during the open season is that it provides safe breeding grounds for many ducks. Much of the land owned by gun clubs would now be reclaimed and under cultivation had it not been appropriated for private game preserves. It is probable that most of our home birds are reared on the same grounds where they are later shot. This being true, it is incumbent upon the sportsmen of the state and others who shoot to see that excessive hunting does not reduce the supply of native ducks to the danger point. The necessary stock of breeding birds is even more important than available breeding grounds.

The continued reclamation of marsh lands is undoubtedly reducing the available nesting grounds. Nor is there hope that the swamping of land for pasturing cattle, or the forming of reservoirs for the storage of water will keep pace with the destruction of breeding grounds. Shooting during the open season is also yet too severe to allow of maintaining the proper breeding stock of native birds, and only a smaller bag limit will remedy this adverse feature. It is, therefore, imperative that steps be taken to not only provide suitable nesting grounds to take the place of those used up for agricultural purposes but also to cut down the annual toll enough so that we may maintain our native duck supply at a maximum productivity.

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A METHOD OF CLEANING SKULLS AND DISARTICULATED SKELETONS

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(Contribution from the University of California Museum of Vertebrate Zoology)

ALTHOUGH skins of birds and mammals have been preserved by museums and private collectors for many years, the saving of complete skeletons has, to a large extent, been neglected. Anyone engaged in intensive scientific research will realize that it is almost impossible to find representative skeletons in even the larger museums, while the private collector seldom if ever saves this part of his specimens which might prove invaluable if made available for study. Indeed, comprehensive osteological research on recent forms is, except in rare instances, impossible.

It requires no argument to show that this is a deplorable condition. The vertebrate paleontologist is, of necessity, an osteologist; yet his work is curtailed at every point because of the lack of descriptions of Recent material or access to such material itself. In taxonomic studies, also, many questions are unsettled upon which the study of the skeleton would throw important light.

One of the chief reasons for the lack of complete collections of skeletons of existing animals,—as complete as such collections might reasonably be expected to be,—is that it has been found both unpleasant and laborious to prepare the bones in shape for comparison or study. Either maceration has been employed, or the bones have been boiled in a solution of lye; the former requires several months for completion, while the latter process is injurious to the bones, and to the hands of the operator. It is hoped that once the greater part of the unpleasantness and labor has been eliminated, the study of osteology will take the place it should among other branches of zoology.

It is with a desire to aid those persons who are likely to interest themselves in this fascinating study, as well as to furnish an apparently new cleaning formula for museums, that the following description of a process of removing flesh from skulls and disarticulated skeletons, is offered.

During the past four years the process here described has been subjected to continual test, and has been proved free from all the objections raised to maceration or cooking in other solutions. It is impossible to eliminate all odor from dried or drying flesh, but the disagreeable stench from maceration tanks is avoided. The "chalking" of bones, as occurs at times with even the mildest alkali, is also eliminated; and, instead of the solution injuring the hands, it acts as a disinfectant and so prevents infection from the tissues handled. In fact, no objectionable results have been observed.

The speed with which skeletons and skulls may be cleaned is another argument for the adoption of this solution. As high as forty-four skulls (*Peromyscus*) have been completely cleaned in an hour, after the proper treatment, while twenty-five is an average rate. With skeletons of small birds and rodents, from ten to thirty can easily be cleaned in a single hour.

SOLUTION I

One part, by bulk, clean phenol or carbolic acid (liquid 90%, commercial)
Three parts clean ammonia (28% commercial)
Ten to fifty parts of clean water (varying in amount according to the degree to which the flesh has dried)
(Make up as needed for immediate use)

SOLUTION II

¼% to 1½% solution of hydrogen peroxide (commercial)

To clean disarticulated skeletons.—Taking a fresh carcass of a bird or mammal, leave the greater part of the flesh on the bones. Do not remove any of the flesh from ducks, rabbits or smaller animals, but carefully tear away the skin and remove the entrails. This lack of preliminary treatment is advisable because the processes and condyles are less likely to be broken after the meat has become tender. With geese, foxes, or larger animals, it may be found advantageous to remove the larger bodies of muscle, such as those found on the breast of the goose and along the back of the fox; but even in these cases the tongue and eyes should be left in place.

Place the skeleton in Solution I and stew (at almost the boiling point) until the meat is tender and can be detached from the bones readily. As *boiling* drives off the ammonia and phenol, it should be avoided; and even at a more gentle temperature the flesh should be watched and if it is found that the flesh becomes bleached, as a result of the action of carbolic acid alone, more ammonia should be added.

When the skeleton has been thoroughly cooked, pour the solution into another retainer, wash the bones in clear water, and place them on the fire again to simmer. This will remove the greater part of the ammonia and phenol which is in the meat and remove much of the dark color. Now remove most of the meat with the fingers and a scraper and place in Solution II. In this the bones should stew until those that are free from grease are of a clear ivory color. Now complete the cleaning by brushing and scraping, and place in the sun to dry.

With small skeletons of birds and mammals, a great number may be cooked at one time by placing the individual specimens in cloth bags. When this is done the first cleaning may be dispensed with, and it will be found that a

stream of water will clean the bones if they are first placed on a fine-meshed screen.

Notes.—Dry flesh requires less cooking than fresh. If practicable, dry before cooking. In shipping undried skeletons dry cornmeal, in quantity, will keep the meat from becoming putrescent.

Sheep, deer, and goat skeletons are so easily cleaned after cooking for considerable time in water alone that no solution should be used.

Cleaning skulls.—The individual age of the skulls, as well as the genus, has much to do with the length of time they should be stewed. The skull of an adult *Peromyscus* will not be injured by a process which would disarticulate the skull of a juvenile *Neotoma.* It is necessary, therefore, to group each genus by itself; and in one genus to separate the adults from the juveniles.

The next step should be the removal of the brains. This should always be done in the field while the skull is still fresh, as it can then be done with greatest ease and least danger of injuring the bones. If this has been neglected the skulls should be thoroughly soaked in warmed water and the brains removed with a bent wire or a small scraper (such as is figured in Hornaday's "Taxidermy"). A half ounce "infant rectal" syringe is also very useful. The nozzle should be filed down until it is thin-walled so that it may be inserted in the foramen magnum of a small skull. By holding the barrel of the syringe between the second and third fingers of the right hand, close to the palm, nozzle facing outward, and the ring of the plunger over the first joint of the thumb, one hand can operate the syringe while the other holds the skull under water. Care should be taken when water is forced into the brain-case, or the bones will be wrenched apart. If the brain is thoroughly softened and broken up, the greater part of it can be *sucked out,* instead of being forced out. If this is done there will be no danger of disarticulating the posterior portion of the skull. If the brains are not removed before cooking, they may expand and force the brain-case apart.

If each skull has a heavy, non-soluble tag attached, with the number or identifying mark written thereon with waterproof ink, many skulls may be cooked loose in one container. Higgins' Eternal Ink on *imitation* parchment paper has been used with success. Each group of skulls should be placed in separate, clean, unrusted granite-ware or aluminum pots and covered with Solution I. These should be cooked as directed for skeletons, trying several skulls at short intervals to observe progress. As soon as done, wash, cook in water, then in Solution II and finally clean.

All clinging flesh should be removed by using a bone scraper (not too large), a tooth brush (previously dampened to soften it), and the syringe. With the exception of the juvenile skulls, which can not be cooked so long, it will be found that the meat will become so softened as to be readily *sucked* off by using the syringe as directed for the brains.

Some experimenting may be found necessary in adopting this method, but it should not prove difficult to master, as these directions have been used in manuscript form by persons without previous experience or personal instruction.

This process has been employed in the osteological laboratory of the California Museum of Vertebrate Zoology for the past four years, and many thousands of skulls and many hundreds of skeletons have been prepared, all with uniformly satisfactory results.

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