Dendrometer Bands Made Easy: Using Modified Cable Ties to Measure Incremental Growth of Trees

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Protocol Note

Dendrometer bands made easy: Using modified cable ties to measure incremental growth of trees[1]

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- *Premise of the study:* Dendrometer bands are a useful way to make sequential repeated measurements of tree growth, but traditional dendrometer bands can be expensive, time consuming, and difficult to construct in the field. An alternative to the traditional method of band construction is to adapt commercially available materials. This paper describes how to construct and install dendrometer bands using smooth-edged, stainless steel, cable tie banding and attachable rollerball heads.
- *Methods and Results:* As a performance comparison, both traditional and cable tie dendrometer bands were installed on baldcypress trees at the National Wetlands Research Center in Lafayette, Louisiana, by both an experienced and a novice worker. Band installation times were recorded, and growth of the trees as estimated by the two band types was measured after approximately one year, demonstrating equivalence of the two methods.
- *Conclusions:* This efficient approach to dendrometer band construction can help advance the knowledge of long-term tree growth in ecological studies.

Key words: baldcypress; dendrometer band; diameter; growth increment.

Dendrometer bands are a widely accepted and popular method of estimating tree growth (Palmer and Ogden, 1983; Keeland and Young, 2004; Krauss et al., 2007; O'Brien et al., 2008). Dendrometer bands, as used to measure circumference, can provide estimates of change in tree diameter at breast height (dbh), basal area, and basal area increment (Lea et al., 1979; Biondi et al., 1994). Repeated measurements of tree growth can be an important component of ecological studies and forestry management (Lea et al., 1979; Krauss et al., 2007; O'Brien et al., 2008; Drew and Downes, 2009). Direct measurements of tree size from year to year with calipers or diameter tapes are less useful to measure tree growth because of the difficulty in remeasuring the same place on trees from one time interval to the next (Cattelino et al., 1986; Avery and Burkhart, 1994; Keeland and Young, 2004). Dendrometer bands are commonly used for making repeated measurements of tree growth, despite some limitations (Bormann and Kozlowski, 1962; Auchmoody, 1976; Fuller et al., 1988; Keeland and Sharitz, 1993; Sheil, 2003). We used dendrometer bands in a long-term study of growth of baldcypress trees (199 tree and knee bands across 26 sites) in the North American Baldcypress Swamp Network (Middleton, 2009; Middleton and Jiang, 2013). For the purpose of ecological studies where a large number of dendrometer bands are required, this method provides economy and ease of use.

The major disadvantage of the "traditional" dendrometer band is that its construction involves hand-making a collar from bent and folded banding material (Liming, 1957; Cattelino et al., 1986), a complicated and time-consuming process (Fig. 1). The banding material has sharp edges, so that the construction of the collar requires manipulation with thick gloves to avoid injuries to the worker. An improperly constructed traditional band built by an inexperienced worker may pass a quick visual inspection, and then could later fail. An improperly constructed band also may cause damage to the tree. Such problems may not be discovered until the next field visit, so that critical data may be lost. We designed and evaluated a modified cable tie method that uses collars made from prefabricated stainless steel cable-tie heads. Heads for stainless steel cable tie can be purchased separately and modified with little effort into uniform dendrometer band collars. While cable tie heads are designed to allow the banding material to slide freely in one direction only, the heads can be modified as dendrometer band collars by removing the internal rollerball of the head. These heads should be purchased as a separate item that is detached from the cable tie. A modified cable tie head produces a uniform collar for each band, so that there is little variability in collar performance, as opposed to handmade collars, which are inherently variable. The objective of this work was to compare both the construction time and the estimated growth rates of trees using both traditional vs. modified cable tie dendrometer bands installed by an inexperienced and experienced worker.

METHODS AND RESULTS

We installed both dendrometer band types on each of 12 baldcypress trees in the artificial wetlands of the U.S. Geological Survey Wetlands Research Center in Lafayette, Louisiana. Installation times were recorded for each band, and the tree growth was measured on both bands after 11 months and 19 months had passed. Installation time and tree growth increment were compared using nested ANOVA and two-tailed t test (JMP SAS version 7.0; SAS Institute, Cary, North Carolina, USA). We used and adapted stainless steel cable tie material from the electrical

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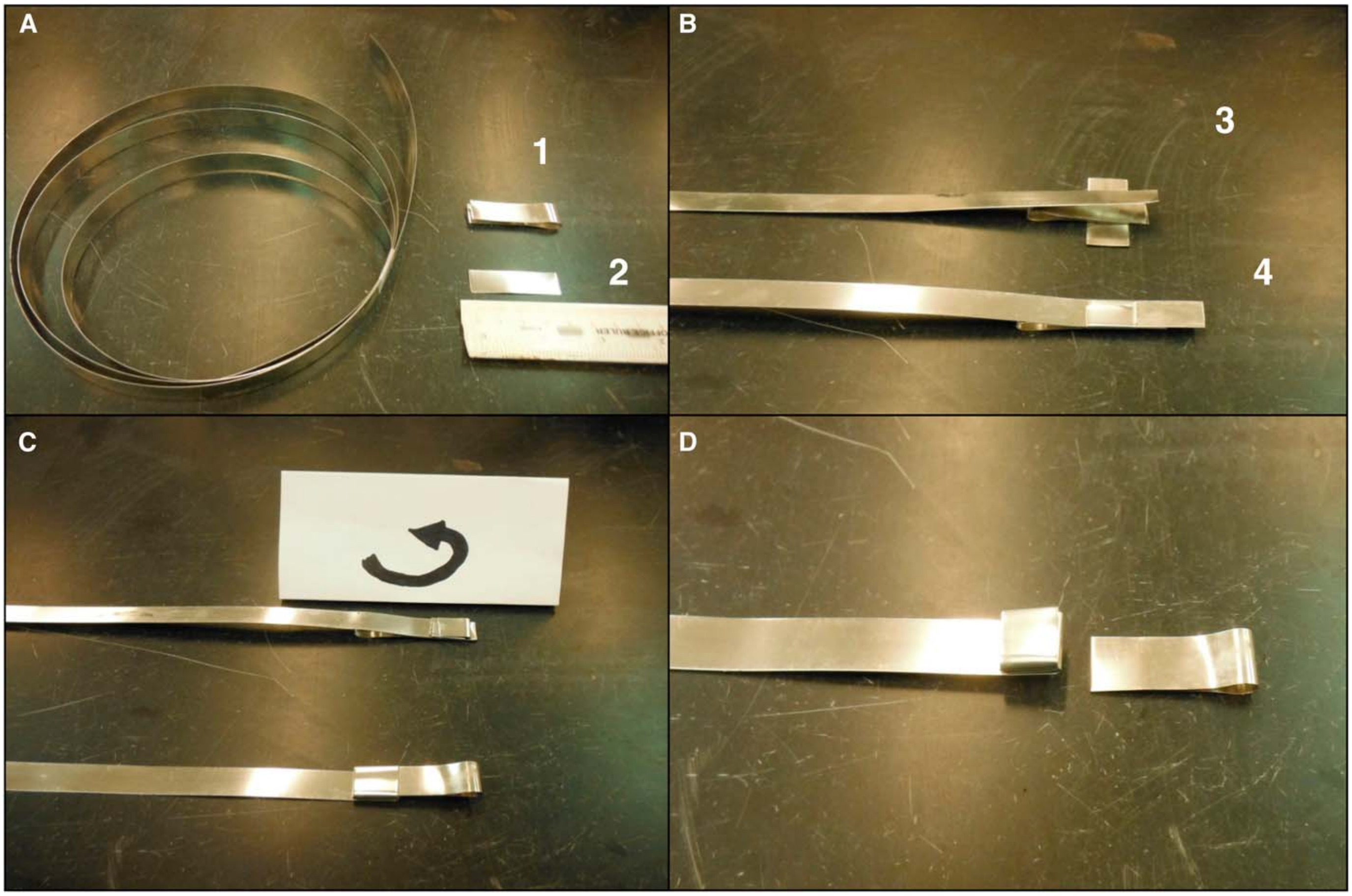

Fig. 1. Constructing a collar on a dendrometer band using the traditional method (from Cattelino et al., 1986). (A) Cut a short section (5–8 cm) from the banding material and fold it back into a loop to create a spacer tool (1), to be reused for making the collar on each dendrometer band. For the collar, cut a section of banding material about three times longer than wide (2); set it aside for the next step. To estimate the length of dendrometer band to cut, measure the tree circumference where the band will be placed (at breast height) and add 20–30 cm to the length of banding material. (B) At one end of the dendrometer band, form the collar by placing the spacer loop under the band as shown (3), with the short piece of banding material held under both the spacer and band, near the end at about the same distance as the width of the band. Fold both sides of the short piece of band up around the spacer tool and the end of the band, forming the collar (4). (C) Fold the end of the band back over the collar, and using the spacer tool for leverage, fold the end of the band again so that the collar ends are concealed and the collar is locked at the end of the band. (D) Pull the spacer tool free of the collar; there should be a gap large enough for the free end of the dendrometer band to be inserted into the collar and move easily as the tree grows. The band and collar are now ready for installation.

industry, which is used to bundle wiring in military and industrial applications where temperature stability and corrosion resistance is essential. For dendrometer bands, we used stainless steel cable tie in spools of 50 or 100 m with a width of 0.31 in (7.9 mm), which is slightly narrower than the 12–15 mm recommended by Keeland and Young (2004). The advantage of cable tie is that it has no sharp edges or burrs that might damage trees or the installer, is stable over a temperature range of −112°F (−80°C) to 1000°F (538°C), and is corrosion-resistant and strong. Other materials needed for band construction include an angular probe, extension springs (stainless steel and corrosion resistant), a heavy-duty hole punch, needle-nose pliers, sheet metal snips, flexible measuring tape, and a rasp or file.

The construction of dendrometer bands made from modified cable ties is as follows (see Appendix 1). To remove the rollerball from the prefabricated cable tie heads, pry up the metal tab using the angular probe (Fig. A1). This step should be done before traveling to the field. After the rollerball is removed, the collar is ready for use. At the field site, standard tree selection and preparation procedures should be followed (Keeland and Young, 2004). Measure and record the tree diameter at 1.3 m above the ground (dbh; Avery and Burkhart, 1994); this is also the position to place the dendrometer band after construction. The banding material should be cut in lengths based on tree circumference. To attach the collar to the band, use the needle-nose pliers to make one fold in the band 2.5 cm from one end of the band and slip the collar onto the short piece of band (Fig. A2A). The "open" end of the collar should be toward the short piece of band, as shown. Tuck the remaining short piece of band under the head/collar and crimp with the pliers (Fig. A2B). The collar should be secured snugly to the end of the banding material.

To install the dendrometer band, use the heavy-duty hole punch to make a hole at the terminal (running) end of the band. Note the proper orientation of the collar (Fig. A3A) with the running end of the band passing through the collar. After the first hole is punched, the band can be placed on the tree. Wrap the band around the tree trunk, slip the running end through the collar, and then thread the wire at one end of the extension spring through the hole at the end of the band. Snug the band down into position and stretch the spring slightly to mark the position for the second hole. The spring should have sufficient tension to keep the band snug, but have enough stretch to allow for tree growth (Fig. A3B). Mark the position of the second hole, loosen the band slightly, and use the heavy-duty punch to make the second hole. The banding material is narrow, so take care to center the hole on the band (Fig. A3C). Settle the band back into place, and thread the free end of the spring into the second hole (Fig. A3D). Make sure that the band can slip freely through the collar when you stretch the spring, and that the spring has enough tension to keep the dendrometer band in place on the tree.

The final step is to mark the initial position of the dendrometer band relative to the collar to act as a marker for subsequent tree growth. Use a sharp-tipped object or knife to scratch the band immediately adjacent to the collar, on the side opposite the running end (Fig. A3E). It is important to orient the band and collar properly so that each tree is banded in a consistent manner. Setting the collar so that the open end is away from the mark makes it easier to scratch a straight line onto the band and generate a better measurement. As the trunk expands, the mark will move away from the collar and the growth can be measured with a ruler or an electronic caliper, providing a record of change in circumference over time.

Installation time was faster with the cable tie vs. the traditional method (F = 6.96, P = 0.0158; Fig. 2A). Tree selection and the time required to smooth the bark at each installation site were not included in the installation time. Seven trees were banded by an experienced technician working alone, and five trees were banded by an inexperienced worker trained and supervised by the experienced worker. The modified cable tie method was approximately 2 min faster than the traditional method under ideal (nonfield) conditions, keeping in mind that tree preparation time, which varies with the size of the tree, is not counted here. Under field conditions, traditional band construction can take up to 30 min or more, while the cable tie method typically takes no more than 10 min. On a qualitative level, both the inexperienced and experienced workers expressed a preference for the cable tie method because of its ease of construction.

Tree growth was measured by noting the increase in tree circumference approximately 11 mo and 19 mo after band installation, using both types of dendrometer band on each tree. The growth increments for both types of band were compared using one-way ANOVA repeated measures test and t test. The comparison of readings by band type was not significantly different overall (F = 0.0639, P = 0.9382), either at 11 mo (t ratio = 0.26, P = 0.7995) or at 19 mo (t ratio = 0.25, P = 0.8037) (Fig. 2B).

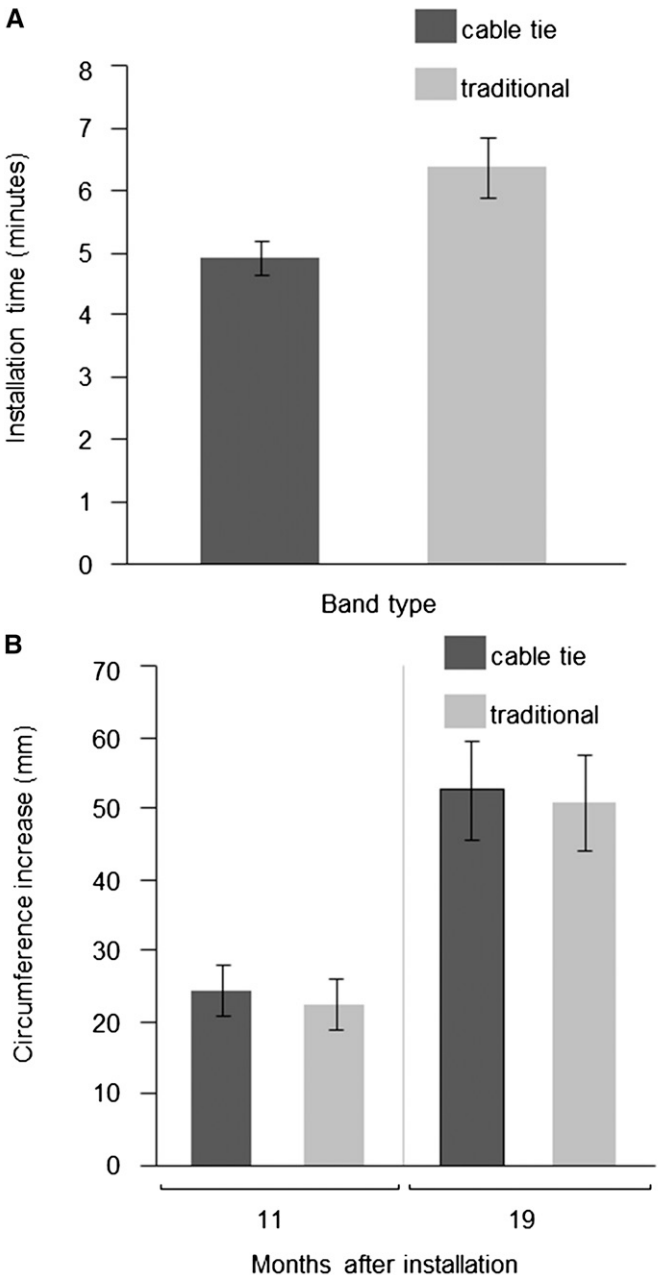

Fig. 2. (A) Time (in minutes, ±SE) for band dendrometer installation using the traditional method vs. the modified cable tie method under ideal conditions. Tree selection and preparation times were not included in the installation times. (B) Circumference measurement (in mm, ±SE) for traditional and modified dendrometer bands at 11 and 19 mo after band installation.

CONCLUSIONS

The modified cable tie method for dendrometer band construction is faster to install than the traditional method, and there is no significant difference in the tree growth measurement using either band type, indicating that the modified cable tie method yields equivalent measurements to the traditional method. In the field, installers familiar with both methods preferred the modified cable tie method over the traditional method of dendrometer band construction because of the ease of construction. Because of its efficient design, this modified cable tie dendrometer band can facilitate studies of long-term tree growth.

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Appendix 1. Cable tie method of dendrometer band construction.

Supplies needed: continuous roll stainless steel cable tie (100 m), attachable cable tie heads, sturdy metal angle probe, rasp or file, dbh tape, tin snips, needle-nose pliers, metal hole punch, stainless steel extension springs, flexible ruler. The cable tie and extension springs should be made of noncorrosive, stainless steel materials; industrial suppliers of such materials include Hayata Ltd., Lee Spring Company, and others.

Step 1: Convert the attachable cable tie heads into dendrometer band collars by using the angle probe to pry up the metal tab and remove the internal rollerball (Fig. A1). Prepare all needed collars before going into the field.

Step 2 (in the field): Select the tree, keeping in mind that dendrometer bands are placed at 1.3 m above the ground, or diameter at breast height (dbh), so the tree should be free of branches or other obstructions at this point. Smooth the bark with a rasp or file to eliminate high or rough spots; do not damage the tree cambium. Measure the tree circumference with the dbh tape and add 20–30 cm (for large trees) or about 50% of the tree circumference (for small trees) to determine the length of band required. Cut the cable tie band to length with tin snips.

Step 3: To attach the collar, use the needle-nose pliers to make a bend about 2.5 cm from one end of the band, and slip a collar on the short section with the "tab" end of the collar away from the bend (Fig. A2A). Fold the protruding short end of the band under the collar and crimp the folds to secure the collar (Fig. A2B). The collar should be secured snugly to the end of the banding material.

Step 4: To install the dendrometer band, punch a hole in the running end of the band (the other end from collar) with the metal punch. Wrap the band around the tree and thread the running end through the collar from right to left (Fig. A3A). Attach an extension spring to the hole in the running end of the band with needle-nose pliers and snug the band into place, stretching the spring slightly (Fig. A3B) to determine the attachment point for the far end of the spring. Punch the second hole in the band (Fig. A3C) and attach the spring (Fig. A3D). There should be enough tension on the spring to keep the band in place; to maximize uniformity, attempt to apply the same initial tension to all dendrometer bands. The band should slide freely through the collar as the tree grows and the spring expands. Scratch the band next to the collar (Fig. A3E) to mark the initial point from which growth will be measured. If the collar is oriented properly, a straight mark is easily made and will move to the right of the collar over time. Measure the distance between the collar and the mark with the flexible ruler (or an electronic caliper) to record increase in tree circumference over time.

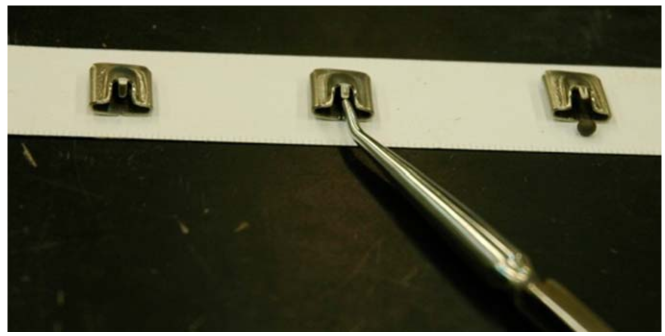

Fig. A1. Preparation of dendrometer band collar.

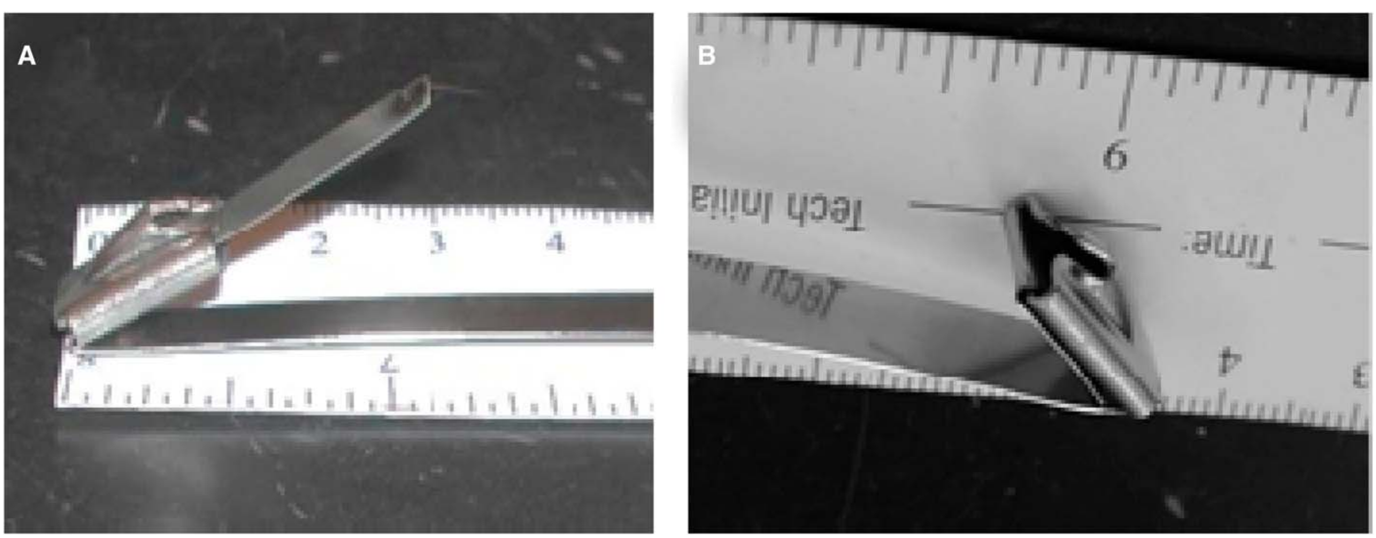

Fig. A2. Attaching the dendrometer band collar. (A) Slip a collar on the short section with the "tab" end of the collar away from the bend. (B) Fold the protruding short end of band under the collar and crimp the folds to secure the collar.

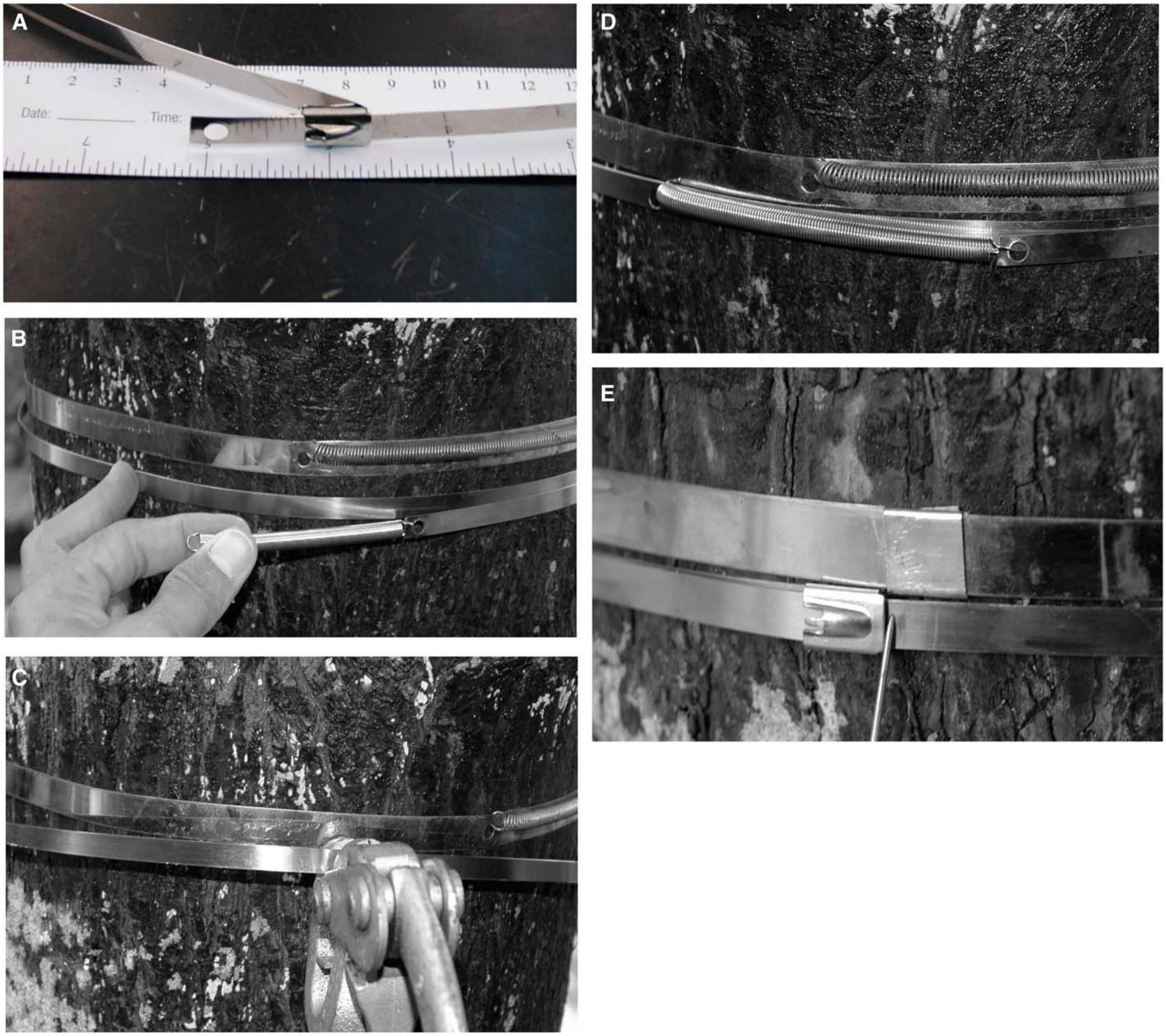

Fig. A3. Visual demonstration of dendrometer band installation. Thread the running end through the collar from right to left (A); snug the band into place, stretching the spring slightly (B); punch the second hole in the band (C); attach the spring (D); and (E) scratch the band next to the collar to mark the initial point from which growth will be measured.