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TECHNIQUES OF COLLECTING MICROVERTEBRATE FOSSILS

BY

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INTRODUCTION

ALTHOUGH the collecting methods reported in this paper are not new to science, their application on a large scale to the study of Cenozoic stratigraphy and fossils has not heretofore been described in detail. The following is an account of the techniques developed and used in a study (1936–47) of unconsolidated, or loosely consolidated, nonmarine sediments in western Kansas and northwestern Oklahoma.

A great many invertebrate and vertebrate fossils were recovered by the use of these techniques from an area that had been previously considered nearly barren. Each technique is adapted to certain types and conditions of matrix.

Old quarry dumps derived from old filled stream channels by the removal of sand and gravel were available for careful and systematic sifting for the removal of the small fossils.

Prospecting for new sites followed chiefly the procedures described by Camp (Camp and Hanna, 1937, pp. 1–5). In addition, the members of the field party crawled over most of the exposures looking for bone fragments of small vertebrates. The presence of two or three such fragments in any zone was considered sufficient to justify intensive work.

Failure to find any specimens by going over an exposure once on hands and knees did not indicate that the area was devoid of fossils. Outcrops on the Borchers Ranch in Meade County, Kansas, extend across parts of two township sections, and more than 50 feet of Pleistocene silts and clays are exposed. These exposures had been examined carefully in 1936 and no remains of vertebrates found. It was impossible to believe that such good outcrops could be barren, so they were repeatedly examined. On July 21, 1938, a few fragmentary bones of rodents were located. Subsequently, this deposit yielded, in 1939 and 1940, the remains of amphibians, reptiles, birds, and mammals. More than 350 complete or fragmentary bird bones and twenty-two different kinds of mammals, seven of which were new to science (Hibbard, 1941 and 1942), were obtained.

One of the best indications that a zone contains remains of small vertebrates is an abundance of land and fresh-water gastropods. There are exceptions, however, for no invertebrates were found in the zone containing the Borchers fauna. No zone containing gastropods has ever been worked in which there have not been associated remains of vertebrates, although the vertebrate remains were at times so rare that it was not profitable to work the deposit.

In two areas where stratigraphic correlations were essential and where no fossils had been found, the ant hills built on the silts were carefully examined and invertebrates and teeth of fossil microtine rodents were recovered. The finding of this evidence resulted in our removal and washing of large quantities of the silt from the formation near the ant hills. The rodent jaws recovered from the silts allowed correlations to be made.

PROCEDURES

Sifting

The procedure followed in screening sand and gravel when a new quarry is opened differs somewhat from that employed at an old site where dumps of matrix are to be sifted. In sifting old quarry dumps which consist chiefly of fine sand and gravel, three sizes of screens are needed. A convenient size frame for the two coarsest screens is one approximately 3 feet wide by 8 feet long constructed of 2-by-4-inch lumber. The width of the frame will be determined by the width of the available wire netting. One of the frames should be covered with 1-inch hexagonal mesh poultry netting and the other with half-inch hail screen. The material which does not pass through the coarser of these two screens accumulates at the base of the frame; it generally contains horse teeth, carpal and tarsal elements, and the like. The material which passed through the large-mesh screen is put through the second screen. The frame for the third-size and finest screen is best made from 25-pound dried-fruit boxes with the wooden bottoms replaced by 16- or 18-mesh screen wire. The 16-mesh screen is preferable in ordinary sand. A double handful of the sand that passed through the medium-sized screen is placed in one of the small boxes and sifted gently onto a white towel. The contents of the sieve as well as the sand on the towel are examined for fossils which are removed with tweezers. It is from the concentrate on the sieve that most of the small rodent and shrew jaws, as well as small isolated teeth, are recovered. There is some breakage of specimens in this procedure, but the number of good specimens recovered is far greater than the number of specimens taken in ordinary field procedures. In order to prevent disintegration of the fossils the matrix must be dry before sifting.

In working a new quarry site the overburden is removed down to the fossil zone. The procedure used in removing the large vertebrates is the same as that used in any quarry where the enclosing matrix is clay and silt, or sand and gravel. If the matrix is silt or clay, it is removed from the quarry and dried for washing. If the matrix is sand and gravel, it is spread on tarpaulins to dry and sifted at the quarry. In most cases it is not necessary to use the coarser screens at a new quarry site because the large pieces of scrap bone and any silt or clay from lenses are removed before the sand is spread to dry.

Do such procedures pay? One quarry in Meade County, Kansas, was worked in 1943 by the ordinary methods of collecting, that is, the removal of all fossils encountered while digging out the fossil-bearing matrix. A careful watch was kept for small material. The remains of mastodon, camel, horse, dog, peccary, and sloth were recovered, but only a single beaver tooth was found. The sifting technique was not used in 1943, since it was difficult to obtain help during the war years. The following summer we were fortunate in having Dick Rinker, an inexperienced grade-school boy, to sift and pick over the material removed from the quarry. He recovered numerous jaws, teeth, and bones. The mammal bones were parts of shrews, moles, skunks, a badger, a marten, rabbits, ground squirrels, beavers, gophers, pack rats, and two kinds of mice. The mammalian fauna alone for this locality was more than doubled (Hibbard and Riggs, 1949).

Washing

Methods of washing matrix to obtain fossils may vary from the use of a small sieve in a wash tub or laboratory sink to an extensive field setup. Much of the credit for the washing process we used goes to Harry Jacob, a chemical engineer, who as a student at the University of Kansas, was a member of our field parties for a number of years. He developed this intensive washing method at the time our party was recovering snails from the Rexroad formation for the late Frank C. Baker. Jacob carried sun-baked clay which contained snails from the Rexroad exposures to a creek in order to remove the gastropods from the clay more easily. He constructed the washer described below and that day recovered several hundred snails and some vertebrate remains. It should be emphasized that the clay containing the specimens was perfectly dry. Experience has shown that damp silt or clay when placed in water will ball and fail to break down.

The washer is a frame with solid ends but with the bottom and lower part of the sides consisting of screen wire (Pl. 3, Fig. 1; Pl. 4, Fig. 2). The open sides allow the water to flow through the washers, thus removing most of the fine particles of matrix. The washer ends are constructed of two pieces of 1-by-12-inch lumber 18 inches long, and the sides consist of two pieces of 1-by-4-inch lumber 2 feet long. Twenty-four-inch, 16-mesh screen wire is used. The wire is stapled to the two ends, extending to within two inches of the top of the end on each side. The sides are then nailed onto the ends. The screen wire is then stapled onto the inner side of the 1-by-4-inch sides. At least six or seven of these washers are needed for a crew of five.

In order to recover the smallest snails, snail eggs, and oögonia of *Chara,* which were found with the Jones fauna, a special washer was constructed of fine-mesh copper screen. Only a small amount of matrix can be run through a washer of this type in the course of a day's work.

All types of matrix containing fossils will be found in the field. A fine sand with a high concentration of fossils is the best type of material for washing, since it does not have to be dry before being placed in the water. The only matrix of this type I found was the fine calcareous sand that contained the Jones fauna (Goodrich, 1940; Hibbard, 1940, 1942, and 1949; Tihen, 1942).

All types of matrix other than sand must be thoroughly dry before they are placed in the water. Furthermore, great care must be taken in removing, transporting, and drying the matrix to avoid breaking or shattering the fossils in it.

After removing the overburden above a fossil-bearing zone, the material containing the fossils is allowed to dry. The drying of the fossil zone allows the enclosed fossils to harden and permits the removal of larger pieces of matrix. Dry matrix transports in better condition than damp or wet matrix. When the fossil-bearing matrix is dry, large pieces are removed and placed in clean, loosely woven sacks. Do not shake down the sacks, but fill in around the large clods with the smaller pieces which have broken loose. These small pieces may contain the tip of a jaw or part of a bone which has been broken in removing the larger pieces. When the sack is full, it is tied and labeled (Pl. 1, Fig. 2). The sack is then carried to the truck by two persons, one on each end, or in a sling, so as not to crush or disturb its contents more than is necessary, and carefully loaded in an upright position. At least twenty sacks of matrix should be removed from a zone for a fair sample. The sacks are then hauled to a building where they can be stored, off the ground, in order to allow as much air as possible to circulate around them. If the deposit is known to contain fossil vertebrates in workable numbers, if the zone is dry enough to work, and if storage space is available, three or four tons of matrix (sixty to eighty sacks) should be collected.

To speed the work and the drying process, a number of drying frames may be used. These frames (Pl. 4, Figs. 1 and 2) are made out of 2-by-4-inch lumber, approximately 3 feet wide, 12 to 16 feet long, and about 3 feet high. They are covered with hail screen, and canvas is spread over the wire. Three or four sacks of matrix are then emptied onto the canvas to dry. The frames must be watched carefully, and in case of rain, all of the matrix must be resacked and moved under cover. I have conveniently used four to six of these drying racks. Two large tarpaulins are spread on the dry ground nearby, so that the matrix when dry may be removed from the racks to the tarpaulins to await washing. A crew of five men is able to wash and sort six or seven sacks of matrix in one day; one to wash, two to fill and dump washers, and two to haul fossil-bearing matrix to storage in the forenoon and sort the dried concentrate. This division of work will vary, of course, according to the type of matrix and the number of fossils contained.

A large area needs to be cleared of vegetation (an old abandoned road is preferable), so that one hundred or more towels can be spread out on the ground. The towels used were of tightly woven cotton. Several large pebbles must be placed along the sides of the towels to keep them from being blown away (Pl. 3, Fig. 2; Pl. 4, Fig. 1). Another method of securing the towels is to build a special drying rack for them. Small rings are sewed into the towels and they are fastened to the rack by means of snaps. The fossil concentrate is placed on the towels to dry before being sorted.

A small shovelful of the matrix to be washed is placed in the washer which is then set in a stream of flowing water 6 to 8 inches deep. The dry matrix absorbs the water rapidly, and as the air is driven out, it breaks down, releasing the fossils. The flow of the stream helps to carry away the fine particles and leaves the water clear. After the matrix has broken down, the washers are slowly raised a few inches in the water and then lowered again so that the fine sediments are carried away by the current (Pl. 2, Fig. 1). The moisture makes the fossils very fragile. If a jaw is noticed, the washer is lifted clear of the water and carried to the bank, where the jaw is transferred with the greatest care to a special drying rack. The washer is then returned to the water. The person attending the washers passes from one washer to another, slowly working out the fine sediments until only the larger material is left. The washer is then lifted out of the water, drained, and taken by another person who dumps the contents on a towel; the washer is then refilled. It usually takes three hours for material on the towels to dry sufficiently for sorting. The length of time for drying depends on the temperature and humidity of the air. After forty or fifty towels are filled, they may be carefully moved to a dry spot to speed up the process of drying. Two people should lift each towel so the contents will not be disturbed.

Matrix, especially calcareous silt which has a high content of calcium carbonate, breaks down slowly. Many times a marl containing abundant fossil material will not break down in the water because of the cementing effect of the calcium. Some types of matrix, especially clays, will break down only after they have been thoroughly dried. The specimens are removed from the towels with tweezers (Pl. 2, Fig. 2) or with a moist camel-hair brush. When a jaw, maxillary, or any small fragile specimen is found, it is wrapped in cigarette paper, moistened, and when dry placed in a vial. It is wise always to have at hand a thin solution of alvar with which to treat a fragile, dry specimen. This often saves many hours of work in the laboratory.

The results of a day's work for a crew of five depends upon the abundance of fossils and the type of matrix, but the recovery of three to seven jaws with teeth each day is considered a good average. This may seem to be a low yield, but it should be emphasized that for every complete jaw recovered, numerous fragmentary rami, isolated teeth, and other skeletal elements are found which are also of considerable value. The following is quoted from notes on the Cudahy fauna: "party of five, June 24, 1942, washed 5 sacks, got only a muskrat tooth; June 25, 158 towels out by 10 o'clock, found only a shrew jaw without teeth; June 26, 4 shrew jaws with teeth; June 27, a complete microtine jaw with two teeth and two fragmentary jaws with M_1." The exceptional day was June 14, 1947, when a crew of three recovered more than one hundred jaws, many of which contained complete dentitions. These fossils were washed from five sacks of sandy silt taken from a Pliocene stream deposit.

It is not necessary to sort the fossils in the field. The concentrate from the towels can be placed in strong tin pails for shipping and will transport in perfect condition. As a rule it is easier to get the material sorted in the field than in the laboratory.

One of the important procedures in collecting fossils by the washing method is to establish a base camp where there is an abundant supply of running water. A crew can easily work within a radius of 150 miles from a base camp if the fossil zones which are to be worked have previously been located.

RESULTS OF WORK

From 1936 to 1942, the following faunas were collected in Kansas, chiefly by the washing method: Jones fauna (Hibbard, 1940); Borchers fauna (Hibbard, 1941); Rexroad fauna (Hibbard, 1941*a*); Rezabek fauna (Hibbard, 1943); Cudahy fauna, Tobin fauna, and Wilson Valley fauna (Hibbard, 1944).

The abundance of fossil material recovered by the techniques described in this paper clearly demonstrates that the remains of amphibians, reptiles, and birds are not so rare in continental Cenozoic deposits as was once assumed. In most cases large numbers of members of a single species were obtained making possible the study of individual and age variations. These faunas have contributed greatly to our knowledge of the late Cenozoic life of the High Plains. Many of the forms have proved useful in the correlation of deposits.

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EXPLANATION OF PLATE I

FIG. 1. Sifting of an old quarry dump (locality 2, Meade County, Kansas, see Hibbard 1949, map 2) to recover small vertebrates. Note the three sizes of sifters.

FIG. 2. Collecting of large pieces of matrix containing fossils, which will be transported by truck for washing.

PLATE I

FIG. 1

FIG. 2

PLATE II

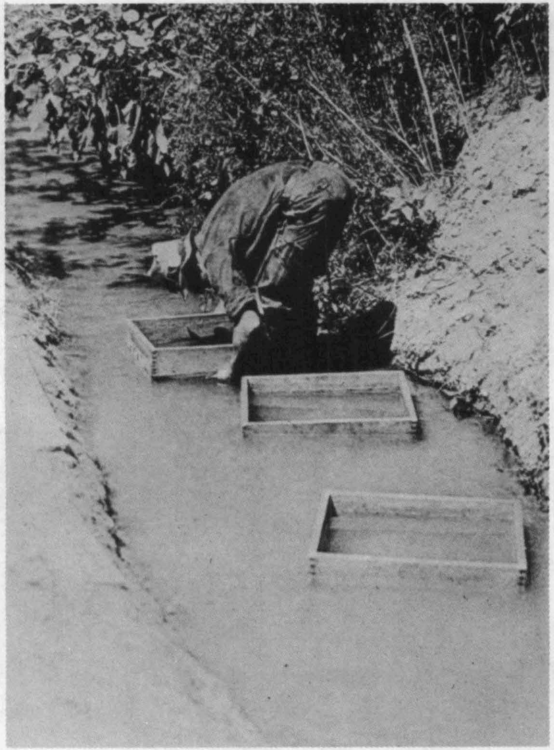

Fig. 1

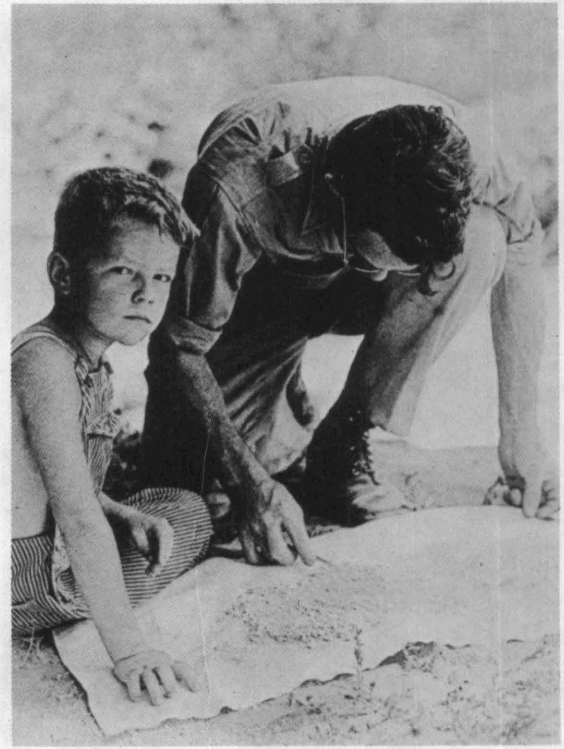

Fig. 2

EXPLANATION OF PLATE II

FIG. 1. Washing of dry matrix to free the enclosed fossils. Harry Jacob at the washer.

FIG. 2. Sorting of dry concentrate after washing.

EXPLANATION OF PLATE III

Fig. 1. Dumping of concentrate from the washer onto a towel to dry.

Fig. 2. Close-up view of the concentrate from a shovelful of matrix.

PLATE III

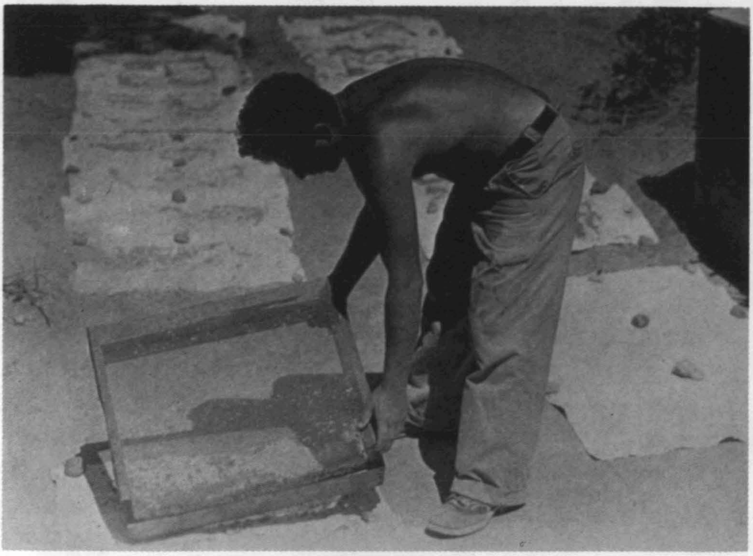

FIG. 1

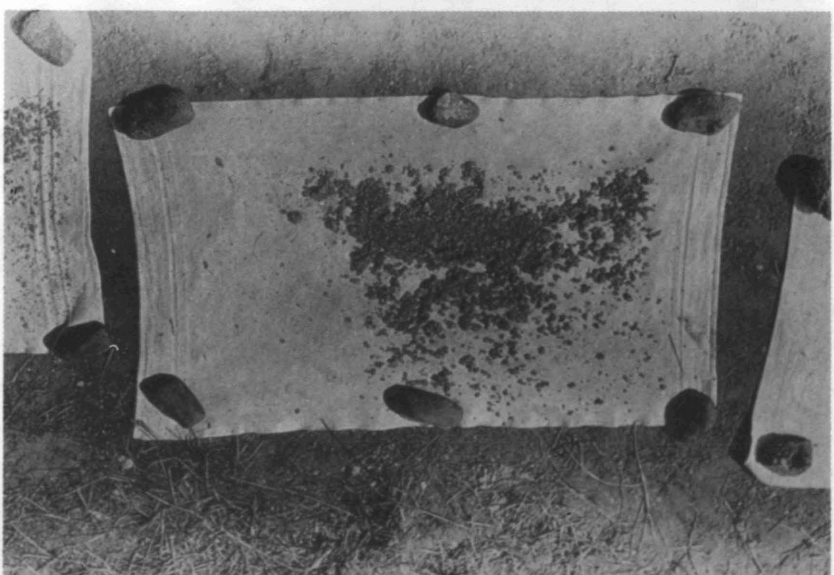

FIG. 2

PLATE IV

Fig. 1

Fig. 2

EXPLANATION OF PLATE IV

Fig. 1. Drying racks with matrix from the quarry and the concentrate on towels. Person in background is filling washer with dry matrix.

Fig. 2. Close-up view of drying rack with matrix. Tarpaulin in background with dry matrix to be washed.

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