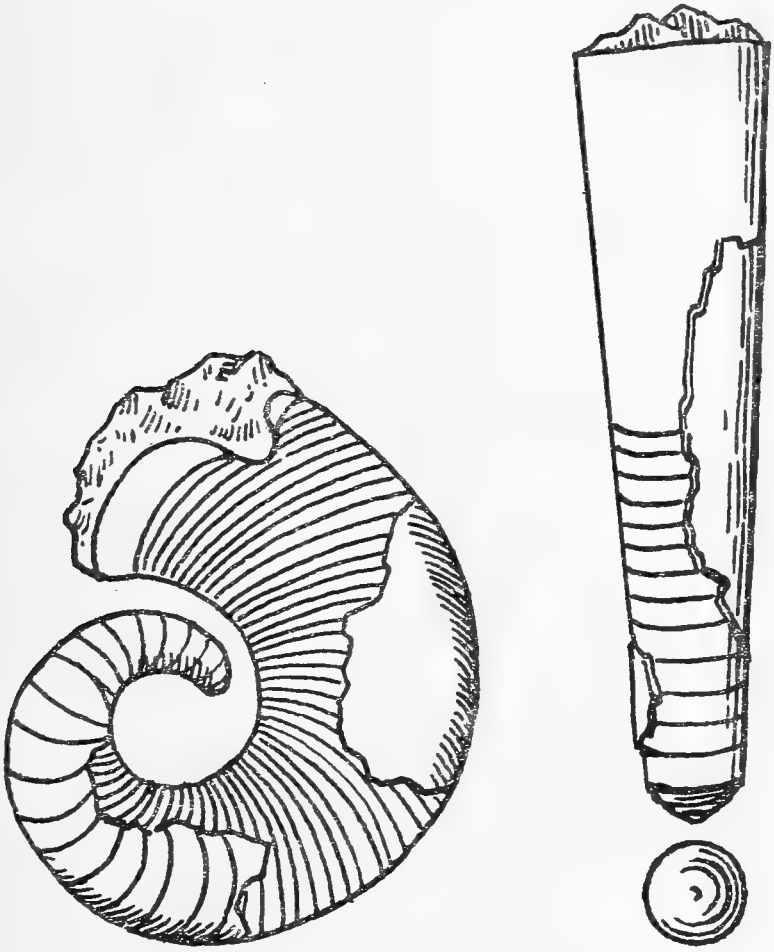


FIG. 63.—Two kinds of nautiloids.

Fossil plants.—Should traces of fossil plants be discovered on an exposed slope, first prospect the slope from bottom to top to locate the source of the fragments. Then open a quarry with pick, shovel, and bar if necessary, by removing an area of cover

down to the fossil layer. This permits removal of large slabs from the fossil-bearing layer and insures the possibility of getting complete specimens. Do not nibble at the outcrop; this only results in small, broken specimens. Split the slabs and lay the fossils out of the way. Reduce specimens to convenient size but do not attempt to clean them and do not attempt to trim them too closely. If the slabs are hard and durable, wrap them as they are, but soft clay and shale, in which fossil leaves often occur, should be wrapped well as soon as they have dried somewhat. Careful wrapping at the right time permits the specimens to dry out gradually and thus prevents excessive checking. Do not put shellac on any specimens.

Fossil leaf imprints come in counterparts like fossil invertebrate impressions. Be sure to save both counterparts but wrap each separately and then bundle the two pieces together so that they can be identified as one individual.

It is well to lay out the collected slabs at some distance from the quarry. Presently it will become apparent that the collection can be separated roughly into species. Thus the collector will see what is common and what should be looked for more carefully. The goal to be kept in mind is to obtain as complete a collection, represented by good specimens, as can be got at the locality. The fossil-bearing bed should be worked at several places along the outcrop for greater variety.

Besides the leaves mentioned above, fruits, seeds, and wood may be found in the same stratum. These are very important, and every slab should be examined with the lens for small seeds. It will help future identification to draw a ring around small specimens with a red pencil. Cross sections of fossil wood should

be examined with the lens to determine if cellular structure is preserved. If none is evident and the wood structure is completely obliterated by mineral substance, it is worthless. Specimens having cellular structure should be saved, in the form of examples measuring at least 2 inches on the side.

Broken specimens, if good, may be taken for mending in the

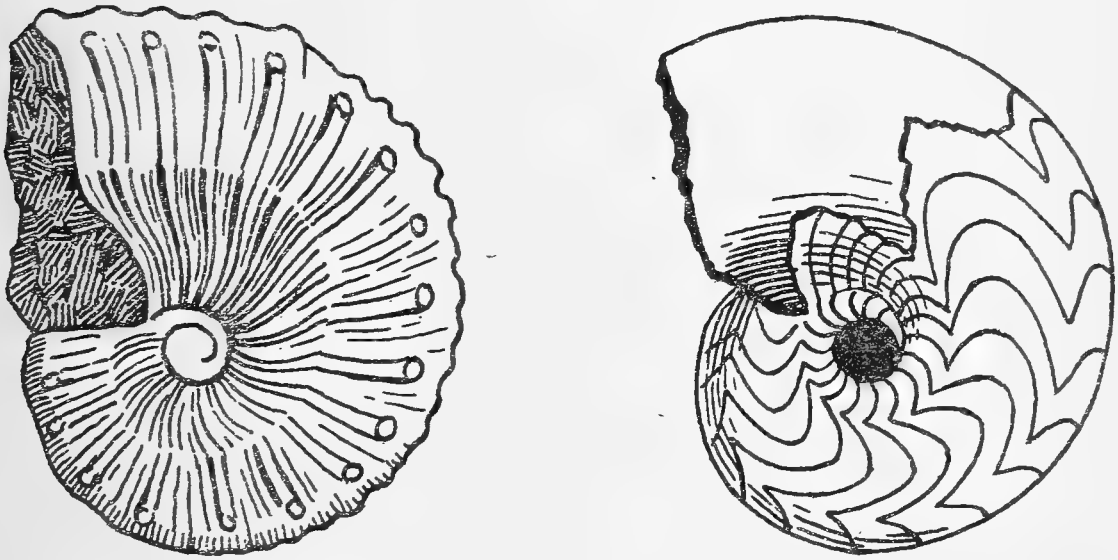


FIG. 64.—Two ammonoids.

laboratory. In the field hold the broken pieces together lightly and make marks across the break (but not on the fossils), which can be matched readily in the laboratory. Wrap the pieces separately but bundle the wrapped pieces together.

A label giving the exact location and stating the formation from which it came should accompany every specimen or collection when possible. However, some regions have not been studied enough to give this geological information. The collector then

can designate the fossiliferous layer by a letter or number, stating its relation to another conspicuous stratum at the collecting locality.

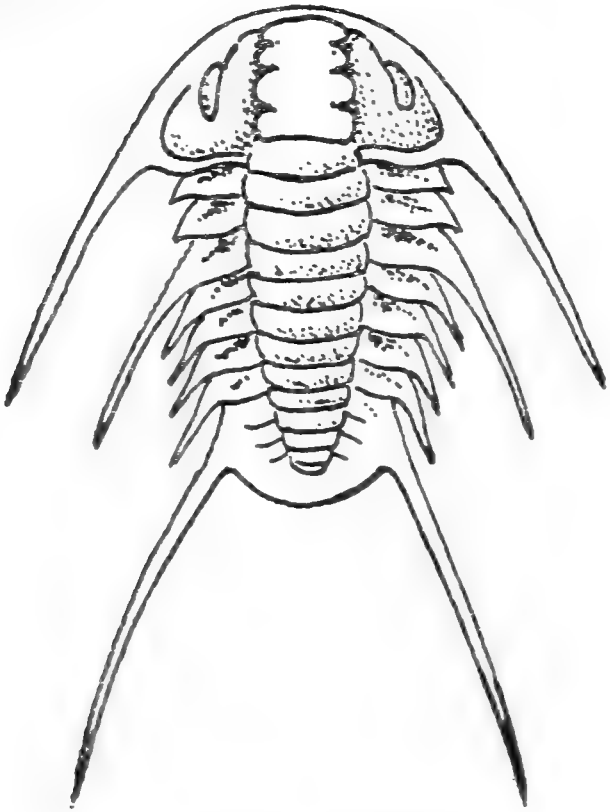


FIG. 65.—A trilobite.

In recording geographical data the location should be so specific that the exact collecting spot can be found at any time in the future. If location is by military coordinates state from what map they were taken. Latitude and longitude can be measured as coordinates from most maps. If locating from a village state distance from a prominent, permanent landmark such as the square, prominent church, or courthouse. Elsewhere make locations with reference to a prominent hill, mountain, or other permanent natural feature. Such locations are best given with azimuth bearing and distance from such major landmark, again stating from what map the reading was plotted.

Write all labels in *black* pencil on good stout paper. Pencil writing will not smudge or be obliterated if wet. Record the

position of the fossils in the geological section if possible, the geographical location, the collector's name, and the date. The last two items should not be overlooked because this information may be of considerable help in relocating a collection in case part of the label is damaged or not clear.

Another method is to number each specimen, entering localities and other details under the same number in a notebook. The locality number is then attached to each specimen by means of a small piece ($\frac{1}{4}$ to $\frac{1}{2}$ inch) of adhesive tape. Mark the tape in pencil or waterproof ink, preferably the former.

Large collections are desirable if the fossils are gathered for scientific purposes. Animals of the same species vary considerably; consequently, many specimens are needed to define a species properly. Besides the biological value of large collections, the additional material is available for exchange after study.

Packing requires, most of all, the exercise of common sense. Wrap all specimens so they will not rub together. Bundle together all specimens from the same zone or layer. See that all bundles and packages have adequate labels. If delicate material has to be packed with heavy specimens, pack the former in a stout box by themselves; then add to the main lot. Pack all bundles in stout wooden boxes, the stoutness of the box to depend on the weight of material to be shipped. Nail kegs are ideal because they are sturdy and not too heavy to handle even if full of rock. Do not use pasteboard boxes unless they are the only containers available, in which case tie them securely in three directions. Address boxes clearly and put on sender's name. Also number all boxes and keep a list of the contents.

Loose fossils can be packed in small sacks or kegs, using

sawdust, if possible, as a packing medium. If clay or shale has been collected for microfossils, the larger free specimens from the same zone can be packed with the clay or shale sample.

ROCK SPECIMENS AND ORES

One who searches for new occurrences of minerals and ores is called a prospector, and to this profession the civilized world owes a great obligation. Wherever man travels it is important that the rocks and ores of the area visited be collected for careful inspection. The prospector should be equipped with the following tools:

Flat, square-headed steel hammer.
Chisel, pick, or bar.
Packing material for specimens.
Notebook in which to record notes and make labels.

If recent excavations have been made in an area where you are working, visit them to familiarize yourself with the type of rocks exposed. Examine steep cliffs, as generally they are composed of firm rocks which are not likely to be deeply weathered. In some places is is almost impossible to get fresh material. Usually the softer external, or weathered, part of rocks can be removed by trimming with a hammer.

Before deciding on the specimens to be collected always take time to become familiar with the general rock exposure. Be certain that the material collected really represents the outcrop in color, mineral assemblage, and texture. Do not collect freak or unusual specimens until the typical ones have been obtained. If more than one type of rock is present collect from each, and

indicate on the labels their relative relationships and distribution. Often this is most conveniently done by means of a sketch. Always break specimens from the parent ledge, and not from the loose material nearby, unless you are certain that this was derived from the main ledge and is typical of it.

Do not collect specimens unless you know they are in place at the locality. Sometimes large boulders have been carried great distances from their true geological positions.

If weathered material is abundant and looks interesting, collect separate samples of this, but be certain to indicate on the label the relationship of this to the fresh rock.

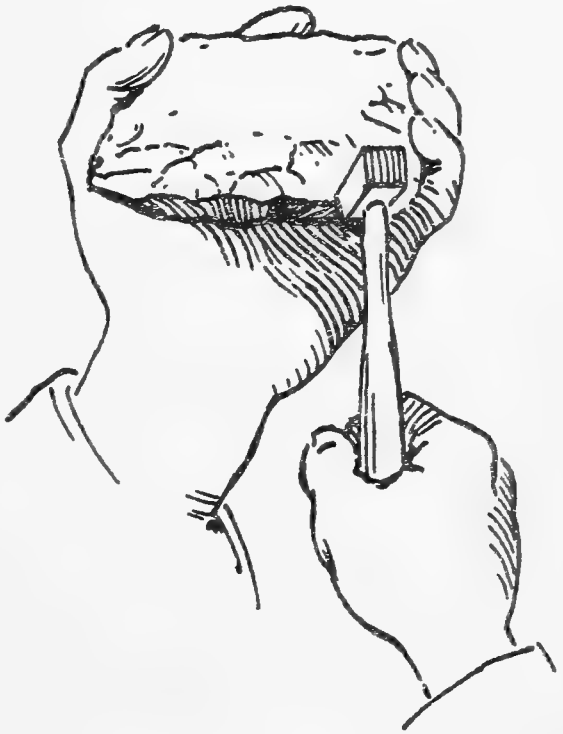


FIG. 66.—Shaping a rock sample.

Look for veins and dikes in rocks, contacts where bedded rocks are placed against crystalline, igneous formations, or where two different kinds of igneous rocks have a common contact. Unusual minerals often occur along such contacts. When large outcrops of ore minerals are found, collect several specimens at different places in order to have a good, representative sampling of the outcrop, and get one or more specimens of the rock which encloses the ore body.

Specimens should be regular in form, about 4 by 5 inches across and 1 to 2 inches in thickness. Avoid irregular pieces with sharp corners. With a little practice it is possible to trim a specimen to a convenient size by striking the edge nearest you with a flat-headed trimming hammer (fig. 66). A single hard blow usually knocks off sizable chips.

After the specimens have been properly prepared write a field label in black pencil or carbon ink, including the date, the collector's name, and the detailed location of the occurrence. Trust nothing to memory. Rivers, towns, mountain peaks, and other permanent landmarks are useful. Give exact distances and bearings, plotted from a map if possible. If a map is used, give a reference to it in the label. Fold the field label so that the writing will not become blurred by rubbing against the sample. Wrap each specimen with its label in paper to protect the samples from grinding against each other during shipment. This also keeps the label and the specimen together.

Always pack specimens tightly in strong containers so that they cannot move around. Do not overload a box beyond the weight that it can safely carry.

MINERALS

The collector must work carefully with mineral specimens so that they are removed free from man-made scars. When a mineral is formed in such a way that it is bounded by sharply defined flat surfaces, it is said to be a crystal. It is not always possible to obtain crystallized samples, but before effort is spent on massive or shapeless minerals, search carefully to make certain that no crystals are available.

Good specimens have been found in all types of rocks, but to

locate them may take keen observation and much careful searching. After selecting the most promising localities for work, take out as many good specimens as time will permit. Set these in a safe place, sort them over, and group them as to appearance and mineral association. Try to get as many different mineral associations as you can from each place. Do not pack the minerals or make final selection until your prospecting for the day or place has ended; then select only the most important.

If there are old, abandoned mines and quarries available, first visit the dumps and old ore piles. Broken up rock usually offers the best collecting; generally it is best to avoid large blocks of rock. Never enter an abandoned underground mine alone, unless you have had previous mining experience and are equipped with a good light.

In areas of volcanic rocks search for those containing cavities. Minerals often occur in these cavities. If the area is one of granitic or coarse crystalline rocks, search for dikes or veins that cut the rocks, as in these veins the minerals may be more coarsely crystalline. Look along any open fractures or joints present.

In limestones look for minerals which weather out differently from the rest of the rock. Search for solution cavities, and examine bedding planes and joints. Split shales and slates horizontally along the bedding to recover material between the layers.

Wherever two rocks of a different nature have a common contact, examine this carefully for unusual minerals.

Rivers and beaches are excellent places to get a preliminary idea of the types of rocks existing toward the headwaters of the drainage area to which they belong. Examine the gravels and the nature of the fine sand. Valuable deposits such as gold, platinum, tin, and precious stones often exist in heavy sands.

Many saline minerals occur in the salt deposits of arid and desert regions where natural seepages or old lakes have evaporated. Often well-crystallized minerals can be found under such conditions. Any deep depression should be examined. On deserts there may be a separating of the minerals by the wind; sometimes unusual specimens can be found exposed on the surface by this type of erosion.

Whenever possible, clean your minerals before leaving the locality where they were found. Washing them off in water will give you a chance to see their true color and beauty. Then sort them into different groups and select the best specimens for packing. It is a waste of time to retain a lot of poor samples.

Only preliminary trimming should be done in the field. Never attempt any trimming until the natural fractures in the specimen have been determined, as otherwise you may ruin a choice specimen. Always remove all loose fragmentary material before wrapping, since this can mar or ruin an entire specimen.

The best of each day's collection should be properly packed and carried back to the base camp. There they should be unpacked and spread out for comparison with the others obtained from that same locality.

In the packing of the final selection for shipment, old newspapers make excellent wrapping material. Wrap each specimen with its accompanying label separately. Fold the label so that the writing will not be blurred. If a specimen contains delicate crystals, cover them with a soft pad of shredded paper and then wrap with plenty of paper. Pack the individually wrapped material in a box sufficiently strong for shipment, and make sure that the contents plus packing completely fills the box.

METEORITES

Meteorites are the only objects we know that have originated elsewhere than on this earth, and they are therefore of great scientific importance. They are so rare that they are found usually by accident rather than by search. They may hit the earth anywhere, and no place is too remote for one. Meteorites contain nothing in themselves of economic value to man, but whenever one is encountered, it should be preserved for the large collections where studies are made of these unusual objects.

Meteorites are of two kinds—stone and iron. The latter are more easily recognized because of their weight and metallic character. Nothing similar to them in appearance exists in nature. It is unusual to find large masses of metallic iron scattered in remote places, and consequently any metallic object answering the following descriptions should be investigated.

The surface of iron meteorites is usually rusty brown and is dotted with holes or depressions which resemble thumb marks in putty. The sound produced by striking an iron meteorite with a hammer or rock is different from that produced by striking a large stone. Hammering on the surface only dents or batters the metal, and chips do not easily break off as they do if boulders are pounded. To remove a sample the collector usually has to resort to cutting with a hacksaw.

Determine the dimensions of the specimen and estimate its weight. If it weighs much more in proportion to its size than other rocks in the vicinity, it may be a meteorite. If your discovery is too large to collect for shipment to the museum, take a photograph and send it in, together with detailed information

as to location. The United States National Museum will be glad to advise and assist if possible in the recovery of such specimens.

Stony meteorites are more difficult to recognize. They are made up of heavy silicate minerals, and the presence of iron inclusions adds greatly to their weight. Therefore a stony meteorite is likely to be heavier proportionately than the other minerals or rocks in its vicinity. It will also have a different physical appearance from other rocks nearby. If a great number of similar pieces are found scattered over wide areas, they are probably not meteorites.

Freshly fallen stony meteorites are covered with a thin black crust of fused material, but the external surface of old ones is usually a rusty brown in color. The general shape is rounded without sharp corners, unless broken since their fall. The surface usually will be pitted with the "thumb marks" mentioned above under iron meteorites.

If a freshly fallen one is carefully chipped, the paper-thin crust is easily broken away, and the exposed interior will be light in color. Ordinarily there are inclusions of bright metal masses scattered throughout. If the meteorite is an old, weathered fall, the interior may be brown, but the presence of metallic inclusions usually is still discernible.

Collect the entire specimen wherever possible and submit it for study. If it is too large to handle easily remove a piece about the size of a silver dollar and forward this directly to the United States National Museum for identification. Be sure to include the location of your find and your name and address on the accompanying label.

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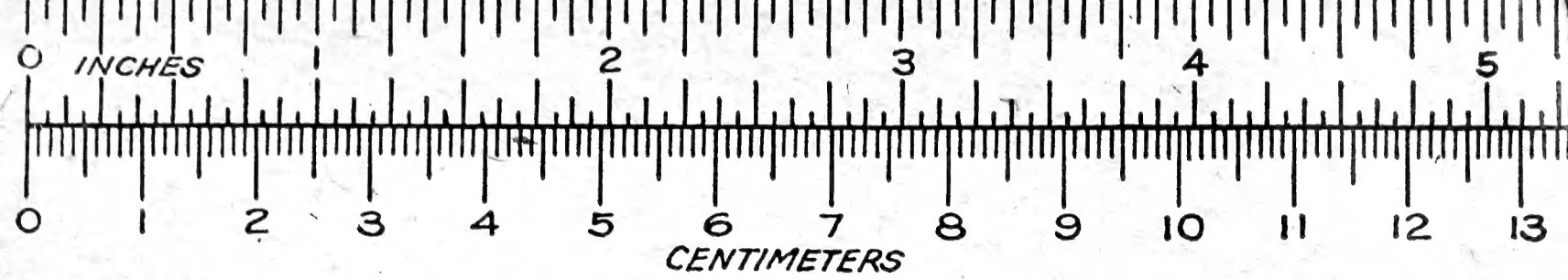
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