

---

## Vitaceae

Vitaceae Juss., Gen. Pl.: 267 (1789), nom. cons.

J. WEN

Hermaphroditic or polygamo-monoecious to polygamo-dioecious woody climbers or vines, rarely small succulent trees; stems unarmed, with conspicuous lenticels, or the bark sometimes shredding (in most species of *Vitis*), branches often swollen at the 3–7-lacunar nodes, pith continuous or interrupted by diaphragms at nodes; tendrils simple, bifid, or 2–3-, or 4–12-branched (in *Parthenocissus*), usually leaf-opposite, rarely tendrils 0; raphide sacs present in the parenchymatous tissues. Leaves simple, lobed or unlobed, digitately or pedately compound to 1–3-pinnately compound, alternate, distichous, variously toothed, commonly with multicellular, stalked, caducous spherical structures known as “pearl” glands; stipules 2 or rarely 0, often caducous. Inflorescences in panicles, corymbs, or rarely spikes, often leaf-opposed, pseudo-terminal, or axillary (in *Cayratia* and *Tetrastigma*). Flowers small, pedicellate, with prophylls, actinomorphic, hypogynous, 4–5(–7)-merous; calyx of 4–5(–7) small teeth or lobes or a continuous ring; petals valvate, 4–5(–7), free or basally connate, or distally connate to form a calyptra (e.g., in *Vitis*); stamens 4–5(–7), antepetalous, anthers tetrasporangiate or rarely bisporangiate, introrse, dehiscing longitudinally; floral disk intrastaminal, ring-shaped, cupular, or gland-shaped; ovary superior, 2-locular, with a simple style, the stigma discoid or capitate, rarely (*Tetrastigma*) 4-lobed, non-papillate; ovules 2 per locule, axile, appearing nearly basal, apotropous or anatropous, bitegmic and crassinucellar. Fruit a berry, 1–4-seeded; seeds endotestal with an abaxial chalazal knot and an adaxial raphe with 2 furrows one on each side; the embryo small and straight; endosperm oily and proteinaceous, copious, ruminate.

A pantropical family of 14 genera and about 750 species, with a few members in north temperate regions; nine genera in East and Southeast Asia.

**VEGETATIVE MORPHOLOGY.** Vitaceae are usually woody climbers or herbaceous vines (often in

*Cayratia*), or small succulent trees (e.g., in some *Cissus* and *Cyphostemma*). They have generally leaf-opposite tendrils, which are considered to be modified shoots or inflorescences (Tucker and Hoefert 1968; Gerrath et al. 2001). In *Parthenocissus* and *Vitis*, a portion of the primordium may be induced to form flowers, with the remainder developing as a tendril arm (Millington 1966; Boss and Thomas 2002). Tendrils sometimes bear adhesive suckers (as in *Parthenocissus*, some young vegetative *Cissus*, and *Tetrastigma obtectum*), enabling the plants to climb up tree trunks, rocks, and cliffs. The branching patterns of the tendrils vary greatly from 2-furcate or 2–3-branched to 4–12-branched (as in *Parthenocissus*) or unbranched. Most species of the family have an interrupted tendril pattern, in which tendrils are at two nodes in a three-node sequence. *Cissus alata* exhibits tendrils at each node. The distribution of the various tendril patterns in Vitaceae needs to be examined.

The phyllotaxis of Vitaceae is unusual because the shoot apex produces both leaf primordia and “uncommitted” primordia (Lacroix and Posluszny 1989a). The latter may develop into either tendrils or inflorescences, but at initiation of the uncommitted primordia there is no structural evidence on their fate (Posluszny and Gerrath 1986).

Stem growth is monopodial (e.g., in *Ampelopsis brevipedunculata*, *Tetrastigma voinerianum*) or sympodial, or sometimes appearing dichasial (e.g., in *Rhoicissus rhomboidea*; Suessenguth 1953a). The sympodial condition was considered to be the basal character state of the family (Gerrath et al. 1998). Gerrath et al. (2001) proposed five basic patterns in shoot architecture (Fig. 162). Pattern 1 is characterized by spiral phyllotaxis, a lack of tendrils, and presence of terminal inflorescences (e.g., some *Cyphostemma* that are not lianas). Patterns 2–5 are found in lianas, and have distichous phyllotaxis. Pattern 2 has interrupted tendrils and axillary buds at the one tendril-less node in the three-node se-

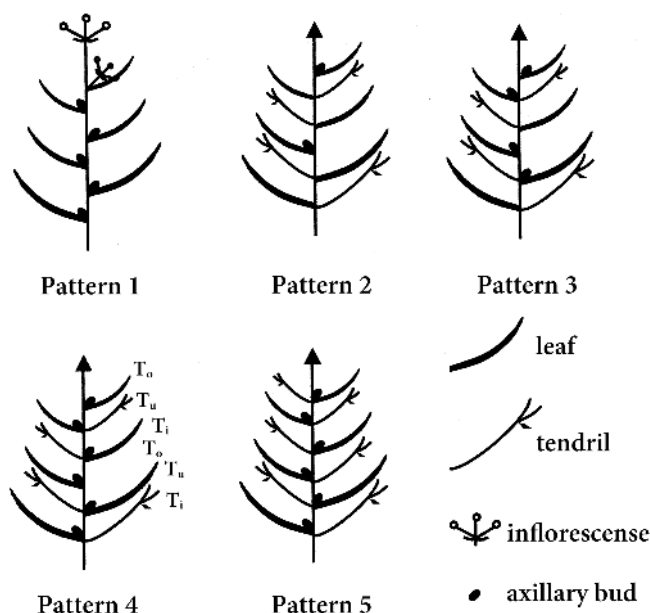


Fig. 162. Vitaceae. Shoot architectural patterns. (Gerrath et al. 2001)

quence (e.g., *Cissus antactica* and *Parthenocissus trifoliata*). Pattern 3 has interrupted tendrils and axillary buds at two of three nodes, the upper tendril node and tendril-less node (e.g., *Parthenocissus inserta*). Pattern 4 is characterized by interrupted tendrils and continuous axillary buds (e.g., *Vitis riparia* and *V. vinifera*). Pattern 5 has continuous tendrils and continuous axillary buds (e.g., *Cissus alata*).

Leaf form varies greatly in the family, with simple or compound leaves. Compound leaves can be palmate, 1–3-pinnate, or ternate. Simple leaves are often palmately divided. Both palmate (usually) and pinnate venations occur in the family. Heterophylly is common in many taxa (Critchfield 1970; Gerrath and Posluszny 1989a; Gerrath et al. 2004). The KNOTTED1-like homeobox (*KNOX1*) genes regulate the development of the leaf from the shoot apical meristem, and may regulate leaf architecture. In *Vitis*, simple leaves are developed from complex primordia through secondary morphogenesis. This developmental pattern is similar to that in *Cissus congestum*, which has trifoliate leaves (Bharathan et al. 2002). The simple leaves in Vitaceae may thus well represent a derived character state, although the evolution of leaf form in Vitaceae is still poorly understood. In several members, the stipules develop before the associated leaf blade and function as protective structures enclosing the rest of the shoot tip (Shah 1959; Lacroix and

Posluszny 1989b; Gerrath et al. 1998). Domatia are sometimes present as tufts of hairs or pits.

**VEGETATIVE ANATOMY.** Leaves in Vitaceae commonly bear “pearl” glands. These glands are usually spherical structures, each with a short stalk. Inside the gland are large polygonal cells surrounded by epidermal cells with a stoma usually situated opposite the stalk. Walter (1921) found evidence for the appearance of pearl glands in *Vitis* and *Parthenocissus* under increased cell sap concentration.

The mesophyll contains calcium oxalate crystals and mucilage cells, often with raphides in bundles of several hundreds per cell (Metcalf and Chalk 1950; Arnott and Webb 2000). Raphide sacs usually have mucilage as well as crystals. Raphides also give fruits of many Vitaceae species an acrid and stinging taste, and can be irritating to tongue and mouth. Sometimes mucilage cells are present. Vitaceae usually have 5–7 leaf traces, although variability (e.g., 3, 4 and 8) has been documented.

Leaf epidermal characters have been studied by Ren et al. (2003). They found anomocytic stomata in *Ampelocissus*, *Ampelopsis*, *Parthenocissus*, *Vitis*, and *Yua*, whereas *Cayratia*, *Cissus*, *Rhoicissus*, and *Tetrastigma* possess staurocytic, hemiparacytic or cyclocytic stomata. *Yua* is distinguished from other genera by its papillate leaf cuticle, whereas the pattern in other genera is striate, scaly or granular.

Wood of Vitaceae has exclusively simple perforation plates, large rays, vessel-ray parenchyma pits with reduced borders, storied imperforate elements, scanty paratracheal parenchyma, and septate fibers (Adkinson 1913; Wheeler and Lapasha 1994; Poole and Wilkinson 2000). Vessels are large in comparison with those in the close relatives in Leeaceae. Genera of Vitaceae can differ in vessel size and arrangement, vessel pitting (scalariform or alternate), crystal type (prismatic, druses, or raphides) and location (in chambered parenchyma or ray parenchyma), and cambial variants (present or 0).

The secondary phloem develops from the cambial ring or sometimes via concentric cambia (e.g., in *Tetrastigma*). It is stratified into hard (fibrous) and soft (parenchymatous) zones, or not stratified (Esau 1948). Sieve-tube plastids in Vitaceae are unusual in having starch and protein inclusions (P-type I (b); Behnke 1991).

**INFLORESCENCE AND FLORAL STRUCTURE AND DEVELOPMENT.** The thorough analysis by Troll (1969) has shown that the inflorescences of Vita-