Vertical Zonation in a Tropical Rain Forest in Malaysia: Method of Study

The distributions of various species of mammals and their endoparasites differ in the various vertical zones of tall, tropical rain forests in West Malaysia (*1, 2*). Harrison has designated three vertical zones—the canopy, under canopy, and ground (*1*). Davis, who worked in similar forests in Sabah (North Borneo), also divided the forest into three vertical zones (*3*). The top story (from about 30 to 60 m or higher), equivalent to Harrison's canopy, is formed by scattered tall trees with trunks more than 1 m in diameter. The boles of such trees have no branches up to at least 25 m and their crowns form an incomplete canopy. The middle story (Harrison's under canopy) is composed of tops of smaller trees, from about 8 to 18.5 m high, that form a nearly complete canopy. The lower story, up to about 8 m (Harrison did not separate this stratum from the under canopy), is composed of young trees and species of small trees.

It is difficult to observe animals in the canopy or even in the upper strata of the under canopy because of the nearly closed canopy of the lower strata. Trapping and netting of mammals and birds, except near ground level, is most difficult. Yet, among the nonflying mammals in West Malaysia, Harrison lists 46 canopy or subcanopy species and 27 ground species (*1*). Of the latter many are semiarboreal.

To study the canopy of the rain forest, investigators have resorted to constructing towers or ladders and platforms on tall trees (*4*). These have been very useful, but they have a disadvantage in that they provide a very limited number of sites for observation and sampling. The radius of vision is limited, as is the range of tree species that can be sampled. To overcome some of these problems, we had an aerial transect constructed through the canopy of a relatively mature forest in West Malaysia, near the outskirts of Kuala Lumpur. Such a transect encompasses a large enough area to include trees of various species which support a larger range of herbivores and, indirectly, more carnivorous species than can be observed from a single tree.

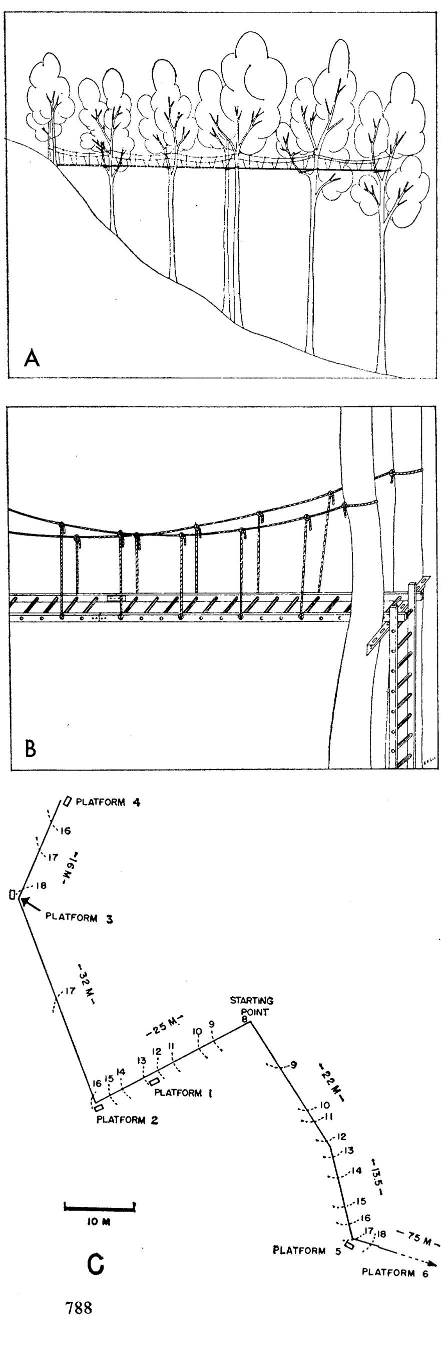

Fig. 1. One may begin from a tree platform which may be reached by a vertical ladder, or one may take advantage of a slope and build a walkway horizontally to reach the canopy (A). In the latter case once the canopy is reached, the transect may be built parallel to the contour of the hill. We prefer at least a partial use of a slope since it eliminates the necessity of a long vertical climb. Two ropes are fixed between two trees, pulled taut with a turnbuckle, and tied (B). Several lengths of rope are passed through the hollow rungs of the ladder and knots are tied on either side of the C channel of the ladder to prevent it from sliding on the length of rope. The ends of these ropes are formed into loops around the two horizontal ropes between the trees, and the ladder is slid out along the horizontal ropes. Once in position the loops are tightened into knots around the horizontal ropes. The near end of the ladder is fixed, and additional lengths of rope are used to secure the ladder to the horizontal span ropes. Once fixed, the ladder can be used as a platform for launching the next section of ladder and the two sections are fastened together with bolts. Light boards may be placed on the rungs to facilitate walking. Two additional horizontal spans of rope or steel cable may be used for added safety and stability. Further stabilization may be obtained from ropes tied from the walkway to branches of nearby trees. (C) Completed transect; numbered, broken lines denote 1-m contour lines of the distance from the transect to the ground below.

The design of this transect might be of interest to all those investigators who are attempting to study various aspects of equatorial rain forest ecosystems. It has the advantages of relatively low cost, durability, ease of repair, and the access it lends to the canopy. The basic materials used were sections of aluminum ladder (about 5 m long), polyester rope (*5*) (about 13 mm in diameter; about 3000 kg, test strength), and perforated, galvanized angle irons. Suitable substitutes may be used, depending on local availability of materials. The construction of the transect was carried out entirely by aborigines, who are accustomed to climbing trees for fruits, nuts, and beeswax. The transect is essentially a rope suspension bridge. The sequence of steps used in its construction is given in Fig. 1.

We have completed approximately 180 m of a transect at heights ranging from about 8 to 20 m (Fig. 2). We are beginning construction of another section at heights above 30 m, of which about 100 m have already been completed. The layout of the completed section of the transect, together with heights at various places, is given in Fig. 1C. This configuration was determined by the presence of tall, healthy trees in the study area. The transect is reached by climbing about 8 m vertically to a horizontal section between two trees. The height of the transect, which is horizontal, is dependent on the slope of the terrain below, since the walkway is constructed on a hillside (Fig. 1C). On platform 2, there is a hygrothermograph at a height of 17 m and another one on the ground directly below it at a height of about 1 m. Rain gauges are located in the canopy and on the ground. Trapping and mist-netting stations are located in pairs, in the

Fig. 2. Completed section of transect through the canopy 20 m above ground.

canopy, and directly below on the ground.

Preliminary observations indicate that vertebrates such as squirrels and birds that are otherwise unlikely to come very near to man when he is on the ground react differently to an observer in the canopy and can be approached sometimes almost to within arm's reach. Usually they carry on normal activities in the presence of the observer. The reactions of squirrels and other arboreal mammals to the transect walkways is similar to their reactions to vines and other growth that join the crowns of individual trees; they sometimes use them to get from tree to tree.

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5. Hemp rope of equivalent strength is much heavier than synthetic fibers and also tends to deteriorate more rapidly over a period of time.
6. Supported by grant DADA17-69-G-9278 from the U.S. Army Medical Research and Development Command, Washington, D.C. We thank C. bin Long, M. bin Tahir, G. bin Kaman, P. bin Kandol, and I. bin Chat for constructing the transect through the canopy.

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Piltdown Man: The Realization of Fraudulence

The association of a human cranial vault with a pongid mandible into the taxon *Eoanthropus dawsoni* (*1*) was not accepted by all authorities. The dualist theory, that the two elements were associated by chance in the same gravels, was proposed as an alternative by David Waterston, professor of anatomy at King's College, London (*2*); and the distinguished zoologist Gerrit S. Miller, of the Smithsonian Institution, Washington, D.C., strongly supported this point of view (*3*, *4*). Miller went so far as to restrict Woodward's name to the cranial fragment, describing the jaw as that of a new species of chimpanzee, *Pan vetus* (*3*). His paper contains this remarkable statement, which now reads like prophecy:

> Deliberate malice could hardly have been more successful than the hazards of deposition in so breaking the fossils as to give free scope to individual judgement in fitting the parts together.

The late T. D. McCown told one of us (C.P.G.) in 1966 that Miller had confided to him his suspicion that things were not quite right about Piltdown but had been persuaded by his colleagues not to publish his suspicion on the grounds that without positive proof this would be too serious an allegation of scientific fraud.

It may be that Miller already suspected fraudulence when he wrote his 1915 paper. For a number of reasons, however, this seems unlikely; in particular, his description of the mandible as a new species of ape was too serious a committal if at that time he believed its features might not be wholly natural.

The Piltdown material was proved fraudulent in November 1953 (*5*). In the following summer, it became apparent that by 1930 Miller was definitely sure that some of the features of the Piltdown jaw were the result of fraudulent alteration: in 1954 the late Remington Kellogg, at that time director of the U.S. National Museum (part of the Smithsonian Institution), told one of us (K.P.O.) that in 1930, when he was about to visit Europe to attend a congress, Miller had requested him to seek an opportunity to look at the original Piltdown teeth in the Department of Palaeontology of the British Museum (Natural History) because he had come to the conclusion that their shape had been artificially modified. It is interesting to note that one of the main reasons why Miller referred the Piltdown jaw to *Pan* rather than to *Pongo*, which it ultimately was shown to be, was the lack of the cusp formation and occlusal crenulation so characteristic of *Pongo*—another reason for believing that as far back as 1915 he did not consider the teeth to be artificially altered.

For Miller's sake, as well as for the progress of paleoanthropology, it was unfortunate that Kellogg did not have the opportunity to inspect the Piltdown teeth and that for a further 20 years *Eoanthropus* continued to represent an awkward and aberrant line of human evolution.

A recent revival of interest in the Piltdown forgery (*6*) makes us feel that it is appropriate to put these facts on record in a scientific journal, so that, at least *in memoriam*, Gerrit S. Miller receives the credit due him for his remarkable percipience.

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