# Section III: Vein Orders

The first step in describing the pattern of venation in a leaf is to recognize discrete categories or ***orders*** of veins that have similar widths and courses. Most angiosperm leaves have between four and seven orders of venation. The first step in describing venation is to recognize the first three orders of veins. In general, the primary and secondary veins are the major structural veins of the leaf, while the tertiary veins are the largest veins that fill the field of the leaf. The primary vein or veins are somewhat analogous to the main trunk or trunks of a tree--they are the widest veins, they usually taper along their length, and they generally run from at, or near, the base of the leaf to the margin. Secondary veins are analogous to the major limbs of a tree. They are the next set in width after the primary(s), they also usually taper along their course, and they ordinarily run from either the base of the leaf or from a primary vein toward the margin. For tertiary and higher order veins the analogy with the branching system of a tree breaks down. Tertiary veins are usually considerably narrower than the secondary set and have courses that connect primary and secondary veins to one another in a similar fashion throughout the leaf. Tertiaries are usually the widest veins that form a more or less organized "field" over the great majority of the leaf area. Generally it is fairly easy to recognize the primaries and tertiaries, but sometimes the secondaries consist of several subsets with different widths and courses. Nevertheless, all the subsets of veins between the primaries and the tertiaries are considered to be secondaries.

After the three lowest vein orders have been demarcated, the observer can proceed to discriminating the higher orders of venation (4-7) present in the leaf. Each of these higher vein orders can be highly variable among species and higher taxa in its degree of distinctness from both the next higher, and the next lower vein order. Good diagnostic features for distinguishing higher vein orders from one another are excurrent origin from their source veins and a distinctly narrower gauge. If they arise dichotomously or appear to be of the same, or nearly the same, width as their parent vein, they are of the same order as the source vein.

Obviously the simultaneous use of two criteria for the determination of vein order introduces a degree of ambiguity into the process because some veins may have the width typical of one vein order but the course typical of a different vein order. However, recognizing orders based solely on their width or solely on their course leads to illogical situations where veins that appear to have different functions and developmental origins are assigned to the same order. Assigning veins to orders also has a somewhat arbitrary aspect because variation in width and course is not discrete - for example, a vein may be intermediate in width between the primary vein and the secondary veins. However, there do appear to be natural breaks in the variation in width and course, so that most veins can be assigned to an order unambiguously. In our experience, vein orders can usually be defined in a repeatable manner for a given leaf by different observers who follow a consistent set of rules.

Leaves with veins that form a high number of discrete orders or that have regular courses, are considered to be more organized or "higher rank" leaves. The concept of leaf rank is discussed and illustrated in Character 46. Figures 8 and 9 demonstrate designation of vein orders for two leaves.

Below we provide a set of instructions for recognizing vein orders.

# Vein orders continued

General rule: All vein orders should be recognized in sequence from lowest to highest. The sole and rare exception is that some leaves with extremely acrodromous primary veins may lack secondaries (Fig. 28.6). To recognize the primary, secondary and tertiary veins, take the following steps.

1. Find the widest vein(s) in the leaf; this is the primary vein. Most leaves have a single primary vein and are called pinnate (if so, go to step 3). If more than one vein originates at or near the base of the leaf, then proceed to step 2 to determine if the leaf has one or more primary veins.

2. After recognizing the widest single vein of the leaf as a primary (generally the midvein), other primaries are recognized by being 74% or more of the width of the the widest primary (at the point of origin of the widest primary). These veins are basal or nearly basal. If these veins enter lateral lobes or run in strong arches towards the apex, they are generally easily recognized as primaries. But if the lateral primaries curve toward the midline apically (Fig. 28.6) or branch toward the margin (Fig. 28.3), they may be hard to distinguish from secondaries. In pinnatifid leaves, primaries may be difficult to distinguish from costal secondary veins.

   If there is more than one primary vein (based on vein width) other veins originating at the base may be considered primaries if their course and function is similar to that of the previously defined primaries, even if their width falls into the range of 25-75% of the widest primary vein. The width of these may fall within the width range of the secondary or tertiary veins. If these veins are narrower than 25% of the widest primary vein, they are not considered primaries.

3. Find the widest veins that fill the field of the leaf; these are the tertiary veins (refer to Character 35, 3° Vein Category). Proceed to step 4. (Watch out for rare exceptions such as Clusiaceae where secondary veins fill the field of the leaves.)

4. Having recognized the limits of the primary and tertiary vein sets, identify the intermediate set. These veins are secondary veins and may consist of costals (the rib forming veins that originate on the primary and run to the margin), interior secondaries, intersecondaries, outer secondaries, and intramarginal veins (refer to Character 29, 2° Vein Category). The secondaries will fall within a smooth continuum of width and behavior. Proceed to step 5. As noted above and illustrated in Figure 37.1, secondaries may be absent rarely.

5. Once you have recognized the first three orders of venation, proceed in sequence to determine the higher orders venation using the criteria of vein width and course.

Figures 8 and 9 on the following page show examples of vein orders.

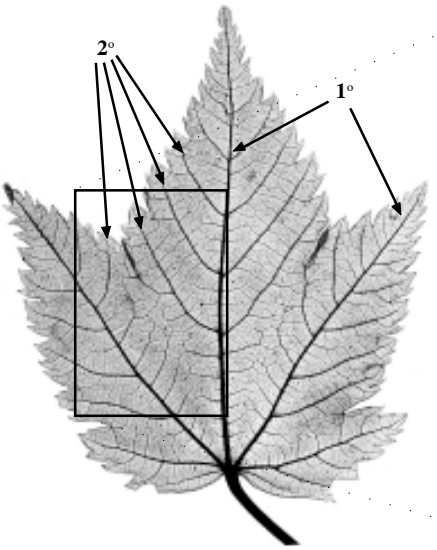



**Fig. 8a**

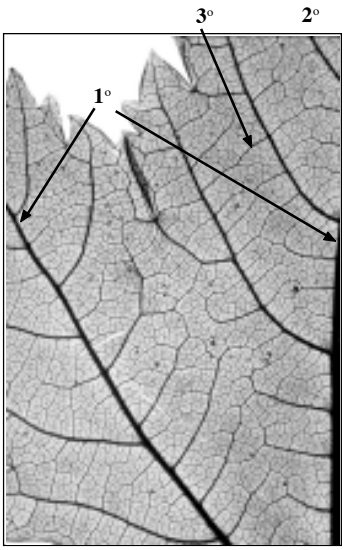



**Fig. 8b**

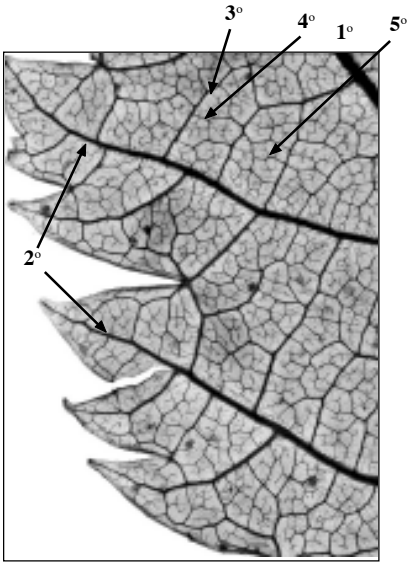



**Fig. 8c**

***Acer argutum*** **(Aceraceae)**

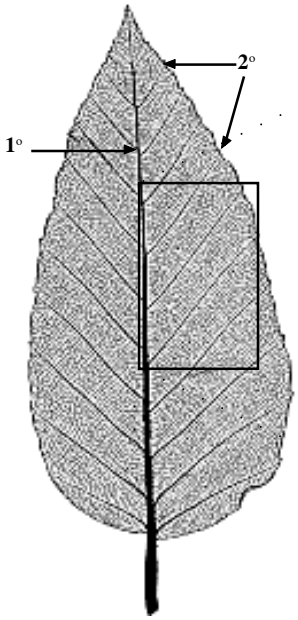



**Fig. 9a**

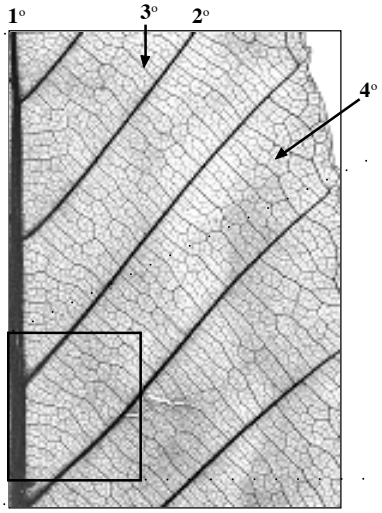



**Fig. 9b**

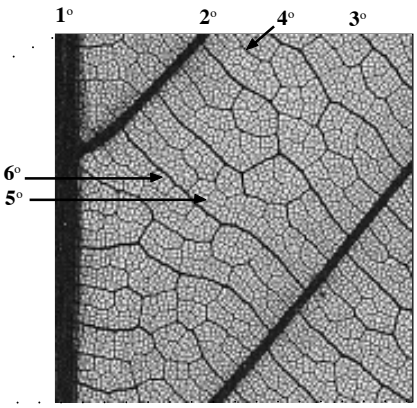
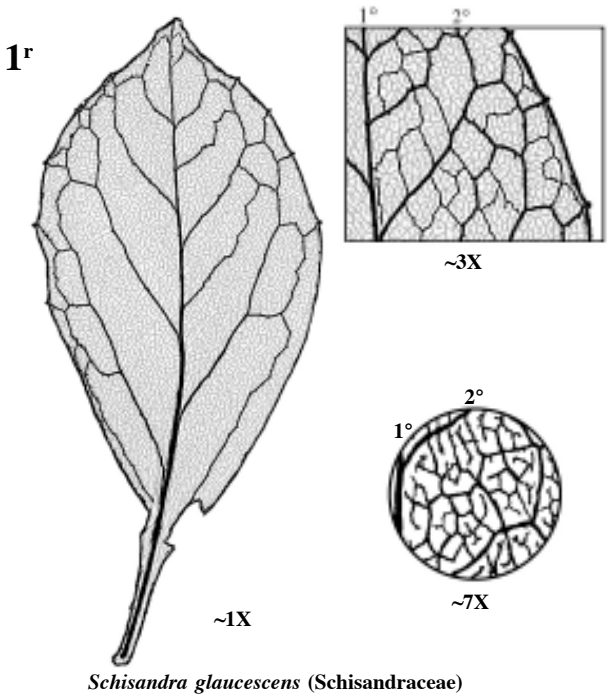



**Fig. 9c**

***Fagus longipetiolara*** **(Fagaceae)**

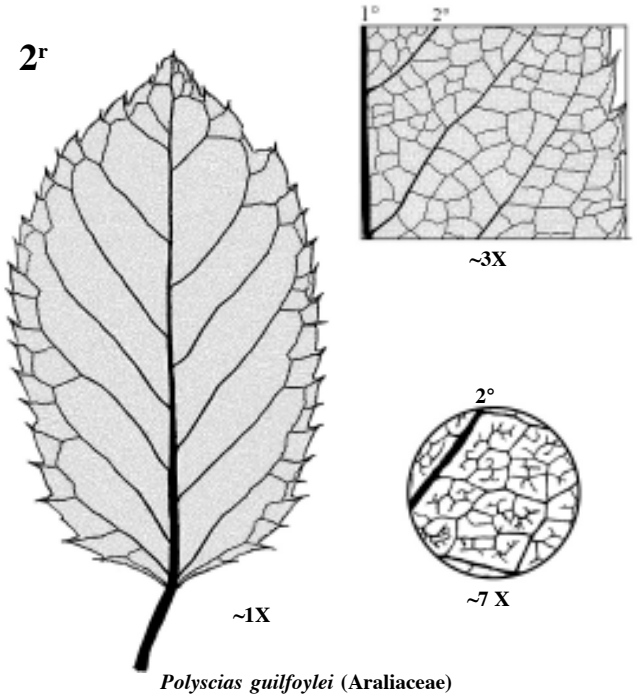
# 46. LEAF RANK

Leaf rank is a semiquantitative description of the regularity of the leaf's vein system, from an arbitrary level of 1r for the lowest rank or level of organization to 4r for the highest. The rank number corresponds to the highest order of veins that is well organized. The table on the next page gives the characters that define the ranks.



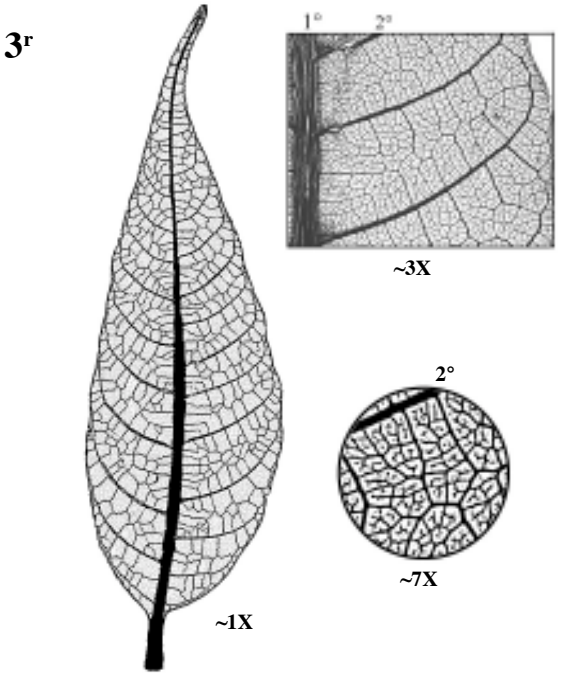

*Schisandra glaucescens* (Schisandraceae)

**Fig. 46.1**



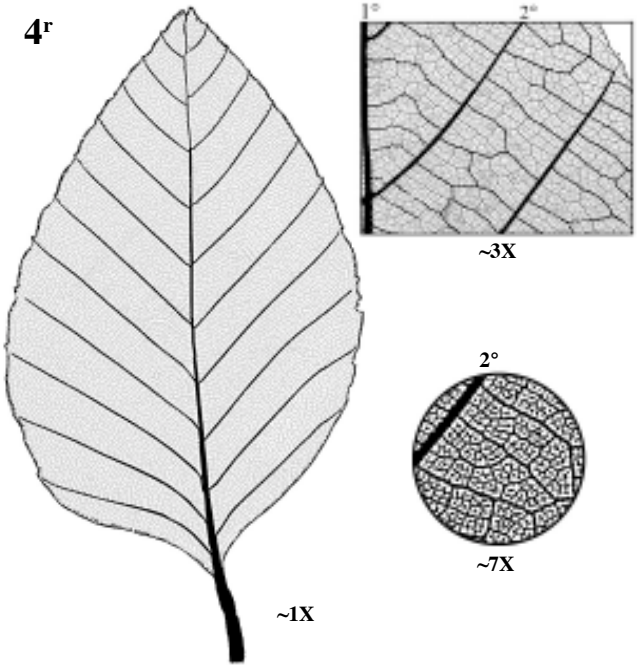

*Polyscias guilfoylei* (Araliaceae)

**Fig. 46.2**




*Toona sureni* (Meliaceae)

**Fig. 46.3**




*Fagus tientaiensis* (Fagaceae)

**Fig. 46.4**

| **Elements** | | **1r** | **2r** | **3r** | **4r** |
|---|---|---|---|---|---|
| 1º course | | regular, rarely irregular | regular | regular | regular |
| 2º vein | course<br>angle of origin<br>spacing | irregular<br>irreg. & decur.<br>irregular | regular<br>us. reg, not dec.<br>irreg. to reg. | regular<br>reg.- not dec.<br>regular | regular<br>reg. - not dec.<br>regular |
| intercostal | area | shapes vary | shapes similar | shapes similar | shapes similar |
| 3º veins | course<br>resolution<br>resolution | irregular<br>poor from 2º<br>poor from 4º | irregular<br>fair from 2º<br>poor from 4º | regular<br>good from 2º<br>good from 4º | regular<br>good from 2º<br>good from 4º |
| areolation | shape<br>size<br>orientation | irregular<br>irregular<br>irregular | irregular<br>irregular<br>irregular | becoming reg.<br>becoming reg.<br>irregular | regular<br>regular<br>oriented |
| vein orders with excurrent branching | | 1º-2º | 2-3º | 3-6º | 4-6º |
| blade - petiole separation | | poor | usually good | good | good |

**Fig. 46.5**