TECHNIQUES IN PROSPECTING FOR TERRESTRIAL MICROVERTEBRATES

ASHOK SAHNI*
Department of Geology, Lucknow University, Lucknow

ABSTRACT—The techniques employed in investigating fluvial deposits for vertebrate remains are broadly explained. Attention is drawn to the fact that fossil collections have often tended to be biassed in favour of the larger fossils because these have usually been handpicked and are thus not fully representative of the contemporary fauna since the smaller vertebrates tend to be excluded. Screened samples obviate this possibility and thus yield a fauna truly representative of the times. Attention is further drawn to the selective preservation of fossils giving an incomplete picture of actual conditions, as in the case of the Sivaliks whence, by virtue of their prominence, the larger mammals and reptiles, etc. have formed the bulk of the collections made in the past.

Sedimentary environment and contemporary life characteristic of stream-channel deposits and flood-plain deposits, and distribution of vertebrates is discussed.

INTRODUCTION

The technique of screening and washing fossiliferous sediments results in the recovery of a sample representative of the contemporary fauna, whereas in the procedure usually adopted for collecting vertebrates, the smaller specimens tend to be overlooked. In the latter case such a selective process of sampling leads to the recovery of a fauna biassed in favour of the larger vertebrates. This is particularly true of Mesozoic vertebrate localities where emphasis was often laid on the recovery of dinosaurs, so that the smaller elements, the mammals, remained undetected. Modern screening techniques widely applied in Cretaceous sediments of some of the western States of North America, have brought to light a prolific microvertebrate fauna consisting of the smaller faunal elements. In the case of the Tertiary as well, this method has been successfully employed in obtaining specimens of small late Cenozoic vertebrates (Hibbard 1949). In the context of fossil vertebrate collections made in the past, it may be emphasised that the application of this technique to the Sivalik system is likely to produce a new component in the fauna consisting of the dimunitive lower vertebrates and mammals such as rodents, bats, small primates and carnivores.

The sample obtained by the process of screening can be used in the reconstruction of the palaeo-community. A study of many

* Pool officer, C. S. I. R.

such communities, separated temporally and spatially, would record migrations and emigrations of community members, changes in their relative frequency of occurrence and the dominance of certain groups. Moreover, climatic conditions prevailing at the time could also be inferred by comparing the ecological amplitude of the component members with the geographic ranges of their present-day descendants.

TECHNIQUE

Charles Moore is believed to have been the first, in the early nineteenth century, to have used the screening and washing technique to obtain an assorted collection from fossiliferous sediments. Hibbard (1949) was so successful in collecting small late Cenozoic vertebrates from Kansas, that the technique has become an accepted standard and has since been applied by a number of workers (Clemens 1963, 1966, Estes, 1964, Mckenna 1965, Sloan and Van Valen 1965, Sahni 1968).

Mckenna (1965) discusses the utility of the screening and washing method and describes the construction of the screens employed in this procedure. These are essentially wooden boxes in which the floor and the two sides are made of copper screen wire meshing of size 14×18 meshes to the inch, (figure 1).

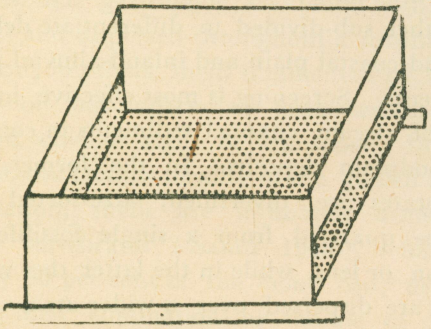

Figure 1. Washing screen used for isolating microvertebates from the matrix.

The matrix is first quarried and packed into burlap (gunny) bags. The material is then washed preferably in a shallow stream or, if this is not possible, in a pond or lake. The advantage in stream washing is that running water combined with manual agitation of the screen, quickly eliminates the sand and silt. Sometimes, when the clay and silt content is high, and grass roots are present, the matrix tends to form nodules In this case, the screens are soaked in water, washed, dried and the procedure is repeated till most of the clay and silt has been washed away. The concentrate left in the washed screens consists of microvertebrates (teeth, vertebrae and other bone elements) grit, iron or limestone concretion.

The technique is an efficient method of obtaining the smaller specimens, i.e., those larger than mesh diameter. If the deposit happens to contain a large quantity of fresh water molluscan shells, these can be dissolved by the use of dilute formic acid without damaging or etching the contained bones.

THE SCREENED SAMPLE

A sample is obtained from the screened material by visual sorting. Some faunal members in the sample may not be represented in the same proportion as they were in the contemporary fauna. Certain factors contribute towards over-representation or under-representation, and sometimes even in the complete absence of particular groups. For example, considering the problem in its wider aspect, the existence of insects can be inferred from the presence of insect-pollinated angiosperms, yet the record of insects, except for some lacustrine and resin deposits, is extremely meagre in fluvial sediments. Those members of which the habitat is farther away

from the basin of deposition (stream channel in the case under discussion) will tend to be under-represented. Members proximal to the depositional basin will be present in relatively greater numbers, and even fragile bones are more likely to be preserved when the distance over which they have been transported is small. The presence of dinosaur egg fragments in the Campanian (Upper Cretaceous) fluvial deposits of the Judith River Formation of north central Montana indicates that the eggs were laid in close proximity to the river bank (Sahni 1968). The representative nature of the fossil sample can also be judged by the ratio of carnivores to herbivores. In general, the proportion should be similar to that found in natural animal populations where the carnivores are relatively fewer than the herbivores.

SELECTIVE PRESERVATIONS OF ORGANIC REMAINS

The most durable and also the most important elements from the diagnostic viewpoint found in screened samples are teeth, particularly those of mammals. In a number of late Cretaceous and early Palaeocene sites of Montana studied by the author, it was noted that fish were well represented by scales, vertebrae and, rarely, by cranial elements; amphibians by maxillary elements bearing broken teeth, and fragments of limb bones; salamanders by jaws and robust vertebrae (usually the atlas) ; aquatic reptiles by skull fragments and vertebrae ; terrestrial reptiles in the Mesozoic by isolated, shed and worn teeth; lizards by jaw fragments and vertebrae ; and turtles by plastron and carapace bones. Except for a few damaged and eroded limb bones, mammals were only represented by teeth.

Mammals are of special interest not only in the Mesozoic because they are so rare, but also in the Tertiary where they constitute a dominant and varied group. But for the exceptional occurrence of skulls in the Djadochta formation of Mongolia, the majority of Mesozoic mammals are represented by isolated teeth with an average length of not more than 2-3 mm., the types represented being herbivores, insectivores and omnivores. In the Tertiary, a pronounced increase in the diversification of mammalian Orders took place. Some members of the Tertiary mammalian Orders are well represented and this is mainly a result of the nature of their habitat ; others such as the Primates tend to be under-represented in the sample because they belong to a distal arboreal community, i.e., a community distal to the main area of deposition. Though bats and birds also belong to the same community, their fossilisation and preservation is even less likely because of the fragile nature of their skeletons.

DETERMINATION OF SEDIMENTARY ENVIRONMENT

The sedimentary record has to be closely examined in order to determine the environment in which the vertebrate remains were deposited. The vast majority of terrestial vertebrates are found in fluvial sediments. These can be further sub-divided to differentiate deltaic, lowland-coastal plain and inland-alluvial plain sediments. Screening is most effective in the case of stream channel sediments in contrast to floodplain deposits. In the former, the vertebrates are diversified, size-sorted and can be quarried from a single fossiliferous horizon or lens, while in the latter the vertebrates are dispersed over a wider area. The position is summarized in Table 1.

TABLE 1—Differential preservation of vertebrates in fluvial (stream channel and flood plain) deposits.

Stream Channel Deposits	*Floodplain Deposits*
1. Vertebrates are taxonomically varied and representative of the contemporary community.	1. Vertebrates consist of individuals and are not representative of the contemporary community.
2. Size-sorted.	2. Unsorted.
3. Consist of isolated teeth, jaw fragments, vertebrae and broken limb elements.	3. More complete specimens; skeletons more common.
4. Concentrated in a single bed or lens.	4. Widely dispersed.
5. Accumulated over a long period of time.	5. Accumulated rapidly.
6. Sediments dominantly arenaceous.	6. Sediments dominantly argillaceous.

ASSOCIATION OF FRESHWATER MOLLUSCS AND PLANTS WITH VERTEBRATE REMAINS

Freshwater molluscs and plants are often associated with the remains of vertebrates. Both constitute important indicators of the environment prevailing in the basin of deposition, the former constituting evidence of stream or lacustrine conditions. In some cases, pelecypods and gastropods are found well preserved and dispersed throughout a fossiliferous horizon; in others, shells fragmented by transportation accumulate to form lenses, and exhibit obvious signs of transport. In the Clambank Hollow locality of the Judith River Formation, shells are intimately associated with vertebrates (Sahni 1968), forming nearly 30 per cent of the bone bed, necessitating their elimination by the use of dilute formic acid.

Plants are also valuable in determining the prevailing climate. Because of the greater mobility of pollen, palynological studies may be indicative more of regional than local conditions which are best inferred from the macroflora.

THE SIVALIKS

The Sivalik system assumes considerable importance in view of its vertebrate content yielding evidence of ecological conditions. The sediments are fluvial in nature and most of the vertebrates recovered so far have been from floodplain deposits. Various questions concerning the paucity of primates and carnivores posed by M. R. Sahni and Ehsanullah Khan (1959) are best explained in the perspective of the habitats of these animals and their frequency of occurrence in comparison

with that of their counterparts in recent natural populations. This aspect needs elaboration. Thus tree-dwelling members of a distal community are less likely to be preserved, and the fossil record of primates, bats, lizards and birds therefore remains incomplete. Carnivores, particularly the upland types, i.e., those living far distant from the basin of deposition, are also not likely to be well represented. On the other hand, the large herbivores which constitute the bulk of the Sivalik vertebrates, had a better chance of preservation because of the proximity of the area of deposition to their normal habitat. Of the enormous mass of vegetation that must have supported such a prolific vertebrate fauna during Sivalik times, only a few and fragmentary plant fossils have been found. The paucity of macrofloral remains is not surprising and is characteristic of arenaceous, stream channel sandstones as disintegration of leaf structure occurs rapidly. Some tree trunks have, however, been found preserved and probably were not transported over long distances. Floodplain and lacustrine deposits which are predominantly argillaceous are better suited for leaf preservation, for example, exceptionally well preserved leaf impressions are found in the lacustrine Karewa deposits of Kashmir.

CONCLUSION

The technique of screening and washing fossiliferous stream channel sandstones for the recovery of microvertebrates is an efficient method of obtaining a sample representative of the contemporary fauna. In the procedure more commonly followed whereby the specimens are hand-picked, this faunal component comprising of smaller fossils, remains undetected. The screened sample is composed of taxonomically assorted, size-sorted teeth, vertebrae and limb-bone elements. Faunal members in the sample proximal to the depositional basin tend to be best represented. Vertebrates are found in a variety of fluvial environments but stream channel sandstones rather than floodplain deposits are better suited for the application of the washing technique. Associated with the vertebrates are remains of freshwater molluscs and plants; both are important indicators of the environment in the basin of deposition.

In the case of the Sivaliks, the emphasis so far has been generally on collecting the larger bones and skulls, to the exclusion of the smaller vertebrates. Application of the washing technique to the fluvial sediments of the Sivalik system as well as the Karewas and other stratigraphic units in India is likely to produce new faunal components comprising of small lower vertebrates and mammals.

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