In use the device is held in both hands (Fig. 1D). By drawing the hands apart the noose is adjusted so that it can be passed over the head of a bird to a point posterior to the carpi of the folded wings. The noose can then be tightened gently to grasp the bird, so that it can be lifted and swung clear of the nest. For weighing and banding an assistant is needed to take the bird from the end of the pole.

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A TECHNIQUE FOR MIST-NETTING IN THE FOREST CANOPY

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Since January 1963 we have been mist-netting birds in a tropical rain forest study area on the property of the Instituto de Pesquisas e Experimentaçao Agropecuarias do Norte (IPEAN), Belém, Brazil. One of the few frustrations in our field work in this region has been our inability to sample the avifauna of the forest crown. The stratification of birds in the forest is discernible but difficult to measure. Mist-netting on the forest floor is highly selective for low-foraging species and does not adequately sample the middle story or canopy.

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Various workers have attempted to overcome this difficulty in one way or another. In the Bush Bush forest the Trinidad Regional Virus Laboratory has erected two triangular radio towers, set in concrete, on which two mist-nets have been raised to about 80 feet. Dr. Neal G. Smith, Smithsonian Tropical Research Institute (Panama), has been using special aluminum pipe which permits him to raise a net to several meters above the ground. Dr. Oliver L. Austin (in litt.) says he has "seen mist nets 30 feet high in Japan with 18 to 20 shelves—usually across gulleys, and many 15 to 20 feet high. They have two methods, one using bamboo poles, with the nets sliding up and down them on loops like those on a sail. The other uses vertical wires, on which the shelf-strings slide on small rings. In both the nets are raised and lowered by a system of pulleys, both to set and to remove the birds."

None of the existing techniques for high netting fitted our special requirements. How were we to rig a net which could 1) be operated easily by one man, 2) sample heights up to 30 meters or more, and 3) be constructed inexpensively with easily portable materials? The problem was solved when we learned of the professional tree climbers working in the forest around Belém. Clearly a good tree climber could get a rope up and suspended between the branches of two tall trees. The rope would provide the support for a high net rig.

Humphrey and Bridge drew up plans for a high net rig early in 1965. The rig was tested in the forest at the Patuxent Wildlife Research Center by Bridge and Lovejoy. The following summer Humphrey and Lovejoy installed four high-net rigs (each rig had three or four mist nets) at heights of 17 to 24 meters in the tropical rain forest near Belém. Practical field experience necessitated minor changes in the original design.

During the period June 30 through September 1, 1965, we operated the high-net rigs two or three days a week and occasionally at night. This enabled us to capture many species that were not taken in the ground-level nets. In all, about 50 species of birds were captured in the high nets; about a third of these were species never captured at ground level and some had not even been seen in the area before.

In addition, information was obtained on the vertical distribution of birds in the tropical rain forest. Many species of birds inhabiting our study area were never captured in the high nets.

DESCRIPTION

Figure 1 illustrates the high-net rig. A top support rope stretched between two tall trees supports the net rig. Two loops in this rope and attachments at ground level support a system of metal rings which act as pullies. Through these metal rings a continuous nylon line is strung so that one vertical line at each end will move in the same direction and at the same speed. The mist nets are attached to the nylon line and can be raised or lowered by one man from either end.

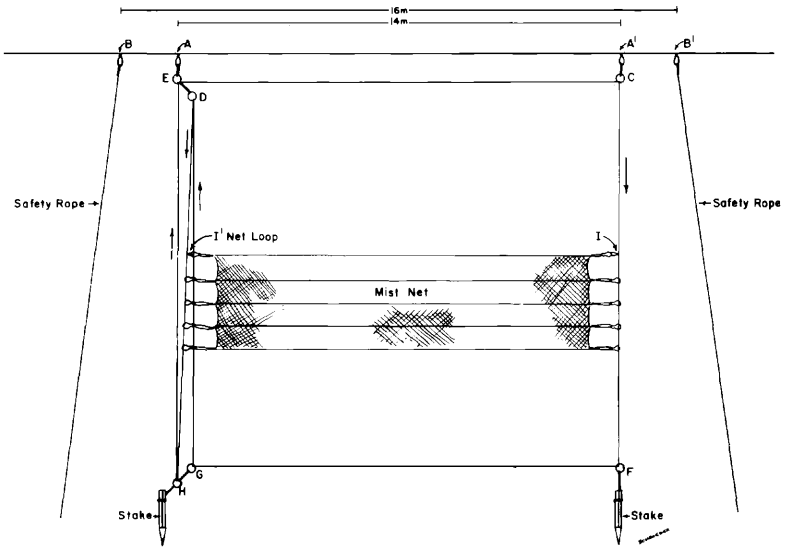

FIGURE 1

Equipment needed for one high net rig.

For computing the amount of rope and nylon line needed, the following measurements are needed: H - height of top support rope from ground and D - distance between supporting trees.

1. *Rope.* 1/2-inch manila or 5/16-inch nylon, approximately 2500 pound test. For top support and safety rope — 6H + D
2. *Nylon line.* Woven, not twisted, surf-casting line of approximately 100 pound test.

For net line	4H + 28 meters
For spacer line	5 meters per mist net
For attaching rings and folded net support	50 meters

3. *Metal rings.* Need 6 nonrusting metal rings.

   (Note: We used brass rings [one inch outside diameter, 1/8-inch thick], but found that the nylon net line wears grooves in the rings. Stainless steel would be better if obtainable.)
4. *Shower curtain rings.* Plastic, snap-shut rings.

For each mist net	10
For furling net	2

5. *Mist nets.* One or more 4-shelf, 12-meter mist nets. If the nets are going to be used extensively at night where bats are common, one or two extra sets should be taken along to replace those destroyed.

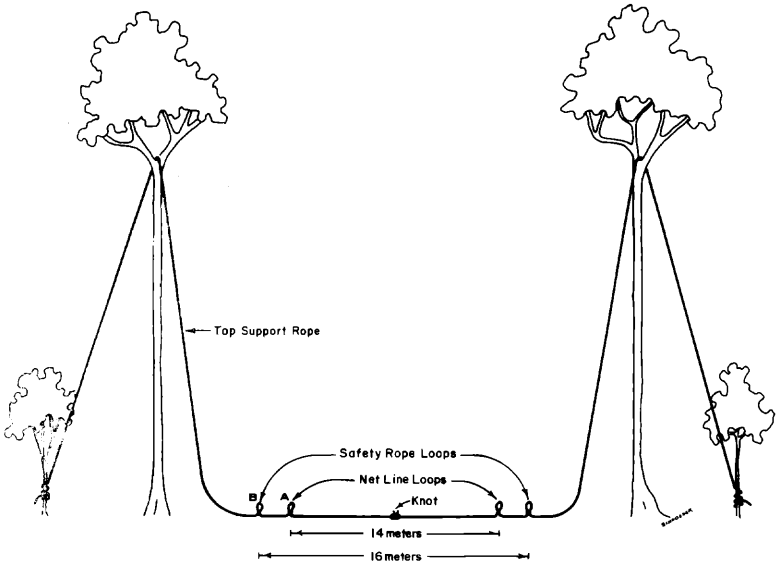

FIGURE 2

6. *Adhesive tape and felt-tipped marking pen* are useful in numbering the nets and marking positions on the net line.

Materials and approximate cost for a high net rig of four nets when H = 100 feet and D = 120 feet:

1.	Rope, 1/2-inch manila	720 feet	$36.00
2.	Nylon line	650 feet	5.00
3.	Metal rings, brass	6	1.00
4.	Shower curtain rings	42	4.00
5.	Mist nets, 12-meter, 4-shelf (type A of NEBBA)	4	13.00
		Total	$60.00

CONSTRUCTION

Site.—The ideal high net site is a narrow rectangular clearing in the forest between two large trees from 25 to 40 meters or more apart. The area between the trees should be relatively level and should not contain any large trees. The site should be cleared from ground level to above the top-support rope to a distance of 3 or 4 meters on each side of the plane of the net rig. In some localities wind conditions may necessitate a wider clearing. A site should be chosen that requires minimal pruning of adjacent trees.

The top support rope and safety ropes.—The top support rope is put over limbs of each of the two trees at either end of the net site; ends of the support rope are then tied securely around the trunk of some convenient sapling or tree. Plenty of spare rope should be left between the supporting trees so that the full length of the top support rope can be stretched on the ground (see figure 2). The two supporting limbs need not be the same distance from the ground. The manner of net attachment permits raising and lowering the net evenly regardless of any difference in height.

In approximately the mid part of the top support rope as it lies on the ground, two loops (A and A^1) are tied 14 meters apart (figure 2). Safety rope loops (B and B^1) are tied about one meter outside each ring loop. A safety rope slightly longer than the height of the completed high-net rig is tied to each of the safety rope loops. These ropes are invaluable in the rigging, maintenance, and operation of the set.

Metal rings and net line.—The rings are attached and the net line strung while the top rope is still within easy reach at ground level. Then the top rope is raised to its final position and the nets are attached. In attaching rings see figure 1.

Two stakes are driven in the ground approximately below loops A and A^1. A metal ring (F) is attached with nylon line to the stake below loop A^1. Metal ring (G) is attached with nylon line to metal ring (H) which in turn is attached to the stake below loop A.

A metal ring (C) is attached with nylon line to loop A^1. Distance between all connections is 20-30 cm. Metal ring (D) is attached with nylon line to metal ring (E) which in turn is attached to loop A.

To string the net line, pass one end of a piece of nylon line through ring (G), allowing the spool of line to remain behind to unwind. Then pass the nylon line through ring (D). Next pass it through ring (H) and then through ring (E). From there, pull the line along the top rope to pass it through ring (C). Then pass it through the bottom single ring (F). Pull the line along at ground level to ring (G) and tie it temporarily to this ring. The net line may be strung in a different sequence, but our experience with the distribution of tensions in the line shows this method the easiest.

After stringing the nylon line, the top support rope is raised, pulling the net line up with it while the line plays off from the spool at ground level. The top rope is raised slowly, several meters at a time, pulling alternately on each end. The safety ropes must be kept under slight tension during the raising to prevent the top support rope twisting and entangling the net rings and nylon net line. (The safety rope at the end not being raised is tied down.) One person can easily pull on one end of the top rope and keep a grip on the nearer safety rope at the same time. A second person is needed to oversee the unrolling of the spool of line and attach a new spool of line if necessary. (If possible use one continuous line.) When the top support rope is fully raised the stakes are placed in their permanent positions so that the rings are directly below the corresponding rings on the top support rope and hence about 14 meters apart. The top support rope and the net rig can be adjusted

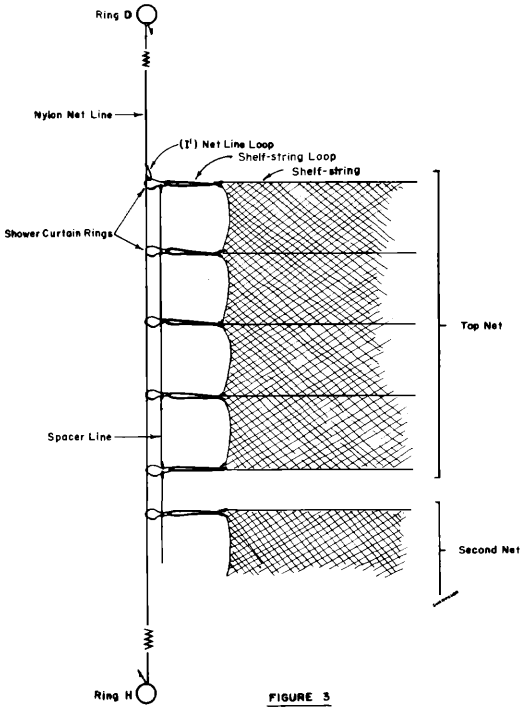

FIGURE 3

laterally so that they can be placed anywhere in the clearing.

Once all the rings are in their final positions, the two ends of the nylon net line can be tied together to create a continuous line. The two ends should be drawn together tightly before tying securely with a double knot. The optimum tautness of the net line is determined once the nets are attached. The nets should be stretched as taut as possible without interfering unnecessarily with the ease of pulling the line.

Attaching nets.—A loop (I) is tied with a secure double knot in a vertical portion of the net line between rings (C) and (F) of the net. A similar loop (I^1) is tied at the same height in the vertical portion of the net line between rings (D) and (H). These two net loops move in the same direction and maintain the same relative position to each other as the net line is moved. They are the only fixed attachments of the net to the net line. Other nets, suspended below the topmost net, are supported solely by the spacer lines and have no fixed attachments to the net line.

Two spacer lines are prepared by tying loops approximately 30 centimeters apart in lengths of nylon cord. The distance between loops may be varied according to the distance desired between shelf-strings. The number of loops in a spacer line will vary ac-

cording to the number of nets to be slung on the rig: 5 for a single four-shelf net, 10 for two such nets, etc.

A shower curtain ring is passed through the net loop (I^1) of the net line and the top loop of a spacer line (figure 3). A shower curtain ring is passed through each subsequent loop in the spacer line and around the net line. The second spacer line is attached to net loop (I) in similar fashion. The nets can now be slung one by one. The top curtain ring, which passes through the top spacer line loop and the net loop (I) is snapped around the top shelf-string line loop at either end of the top net. Each subsequent shelf-string line loop of the net is snapped into a shower curtain ring which already passes through a spacer line loop and around the net line. If a second net is desired, a sixth shower curtain ring (assuming the top net is a four-shelf net) is passed through the sixth spacer line loop and around the net line and then attached to the top shelf-string loop of the second net. The second net is more easily attached if the first one is raised up out of the way during the process. Any additional nets are attached in the same manner.

The nets may now be raised all the way. This is done most easily by pulling simultaneously on the outside and the inside vertical lines of the double ring end. The nets will automatically open and stretch out as they are raised. To lower the nets the same two lines are pulled upward. The nets will automatically fold up as they near the ground. The nets may also be raised and lowered by pulling on the vertical line at the single end, but not so easily, and this allows the nets to sag so they may brush the ground and pick up debris. Adjusting net-line tensions to prevent this temporary sag can be done only at the double ring end of the net rig.

Folded net support lines pass horizontally at right angles to the plane of the net rig at a height of approximately two meters. Three such lines spaced along the length of the net at 3, 6, and 9 meters from one end are sufficient to support the folded nets. They can be easily strung between saplings or tall stakes.

With use both the top supporting rope and the nylon line will stretch. Thus it is necessary to tighten the top rope occasionally by retying it at its attachment points. The nylon net line may be tightened by tying a loop in it, taking care not to change the altitudinal relation between the two net attachment loops. The knot securing the loop should be securely tied to avoid slippage. The supporting ropes should be checked for stretching once a week for the first month of use and less frequently thereafter. Otherwise the top rope may sag so that it hangs below the top part of the nylon line. Birds flying into the upper shelves may then twist the net around the top rope, which will have to be lowered to release them.

When the nets are lowered they automatically fold and come to rest on the net support lines which prevent the net from sagging and picking up debris on the ground.

When the nets are folded, the aggregate of hanging shelves can be folded over as with a single mist net strung between two poles. We have found it easiest to leave the folded nets resting on the net

support lines when not in use. It is also possible to lock the shower curtain rings together and raise the folded nets up out of the way.

We put three 12-meter mist nets on our first high net rig and found that they worked satisfactorily after we had adjusted the tension of the nylon net line. Four nets were put on the other high rigs. With four nets we experienced occasional minor difficulties in handling the high rig, particularly when cleaning and closing it. We never attempted to use more than four nets. Although using as many as six or eight nets on one rig may well be feasible, we suspect that a large number of nets on one high rig would greatly increase operating problems.

The first several days we operated the high nets we lowered them only when we saw birds caught in them. We soon learned, however, to lower them every half or three-quarters of an hour to clean out all leaves and other debris. We lost several birds in the first day or so by overlooking them or mistaking them for leaves only to find them dead of exposure at the end of the day.

During the regular operation of a high net any difficulties with the high part of the rig are easily remedied by freeing one end of the top support rope and pulling the top support rope down to ground level by means of the safety rope.

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