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THE CAFOTROP METHOD: AN IMPROVED ROPE-CLIMBING METHOD FOR ACCESS AND MOVEMENT IN THE CANOPY TO STUDY BIODIVERSITY

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Abstract. The Cafotrop method is an improved method of tree climbing, and here movement into the tropical canopy is described. The method results from a fruitful collaboration between canopy biologists and professional arborists and has been tested in numerous situations and environments over the past seven years. By efficiently combining classic single rope technique with the double rope technique used by arborists, our method offers easy access to the tallest tree canopies, immediate escape capabilities in case of danger while ascending or descending on the main rope, and great flexibility of movement. It is suitable for a wide range of applications and can be learned by a novice climber under supervision within a few days.

Key words: rope access technique, tropical biodiversity, single rope technique, double rope technique, tree climbing

INTRODUCTION

The forest canopy has been designated as the last biotic frontier (Erwin 1982, 1983; Wilson & Moffett 1991, Stork *et al.* 1997) and still remains poorly described and understood (Linsenmair *et al.* 2001, Lowman & Rinker 2004, Lowman *et al.* 2012). This situation primarily results from access difficulties (Nadkarni & Parker 1994, Schowalter & Ganio 1998, Barker & Pinard 2001). Many studies on canopy arthropods based on indirect sampling methods, such as insecticidal fogging, provide estimates of the number of living species and fuel speculations about the biological richness of the canopy and its structure. Consequently, many methods of access to the canopy have been developed for scientific studies.

On the one hand, "low tech" and ground-based methods are widely available but can have limited use. For example fogging methods (Roberts 1973) are extremely efficient for collecting large quantities of canopy arthropods but provide little information on species ecology (Guilbert *et al.* 1995). On the other hand, "high-tech" methods – such as canopy raft (Halle 1990) or crane (Parker *et al.* 1992) – are difficult to implement when not simply impossible for researchers because of human and financial costs. Such methods involve much organization and material. Thus direct access to the canopy with "low-tech" techniques has been the method of choice of canopy researchers (Perry 1978) but limitations still exist.

The single rope technique (hereafter SRT) used by vertical cavers was originally adapted for use in forests by Perry (1978) and Perry & Williams (1981) to avoid damage caused by climbing spikes (Hingston 1932) or lag bolts (Denison *et al.* 1972). One end of the rope is anchored at ground level, then it passes over a branch leaving the other end of the rope free for ascent. Providing a lightweight, cheap and non-destructive canopy access technique, SRT was later improved (Whitacre 1981, Risley 1984, Ter Steege & Cornelissen 1988, Laman 1995, Vieira & Marinho-Filho 1998), mainly for safety and practicality (reviewed in Moffett & Lowman 1995, Barker

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1997, Barker & Sutton 1997), and is still in use today (Houle *et al.* 2004, Hall & Willmott 2010). Because SRT was originally designed primarily for vertical movement, it provides limited capacities for the climber to move securely and easily within the canopy.

Alternatively, arborists developed the double rope technique (hereafter DRT) (Dial & Tobin 1994, Jepson 2000, Dial *et al.* 2004, Maher 2010). One end of the rope is attached to a harness, passes over a branch and returns to the climber. Despite its name, DRT uses a single rope but both sides of the rope are used for the ascent. Coupled with an adjustable lanyard, it provides great horizontal mobility once in the canopy, but is difficult to use to climb tall trees such as are found in the tropics.

While many biologists working in tropical canopies use a combination of SRT and DRT (Ellyson & Sillett 2003, Yusah *et al.* 2012), there has still been a need for an efficient combination method that can be easily implemented by a single researcher. We describe here an improved method for reaching and moving in the canopy of the largest trees in tropical forests. This method, which we here define as the "Cafotrop method", has been elaborated and tested as a collaboration between entomologists, botanists, and professional arborists through the Cafotrop project (Guilbert *et al.* 2012).

MATERIALS AND METHODS

Here we provide detailed description of the materials and methods used. For each material, we provide indicative references to equipment that we currently use (Table 1).

Choosing the tree. Before any installation of climbing material in a tree, the climber must visually inspect the health and architectural integrity of the tree. After the diagnosis, the climber chooses where to put the rope and where to climb. The climber needs to choose a supporting branch high enough to access the working area, with a secondary branch below the anchoring one to serve as additional insurance in case of breaking.

Installing the ropes. A helmet should always be worn when installing the material and progressing in the tree. We recommend the use of gloves when manipulating wires and ropes. We also suggest the use of distinct bags to put each rope into.

Once the firing angle is chosen, a large cloth is installed on the ground on which is placed a collapsible bag to unroll the launching wire. This cloth

TABLE 1. Material used and suggested for the Cafotrop method

Equipment	Model used
Helmet	Vertex Vent - Petzl
Gloves	Dynaflexair Rostaing
Collapsible bag	Complete Matriosac – FTC
Launching wire	Dyneema wire - 1.8 mm diameter - 80 m – FTC
Throw weight	300 g - Harisson Rocket
Sling shot	Complete Sling-Line 2 - FTC
Static rope	Ultima - 8.5 to 11 mm - 80 m - Meetic Technology - Courant
Harness	Abies 2.1 with adjustable central point - FTC/Antec
Foot ascender	Pantin - Petzl
Two-handled rope clamp	Ascentree - Petzl
Small prusik	8 mm diameter - Beal
Steel carabiner	OK Screw Lock - Petzl
Climbing rope	Industry - 11 mm diameter - 80 m - 1 loop - Beal
Rope sleeve	Capriplast #13 70cm - FTC
Aluminum carabiner	AMD ball lock - Petzl
Prusik	Volcano anti-fusion - 10 mm diameter - 0.90 meter long
Adjustable lanyard	4 meters long - Grillon - Petzl

FIG. 1. General view of the system. The static rope is anchored on the tree; the climbing rope is lying on the soil.

prevents the launching wire from getting caught on ground vegetation during shooting. The throw weight is attached to the wire and placed in the sling shot. The weight is thrown well above the chosen supporting branch. Once launched, the weight is recovered on the other side.

The main static rope, 10-12 mm in diameter, is attached to the launching wire in place of the weight. We suggest the use of a capstan knot (clove hitch) with a stop key plus three braids along the rope (Fig.1). The wire is pulled to raise the main rope until it passes the supporting branch. Once the rope is installed on the supporting branch, the extremity is attached twice to two distinct trunks as anchoring points, with a capstan knot doubled with a stop knot (Fig.1). Tree climbers use low-stretch main rope which reduces a bouncing effect during the ascent.

Ascending. The climber is equipped with a harness and foot ascender. Tree climbers, especially those conducting scientific research, should wear a comfortable harness to allow them to stay in suspension for hours in the canopy. A two-handled rope clamp is installed on the main rope (Fig. 2). On the top of some two-handled clamps is a protection of the groove where the rope passes through, to avoid small branches lodging in the device and causing slippage. If no protection is on the clamp, we recommend installing a slender prusik knot three rounds/three rounds on the main rope above the handle clamp as additional insurance. A chest ascender sliding up passively can also be used but it needs a supplementary manipulation. The knot will be attached to a steel carabiner placed in the lower connection hole of the handle. (Fig. 2).

A semi-static second rope 9-10 mm in diameter (hereafter called climbing rope) is passed through the steel carabiner. The loop at the tip of the rope is attached to an aluminum carabiner at the anchoring point of the harness. A prusik knot three rounds/one round is also attached to the anchoring point of the harness by an aluminum carabiner. The climber reaches the anchoring point or the working area using the handle and the foot ascender placed on the static rope. We recommend attaching the loose part of the second rope to the harness to avoid carrying its weight with the handle clamp (Fig. 2).

Moving and descending. Once the anchoring point is reached, the foot ascender must be removed from the main rope. The loose part of the access rope is also removed from the harness. To access the working area, the climber simply needs to take the prusik knot in one hand and makes it slip down the second rope. The prusik is a self-lock knot, and as such slips upwards and downwards, but locks as soon as it is released. This allows the climber to go down quickly and without any extra manipulation. In contrast to mechanical devices, the prusik knot is easy to handle with only one hand, and allows a better control of speed by a novice tree climber.

In the working area, the climber can move laterally from the main rope into/out of the tree crown. This requires care and experience. The climber can take position on a chosen branch to put the adjustable lanyard to stabilize himself (Fig. 3). If necessary, the climber can go back up to the anchoring point (the handle clamp) by placing the foot ascender on the climbing rope and sliding the prusik knot upwards.

An important aspect of our method is the ability to move more easily into the canopy. Using the second movement into the tree crown is limited laterally as it is dangerous to climb further up the anchoring point or far laterally from it. When moving out into the canopy or even above the anchorage point, the weight of the main rope opposite of the access side will pull down and will exacerbate the movement and balance of the climber. It will also move back down towards the anchor on the ground, so that the climber will slip down some centimeters when weight is put again on the access side. As it is not possible to move the anchoring point, moving far from it requires delivering the climbing rope from the two-handle clamp on the static rope and use it "more classically" with other techniques. Using the climbing rope and a rope sleeve, it is possible to go over the initial anchoring point, continue moving into the tree or even reach another tree (Fig. S6). The double rope (the loose part of the second rope) or the rope sleeve can be used to limit the pendulum movement back to the trunk (Fig. S6) using the "spider" technique (Maher 2010). The use of the rope sleeve is highly recommended to avoid rubbing the rope onto the tree and damaging both the rope and the tree. The climber can also free the second rope from the two-handle clamp (be careful to not free the prusik in order to not lose the rope) and continue moving in the canopy using standard arborist DRT (Dial & Tobin 1994) or more elaborate techniques (Dial *et al.* 2004). When descending on the second rope, it is better, when possible, to follow the main rope in order to avoid tangling the ropes and rope clamp with branches and lianas, particularly in tropical forests.

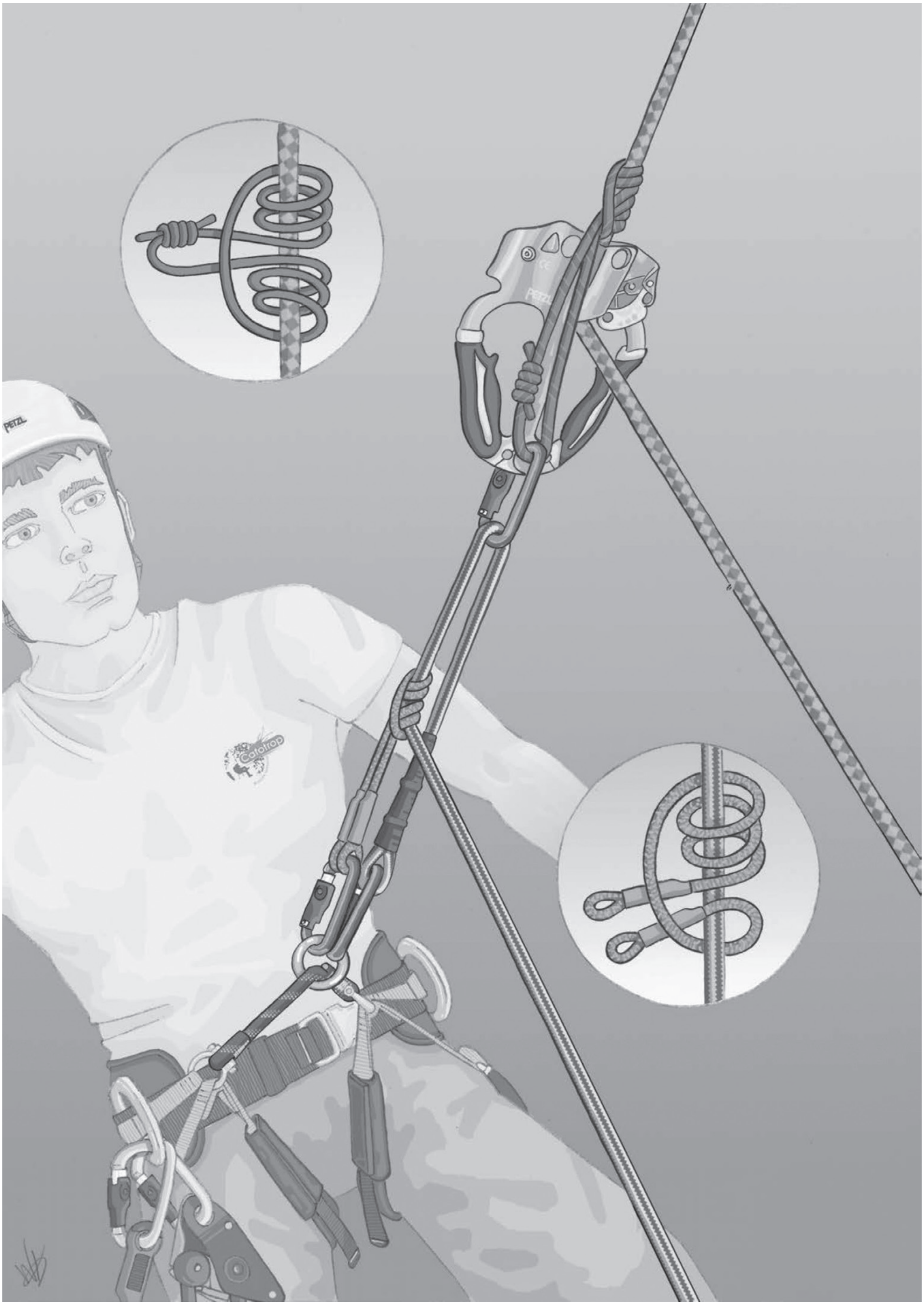

FIG. 2. Detailed view of the installation showing the handle clamp attached to the static rope and the climbing rope.

FIG. 3. The figure shows the climber stabilized with the lanyard in the working area. Details of the anchoring points on the harness are shown.

Installation removal. Removing the system after the descent on the second rope is simple. Once the anchoring points at the base of the two trunks are untied, the two ropes (main and second) are recovered together with the handle clamp from the climbing side. We recommend recovering the ropes after every climb as nocturnal mammals might be attracted by the sweat left by the climber and chew the ropes (Houle *et al.* 2004).

DISCUSSION

Tree climbing methods are an easier and cheaper alternative to "high-tech" methods. The method described here offers the advantage of a combination of SRT and DRT. It allows easy ascending as well descending movements. Single rope technique uses a single rope and ascenders that permit free vertical movement but limit lateral movement, thus requiring some extra manipulation before being able to perform the descent. Mechanical descenders can also be easily set up. The major improvement of our method lies in the possibility of quickly escaping from danger when climbing, such as attack by insects (particularly bees, wasps, and ants), which has already occurred in our field experience in the tropics. The use of a prusik knot on a second rope, independent of the main rope, makes it possible to react quickly and to go down immediately in the event of danger. Our method is very safe as it avoids any improper manipulation before the descent (Laman 1995).

In addition, SRT usually provides a very narrow sampling path that limits collecting opportunities (Risley 1984). The rope web technique of Perry & Williams (1981) has proved to be difficult to install and arduous to use (Parker *et al.* 1992). Our method is very effective in providing the climber great freedom of movement in the canopy while still being easy to implement by a single researcher.

Several investigators (Dial *et al.* 2004, Maher 2010) have already advocated a combination of SRT (for easy ascent) and DRT (for efficient canopy movement), but this requires ground staff to untie the SRT ground level anchor (Maher 2010) before switching to DRT. By completing the SRT/DRT combination setup on the ground, our method can be easily implemented by a single researcher and offers the best of both techniques while avoiding the disadvantages. It only requires one extra rope to be carried by the investigator.

We refined and simplified our method by reducing the number of devices or knots to learn, but always providing the highest standards of safety. Experience has shown that a novice in climbing techniques can learn our method in three to four days and efficiently implement it to collect botanical samples or entomological specimens in the canopy. While we advocate that scientists should be able to be independent in the canopy to perform their research, the presence of a professional tree climber with proper on-site rescue training is always necessary.

Supplementary Online Materials available on http://www.gtoe.de/ecotropica/:

FIG. S1. General view of the installation of the static rope. On the left side, the launch of the throw weight is shown with details of the knot to attach the weight to the wire. On the right side, we show how to recover the static rope, with details of the knots to attach the launch wire to the rope.

FIG S2. General view of the system. The static rope is anchored on the tree; the climbing rope is lying on the soil.

FIG. S3. Detailed view of the installation showing the handle clamp attached to the static rope and the climbing rope.

FIG. S4. General view of the ascent technique with a foot ascender and a handle clamp. Details of the node to attach the loose part of the rope to the harness is shown.

FIG. S5. The figure shows the climber stabilized with the lanyard in the working area. Details of the anchoring points on the harness are shown.

FIG. S6. The climber has moved from the anchoring point to another working area using the climbing rope. A new anchoring point is made using the rope sleeve. Details show the anchoring point on the harness.

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REFERENCES

Barker, M.G. 1997. An update on low-tech methods for forest canopy access and on sampling a forest canopy. Selbyana 18: 16-26.

Barker, M.G. & M.A. Pinard. 2001. Forest canopy research: sampling problems, and some solutions. Plant Ecology 153: 23-38.

Barker, M.G. & S.L. Sutton. 1997. Low-tech methods for forest canopy access. Biotropica 29: 243-247.

Denison, W.C., Tracy, D.M., Rhoades, F.M. & M. Sherwood. 1972. Direct, nondestructive measurement of biomass and structure in living old-growth Douglas-fir. Pp. 147-158 *in* Research on coniferous forest ecosystems: a symposium. USDA Forest Service Pacific Northwest Forest and Range Experimental Station, Portland, Oregon.

Dial, R.J. & S.T. Tobin. 1994. Description of arborist methods for forest canopy access and movement. Selbyana 15: 24-37.

Dial, R.J., Sillet, S.C. & J.C.Spickler. 2004. Methods for horizontal movement through forest canopies. Selbyana 25: 151-163.

Ellyson, W.J.T. & S.C. Sillett. 2003. Epiphyte communities on Sitka spruce in an old-growth redwood forest. The Bryologist 106: 197-211.

Erwin, T.L. 1982. Tropical forest: their richness in Coleoptera and other arthropod species. Coleopts. Bull. 36: 74-75.

Erwin, T.L. 1983. Canopy arthropod biodiversity: the last biotic frontier. B. Ent. Soc. Am. 29: 14-19.

Guilbert, E., Baylac, M. & J. Najt. 1995. Canopy arthropod diversity in a New Caledonian primary forest sampled by fogging. Pan.-Pac. Entomol. 71: 3-12.

Guilbert, E., D’Haese, C., Forget, P.M., Daugeron, C., Legendre, F., Murienne, J., Psaila, P. & L. Picart. 2012. Cafotrop, missions scientifiques évolutives en canopée des forêts tropicales. Available at http://www.cafotrop.fr (last accessed May 2013).

Hall, J.P.W. & K.R. Willmott. 2010. Description of a new *Lucillella* species (Riodinidae: Symmachiini) discovered in the eastern Andes of Ecuador using the single rope canopy access technique. J. Lepidop. Soc. 64: 139-146.

Halle, F. 1990. A raft atop the rain forest. Natl. Geogr. 178: 129-138.

Hingston, R.W.G. 1932. A naturalist in the Guiana forest, vol. 558. Longmans, Green, New York.

Houle, A., Chapman, C.A. & W.L. Vickery. 2004. Tree climbing strategies for primate ecological studies 25: 237-260.

Jepson, J. 2000. The tree climber's companion. Beaver Tree Publishing, Longville, Minnesota.

Laman, T. 1995. Safety recommendations for climbing rain forest trees with "single rope technique". Biotropica 27: 406-409.

Linsenmair, K.E., Davis, A.J., Fiala, B. & M.R. Speight. 2001. Tropical forest canopies: ecology and management, vol. 69. Kluwer Academic Publishers, 377 pp.

Lowman, M. & H.B. Rinker. 2004. Forest canopies. Academic Press, 544 pp.

Lowman, M.D., T.D. Schowalter & J.F. Franklin. 2012. Methods in forest canopy research. University of California Press, 240 pp.

Maher, J. 2010. Canopy access: beyond single rope technique. Nylon Highway 55. Vertical Section of the National Speleological Society Edition

Moffett, M.W. & M.D. Lowman. 1995. Canopy access techniques. Pp. 3-26 *in* Lowman, M. and N. Nadkarni (eds.). Forest canopies, San Diego, California.

Nadkarni, N.M. & G.G. Parker. 1994. A profile of forest canopy science and scientists – who we are, what we want to know, and obstacles we face: results of an international survey. Selbyana 15: 38-50.

Parker, G.G., Smith, A.P. & K.P. Hogan. 1992. Access to the upper forest canopy with a large tower crane. BioScience 42: 664-670.

Perry, D. 1978. A method of access into the crowns of emergent and canopy trees. Biotropica 10: 155-157.

Perry, D.R. & J. Williams. 1981. The tropical rain forest canopy: a method providing total access. Biotropica 13: 283-285.

Risley, L.S. 1984. A modified rope-climbing technique for reaching canopies of forest trees in remote areas. J. Georgia Entomol. Soc. 19: 533-538.

Roberts, H.R. 1973. Arboreal Orthoptera in the rain forests of Costa Rica collected with insecticide: a report on the grasshoppers (Acrididae), including new species. Proc. Acad. Nat. Sci. Philad. 125: 49-66.

Schowalter, T.D. & L.M. Ganio. 1998. Vertical and seasonal variation in canopy athropod communities in an old-growth conifer forest in southwestern Washington, USA. B. Entomol. Res. 88: 633-640.

Stork, N.E., Adis, J. & R.K. Didham (eds.). 1997. Canopy arthropods. Chapman and Hall, London, UK.

Ter Steege, H. & J.H.C. Cornelissen. 1988. Collecting and studying bryophytes in the canopy of standing rain forest trees. Pp. 285-290 *in* Glime, J. M. (ed.) Methods in Bryology. Hattori Botanical Laboratory, Nichinan, 403 pp.

Vieira, E.M. & J. Marinho-Filho. 1998. Single rope techniques in tropical rain forest trees: going down safe and sound. Biotropica 30: 496-497.

Whitacre, D. 1981. Additional techniques and safety hints for climbing tall trees, and some equipment and information sources. Biotropica 13: 286-291.

Wilson, E.O. & M.W. Moffett. 1991. Rain forest canopy: the high frontier. El dosel del bosque lluvioso: la frontera alta. Natl. Geogr. 180: 79-107.

Yusah, K.M., Fayle, T.M., Harris, G. & W.A. Foster. 2012. Optimizing diversity assessment protocols for high canopy ants in tropical rain forest. Biotropica 44: 73-81.