

# KEY TO THE SPECIES OF *DIOON*

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## Preamble

The genus *Dioon* is particularly difficult to work with taxonomically because the differences between species are subtle. The range of form within the world's other major cycad genera—*Cycas*, *Ceratozamia*, *Encephalartos*, *Macrozamia*, and *Zamia*—is much more considerable, thus making identification by key a slightly easier task. The following key is designed to enable workers to identify all known species within the genus *Dioon*, as well as several distinct "types" that are currently under investigation.

When working with keys, it is important to remember that they are contrivances to facilitate identification, not phylogenetic or taxonomic schemes. As such, the overall arrangement of species and the individual pairings provided do not necessarily imply relationship. Perhaps not coincidentally, the species within the "Spinulosum" Clade differ significantly from the species in the "Edule" Clade and, by definition, clades do represent phylogenetic groupings. Similarly, the traits that separate the three species within the "Spinulosum" Clade produce a hierarchical structure for the respective species that coincides with published phylogenetic relationships.

By convention of the participants, an attempt has been made to adhere to the glossary provided in the proceedings of the Cycad Classification Concepts workshop (Walters & Osborne, 2004)—held in April 2002 at the Montgomery Botanical Center in Miami, FL, USA—as the standard of definition for all cycad morphological terminology. In addition, Grobbelaar's (2003) excellent book identifies important angles of leaflet insertion and we have chosen to follow his novel convention herein. Workers may need to reference both works to fully appreciate the proposed key.

It is our intention to provide a key that can be used in the absence of reproductive structures. Not only are the strobili of *Dioon* species much less distinct compared to the other large cycad genera, but they are also often not present in habitat. Therefore, we have developed a vegetative key that can be applied almost entirely using adult leaf material. Identification of *Dioon* seedlings is also quite difficult; thus, eophylls are mentioned only when diagnostic. On occasion, reference is made to newly emergent leaves, but each applicable couplet also contains character separations based on hardened leaves.

It is important to remember that considerable variation exists within many species in this genus. While we have tried to account for the major contingencies, exceptions are regularly encountered. For example, marginal prickles may or may not be present in many instances, and some leaves may be flat or keeled. In addition, differences in leaf morphology can sometimes be found even within a single cohort of leaves on an individual plant, which, in turn, may differ slightly from leaves in previous cohorts. Thus, there is no substitute for a large sample size when contending with vegetative traits.

It is our hope that, in spite of these daunting subtleties and seeming ambiguities, this key will aid in the identification of species within this most "difficult" cycad genus.

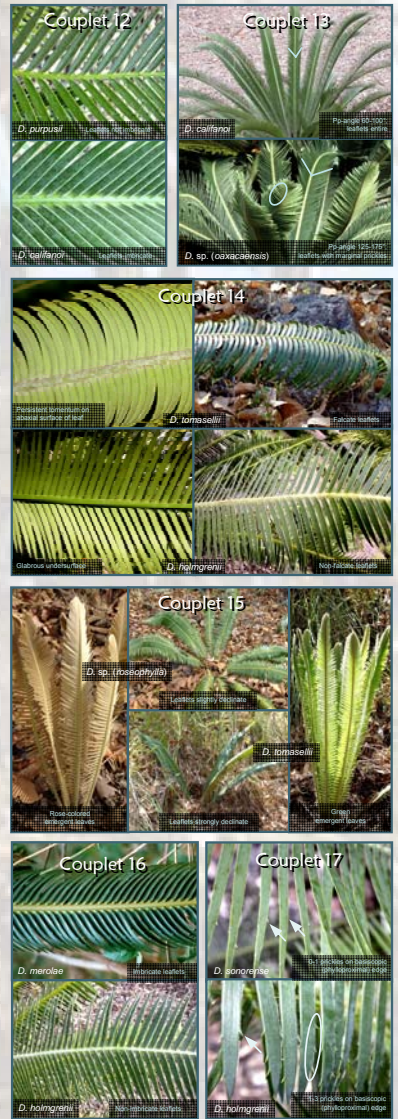
## Illustrations (Couplets 1-11)



## Vegetative Key

- "Spinulosum" Clade**
- 1A. Adult leaflets wide (usually  $\geq 15$  mm); eophyll leaflets wide with serrated margins
  - 2A. Median leaflets of adult leaves elliptic-ovate, pungent; eophylls resembling adult leaves, with proximal leaflets reducing to pinaculata; and with petioles short ( $\leq 20\%$  of leaf length) or absent; emergent leaves densely, persistently tomentose *D. molle*
  - 2B. Median leaflets of adult leaves lanceolate; not pungent; eophylls with proximal leaflets nearly equal in size to median and distal leaflets and with long, unarmed petioles ( $\geq 50\%$  of leaf length); emergent leaves glabrous to pubescent
  - 3A. Adult leaves to 2 m long, usually lacking petioles; proximal leaflets lanceolate, reducing to pinaculata; median leaflets symmetrically lanceolate, to 21 cm long and 20 mm wide; distal and median leaflet margins usually serrated; leaflet attachment usually slightly decurrent; emergent leaves glabrous *D. spinulosum*
  - 3B. Adult leaves to 1.8 m long with unarmed petioles 10–15 cm long; proximal leaflets linear-lanceolate to linear, reducing, not to pinaculata; median leaflets asymmetrically lanceolate, to 19 cm long and 25 mm wide; distal and median leaflet margins usually entire; leaflet attachments strongly decurrent; emergent leaves pubescent *D. rzedowskii*
- "Edule" Clade**
- 4B. Adult leaflets narrow ( $< 15$  mm); eophyll leaflets narrow, distally serrated
  - 4A. Leaflets flat, not declinate or deflexed; margins sometimes strongly revolute
  - 5A. Leaves flat or slightly keeled (pp-angle  $> 165^\circ$ )
  - 6A. Leaflets usually ( $> 95\%$  of individuals) entire
  - 7A. Leaflets  $< 6$  mm wide, flat
  - 7B. Leaflets  $> 7$  mm wide, flat to strongly revolute *D. edule*
  - 8B. Leaflets usually ( $> 80\%$  of individuals) with marginal prickles
  - 8A. Leaflets  $< 7$  mm wide; narrowed gap between leaflets  $< 0.7\times$  leaflet width
    - 9A. Pp-angle  $45-60^\circ$ ; leaflet adaxial surface dull but not glaucous; leaflet prickles few (sometimes absent) and large (2 mm) relative to leaflet width; leaflet length/width ratio usually  $< 1.2$  (80% of individuals) *D. caputoi*
    - 9B. Pp-angle  $60-90^\circ$ ; leaflet adaxial surface frequently glaucous; leaflet prickles usually (80% of individuals) present; leaflet length/width ratio usually  $\geq 1.2$  (75% of individuals) *D. sonorense*
  - 9B. Leaflets  $> 7$  mm wide; narrowed gap between leaflets  $< 0.5\times$  leaflet width
  - 10A. Mature leaflets persistently tomentose on adaxial surface and pubescent on abaxial surface *D. argenteum*
  - 10B. Mature leaflets glabrous on adaxial and abaxial surfaces
    - 11A. Leaflets with 2-6 total prickles, 1-3 on basiscopic (phyllonomeral) edge; leaflet width usually  $\geq 8$  mm (80% of individuals) *D. holmgrenii*
    - 11B. Leaflets with 1-3 total prickles, 0 on basiscopic (phyllonomeral) edge; leaflet width usually  $< 8$  mm (50% of individuals) *D. sp. (mixoquensis)*
  - 12A. Leaflets usually not imbricate; rachis usually stiff and straight; pp-angle  $100-160^\circ$
  - 12B. Leaflets usually imbricate; rachis straight or recurved; pp-angle either  $< 100^\circ$  or  $> 120^\circ$
  - 13A. Pp-angle  $60-100^\circ$ ; pp-angle  $30-45^\circ$ ; rachis frequently recurved in distal 25-50% of length; leaflets frequently (20-50% of individuals) entire *D. callitroch*
  - 13B. Pp-angle  $125-175^\circ$ ; pp-angle  $60-70^\circ$ ; rachis usually ( $> 95\%$  of individuals) stiff and straight; leaflets usually ( $> 90\%$  of individuals) with prickles *D. sp. (caucasicensis)*
- 4B. Leaflets declinate or deflexed on rachis
- 14A. Abaxial leaflet surface persistently pubescent; pp-angle ca.  $90^\circ$ ; leaflets flat with tips curving proximally, frequently (up to 50% of individuals) entire *D. sp. (rosaphylla)*
  - 14B. Emergent leaves rose colored; leaflets slightly to moderately declinate, usually ( $> 90\%$  of individuals) with marginal prickles; adult leaf length usually (90% of individuals) 65-115 cm; adult trunk  $< 15$  cm in diameter *D. sp. (rosaphylla)*
  - 15B. Emergent leaves green; leaflets moderately to strongly declinate, frequently (60-90% of individuals) entire; adult leaf length usually (90% of individuals) 98-198 cm; adult trunk  $> 15$  cm in diameter *D. tonsoletii*
- 14B. Abaxial leaflet surface glabrous; pp-angle  $< 80^\circ$ ; leaflets not flat with tips not curving proximally, usually ( $> 80\%$  of individuals) with marginal prickles
- 16A. Leaflets imbricate, recurved, with tips curving distally, forming a regular pattern; adaxial leaflet surface usually nitidus *D. merolae*
  - 16B. Leaflets not imbricate; flat; adaxial surface dull or glaucous
  - 17A. Leaflets  $< 7$  mm wide, with 0-1 total prickles, 0-1 on basiscopic (phyllonomeral) edge; adult trunk usually  $< 1.2$  m in length *D. sonorense*
  - 17B. Leaflets  $> 8$  mm wide, with 2-6 total prickles, 1-3 on basiscopic (phyllonomeral) edge; adult trunk usually ( $> 80\%$  of individuals) 1.5-8 m in length *D. holmgrenii*

## Illustrations (Couplets 12-17)



## Distribution of *Dioon*



## References

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## Glossary

**abaxial**: Side of organ facing away from central axis; e.g. lower side of leaf or leaflet. Cf. **adaxial**.

**asymmetrically**: Tapering to protracted point, with sides nonparallel concave.

**axial**: Side of organ facing towards central axis; e.g. upper side of leaf or leaflet. Cf. **abaxial**.

**basiscopic**: Leaflet margin closest to the base of the leaf. See also **phyllonomeral**. Cf. **acropscopic**, **phyllostyl**.

**distal**: Farthest from point of attachment; **axial**. Cf. **proximal**.

**edge**: Two-dimensional structure without inner or outer side; not flattened toward each rounded end.

**entire**: Continuous margin, not toothed or lobed. Cf. **serrate**.

**epiphyll**: First leaf produced by seedling.

**glabrous**: Smooth surface; without hair or any kind. Cf. **pubescent**, **tomentose**, **glaucous**. Surface covered by short grey, white or silvery pubescence. Cf. **albescens**.

**imbricate**: Leaflet arrangement in which one leaflet partially shades next distal leaflet (concave) or next proximal leaflet (convex) when viewed from above.

**keeled**: Vein shaped; assembling long but broad; wide base; tapered apex; widest below center.

**lanceolate**: Lance-shaped; much longer than broad.

**linear**: Long and narrow; sides parallel or nearly so.

**nitidus**: Smooth and shiny. Cf. **glaucous**.

**petiole**: Section of leaf axis between stem/leaves; **pinaculata**, or **pinna**.

**phyllonomeral**: Leaflet margin that, in uninvolved leaflet, is directed toward proximal part of leaf. See also **basiscopic**. Cf. **acropscopic**.

**pp-angle**: Sharp-pointed structure intermediate between leaflet and spine, usually green.

**prickle**: Pinnate angle (pinna = leaflet) measures angle, on abaxial side of leaf, between pinna in which long axis of leaflet is directed through distal end of leaflet and rachis in distal direction.

**prickle**: Small, sharp protrusion of epidermal origin, usually green and somewhat irregularly distributed.

**prostrate**: Near to point of attachment; **base**. Cf. **distal**.

**pubescent**: Covered with fine, short hair. Cf. **glabrous**.

**pungent**: Terminating in a stiff, sharp spine.

**pubescent**: Section of leaf axis where leaflets are attached.

**recurved**: Bent or turning abaxially.

**revolute**: Margin of leaf or lobed, sharply-tipped protrusions pointing apically. Cf. **winke**.

**tomentose**: Densely woolly in a feely matted fashion. Cf. **glabrous**.

## Notes

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Credits: Background photo of *Dioon callitroch* in habitat, L. Whitlock; drawing of *D. callitroch* (above), & *spin* (both from Whitlock, 2002)