PHILOSOPHY

In the years since publication of *The Jepson Manual: Higher Plants of California*, or *TJM* (1993), the study of evolutionary relationships and classification (systematics) has undergone revolutionary change, with rapid innovations in molecular biology, evolutionary methods and philosophy, and computer technology. Those changes have allowed for rapid progress in resolving evolutionary relationships (phylogeny) at deep- and fine-scale levels of divergence, with much focus on California's vascular plants. At the same time, botanists have been targeting under-collected areas of California with high potential for harboring new diversity (e.g., on unusual soils, such as serpentine), aided by the rise of electronic databases of herbarium (botanical museum) specimens and innovative search capabilities across those collections (i.e., the Consortium of California Herbaria). Other botanists, with close attention to alien taxa, have documented the recent rise (and occasional extirpation) of introduced plants, which continue to become naturalized in the state.

All of the above advances have translated to accelerated botanical discovery for California, including about 150 minimum-rank taxa (species, subspecies, and varieties) that have been described as new-to-science since publication of *TJM* (1993). In addition, higher-level classification of Californian plants (e.g., genera and families) has been revised to reflect monophyletic groups (clades, i.e., containing all and only descendants of a common ancestor) more precisely. All of these improvements to California plant classification, evident throughout *The Jepson Manual, Second Edition* (*TJM 2*), are essential to making taxonomy reflect evolutionary groups that are of primary importance to conservation and comparative biology.

TJM 2 is organized to follow the new understanding of vascular plant phylogeny. Families are grouped together into eight major clades of vascular plants. The relationships of all families included in *TJM 2,* as currently understood, are shown on the back endpaper, along with the page numbers where they are treated (also see the Angiosperm Phylogeny Website: http://www.mobot.org/MOBOT/Research/APweb/welcome.html). Within each major clade, families continue to be presented alphabetically (for convenience), but the relationships indicated on the back endpaper should aid identification of plants to family. Taxonomies presented here include some that depart from those in other floras; authors were encouraged to produce such treatments if adherence to the book philosophy (e.g., the criterion of monophyly) warranted it.

TJM 2 has been guided by the importance of the above developments and the conviction that all evolutionary groups warranting taxonomic recognition should be included, so that *TJM 2* can serve well as a primary reference on California's native and naturalized vascular plant diversity. In some instances, the need to be comprehensive has required that authors recognize taxa that are cryptic; that is, difficult or impossible to recognize reliably based on morphology alone, but distinct evolutionarily (and often ecologically) based on multiple lines of evidence. Such examples force us to confront the relative importance in taxonomy of practicality, on the one hand (e.g., identification difficulty), and evolutionary real-

ity, on the other hand. For reasons of scientific accuracy, the latter approach was adopted here. Plants do not necessarily change in ways that are readily evident to human senses, although they may still be divergent in ways that are important to their survival or even to humans (e.g., in producing different chemical compounds). Sometimes the decision as to whether or not to recognize cryptic taxa is forced on botanists by the finding that such entities are not even each other's closest relatives (e.g., *Lasthenia californica* and *L. gracilis*, in Asteraceae; *Downingia pulcherrima* and *D. willamettensis*, in Campanulaceae).

From the standpoint of practicality, production of *TJM 2* was marked by a strong commitment to improving the ability of botanists to identify California vascular plants. Even without considering cryptic diversity, the difficulty of distinguishing closely related plants in the California flora is often challenging, in part because of the youth of much of the plant diversity in the state. Major effort went into ensuring that keys and descriptions are internally consistent and functional. Another strategy to aid plant identification in *TJM 2* was to refine, augment, and add illustrations, with 272 full plates compared to 242 in *TJM* (1993), including a substantial increase in the number of taxa illustrated and in the amount of illustrative detail provided for taxa included in plates in *TJM* (1993). Illustrations, like written treatments, underwent rigorous editing to find and correct problems. Posting of treatments upon completion of editing (but well prior to publication) on the Jepson Herbarium website also helped to allow input from botanists worldwide, who provided helpful reviews.

Accuracy of other components of treatments beyond keys and morphological descriptions also were editorial priorities. For example, geographic and elevational ranges of taxa were improved by drawing attention to outlying records in the Consortium of California Herbaria and aiding authors in resolving such discrepancies, where practicable. In addition, some of the changes in plant names evident in *TJM 2* are not the result of taxonomic changes (i.e., changes that reflect revised understanding of plant relationships) but instead of nomenclatural matters, where a name previously applied to a particular plant group was found to be incorrectly used or to be superseded by another name. In other cases, the authorship assigned to scientific names in *TJM* (1993) and elsewhere was found to be in error and was corrected.

The magnitude of change in *TJM 2* relative to *TJM* (1993) is difficult to express quantitatively. For example, inclusion of 185 plant families in *TJM 2* and 172 in *TJM* (1993) fails to capture the magnitude of revision involved, with 13 families from *TJM* (1993) now treated within other families, 30 families within *TJM 2* that were not recognized in *TJM* (1993) — some (22) segregated from families recognized in *TJM* (1993) and some (8) comprised of taxa that are new to California (all naturalized) — and 1 family extirpated from the state (Cymodoceaceae; an alien here). Similar considerations mask much of the revision that is represented in considering that more than 6500 native minimum-rank taxa (species, subspecies, and varieties) are recognized in *TJM 2*, about 310 more than in *TJM* (1993). In addition, the relatively modest increase in number of naturalized minimum-rank taxa in *TJM 2* (now numbering about 1100 total), about 30 more than in *TJM* (1993), is explained in part by downgrading of some taxa to waif status that were treated as naturalized in *TJM* (1993).

Important elements of the philosophy of *TJM* (1993) and the philosophy of Willis Linn Jepson are still embraced in *TJM 2*, including a commitment to producing a field portable volume that will serve botanists of diverse backgrounds. Like *TJM* (1993), *TJM 2* owes much to the collaborative spirit and international scope of this effort, with hundreds of authors and a sizable group of editors, staff, and illustrators. Most of these individuals worked without compensation, apart from the satisfaction of contributing their knowledge, time, and effort to further floristic knowledge and conservation. Jepson's philosophy that floristics is a never-ending study also aligns with the *TJM 2* effort, which helped to refocus attention on Californian plants that led to discoveries made too late for inclusion here. The growing urgency of rapidly communicating new discoveries to the broader community requires a new approach, one of continual revision and immediate distribution to the botanical community, as is possible now with the new *Jepson eFlora* (see inside front cover).

CONVENTIONS USED IN *THE JEPSON MANUAL, SECOND EDITION*

Producing a field-portable manual on the California flora that is accessible to a wide audience requires balancing somewhat competing interests. For example, if technical terms are reduced in the interest of user-friendliness, more words are generally necessary to convey descriptive information and the book must be larger. In part to balance the increase in new plant taxa for California, *The Jepson Manual, Second Edition* (*TJM 2*) includes more technical terms — about 100 additional glossary entries — than were included in *The Jepson Manual*, or *TJM* (1993), and has continued other space-saving conventions (also see Glossary introduction). These other conventions include a concise, abbreviation-rich format that is described here (also see Abbreviations and Symbols). Those familiar with *TJM* (1993) will find many of the same conventions in *TJM 2* but also some that might not be understood without the explanation provided below.

General Conventions

Comprehensiveness. A primary goal of *TJM 2* was to include all native and naturalized vascular plant taxa in California that are accepted by *TJM 2* authors as scientifically sound (also see Philosophy). Natives include both endemic and non-endemic, indigenous taxa. Naturalized plants are defined here as aliens growing in wild or approximately wild conditions and reproducing either sexually or asexually. Aliens that occur in such conditions but are not reproducing and therefore not persisting and becoming established parts of the flora are considered here to be waifs. Recently documented waifs are included in the keys (with names in square brackets) but their descriptions appear only online, in the *Jepson eFlora* (see Associated Electronic Resources, inside front cover). Waifs that have not been collected recently (in the last half-century or so) are not treated at all in *TJM 2*, under the assumption that such "historical waifs" have not persisted to become established parts of the flora. Also excluded here, in general, are taxa represented in California by non-reproducing but long-persisting individuals (e.g., planted fruit trees) or clones. Alien taxa occurring outside cultivation but only in highly modified environments, such as urban, suburban, or agricultural lands, are not included in *TJM 2*.

The establishment status of alien plant taxa in California is dynamic and sometimes questionable based on the best available evidence. Extensive consultation with weed scientists and other botanists focused on naturalized taxa in California helped greatly to improve treatment here of aliens. Nonetheless, some fully naturalized taxa as well as waifs probably have not been included in *TJM 2*; documentation was lacking to substantiate some reports that were considered during treatment preparation. In addition, alien plants in general are often given low priority by collectors, with the result that there are gaps in our knowledge of alien plants occurring outside of cultivation in California. Because of the potential harm that alien taxa can inflict on populations of native plants and animals and their habitats,

there is an ever-growing need to monitor their occurrences, as well as to document them with the addition of properly accessioned and curated specimens to herbaria.

Uniformity. A consequence of treating an exceptionally diverse and complex flora is that many specialists are needed to describe it well. Differences among the hundreds of contributing authors in philosophy and style were constrained by editorial conventions on terminology, structure of treatments, and taxonomic philosophy. Nonetheless, differences remain that are unavoidable in a work with such a high level of taxonomic coverage and scientific participation.

Organization. The book is organized into eight major monophyletic groups or clades that reflect the most recent classification systems of vascular plants (also see Philosophy): Lycophytes, Ferns, Gymnosperms, Nymphaeales, Magnoliids, Ceratophyllales, Eudicots, and Monocots. Families within these groups, genera within families, species within genera, and infraspecific taxa within species are arranged alphabetically for convenience, but relationships among the families are depicted on the back inside cover. Difficulty in identifying the family of an unknown plant may be aided by considering families that are most closely related to the one in consideration.

Measurements. All linear measurements are given in metric units. Conversion scales (centimeters to inches, meters to feet) are provided near the end of the book (after the index).

Illustrations. Illustrations are provided here to convey descriptive information that the written word cannot adequately express. All native genera are at least partially illustrated. Because all taxa could not be illustrated, priority was given to native taxa considered to be sufficiently uncommon or threatened to warrant monitoring or, conversely, to aliens that are very likely to be encountered, as well as aliens that have become increasingly problematic because of their growing numbers. Unusual or difficult diagnostic features were also given priority in illustrations. Illustration plates of taxa appear on right-handed pages and, with few exceptions, appear after the descriptions of the taxa they represent; order within a plate is primarily alphabetical.

Index. All family names, genus names, common names, names in notes, and names here considered to be synonyms (or to have been misapplied to plants in California) are listed alphabetically in the index. Accepted specific and infraspecific names are excluded from the index because they are ordered alphabetically under the appropriate genus and therefore are easily found.

Appendices from *TJM* (1993). Appendix I (floristic summary) has been revised. Appendix II (classification of California plant families) has been replaced in part by online resources, and in part by the phylogenetic tree of California vascular-plant groups and families on the back inside cover. Appendix III (name changes) has been replaced by various resources on our website, including primarily the Index to California Plant Names (ICPN), which is intended to account for names that have been applied to plants in California, as accepted names, synonyms, or misapplied names.

Conventions Applying to Keys

In addition to comprehensively treating California's native and naturalized vascular plants, a central goal of *TJM 2* is to facilitate plant identification. Dichotomous keys are the primary means to identify plants treated here (descriptions are primarily useful for confirming identifications). Although so-called natural keys also serve to convey relationships among the included taxa, this book primarily uses artificial keys, which are organized principally for ease of usage rather than for expressing relationships (natural keys can be difficult to use if trait evolution within groups has been dynamic). Where characters used in keys here correspond with characters that are useful for recognizing natural groups or clades of taxa, then those components of the keys can be considered natural, and artificial

keys often contain a mix of natural and artificial constructs. Artificiality of keys should not be confused with artificiality of taxonomy; classification of plants recognized in *TJM 2* is guided by a commitment to recognizing natural or monophyletic taxa (see Philosophy).

A dichotomous key is a series of paired, mutually exclusive statements that divides a group of unknowns into progressively smaller subsets until all possibilities but one have been eliminated. Keys are used here to identify plants to family, genus, species, and, if pertinent, subspecies and/or variety. To enhance efficiency, for each pair of statements (couplet), the choice (lead) under which fewer taxa appear is given first. In this way, for example, a very unusual species or group of species within a large genus may be identified without having to read through the entire key; this convention also tends to bring the two leads of a couplet closer together physically, thereby enhancing the ability to compare and contrast and then choose between them. Within this arrangement, taxa appear alphabetically.

Ideally, key leads are mutually exclusive and allow for a straightforward solution, but complex patterns of variation in some groups (e.g., as a result of recent evolutionary divergence of taxa or a history of hybridization) or absence in a partial specimen of a key character for a particular couplet may necessitate trying both leads, and reading through subsequent couplets, in order to make the correct choice. Some taxa are so complex or variable that an easily usable key cannot be constructed in which each taxon keys out in only one place. The names of such taxa are preceded in the key by a superscript indicating the number of times that taxon occurs in that key (or, for subdivided keys in some large families or genera, in a particular key "group").

Keys are generally written so that the more effective and more easily determined traits appear earlier in the lead. Sometimes, unfortunately, only a single feature allows for a choice between leads. To facilitate the choice between two leads in a couplet, traits are presented in the same order and described in the same form, to the extent possible, in both leads. Unilateral statements are included in some couplets, but in each case they are set off, after an em-dash, at the end of the lead to alert users that the trait or traits involved are not addressed in the other lead. As in descriptions (see below), character states indicated in parentheses generally are rare or exceptional conditions, although sometimes parentheses are used to provide additional context or explanatory information. Square brackets are sometimes used for the last-mentioned purpose in keys (e.g., in the key to families), unlike in descriptions, where square brackets are used to indicate conditions that apply only to plants outside California (see below).

The sequence of keys that are used to obtain an increasingly refined identification of an unknown vascular plant follows from the key to groups of families, to the key to families within each group, to the key to genera within each family, and finally to the key to species, subspecies, and varieties within each genus. In some cases there are keys to groups of genera within a family or to groups of species and infraspecific taxa within a genus. One or more of the early keys in the above sequence can be bypassed, of course, if the family, genus, or species of the plant in hand is already known. In some keys, e.g., the key to families, accommodation was made for common mistakes and misinterpretations, so that the correct answer may be obtained even if a technical error is made.

A key to the genera of a family follows each family description, if there is more than one genus in California. Normally, a key to species as well as any infraspecific taxa (subspecies or varieties) follows each genus description, if there is more than one taxon at the level of species or below in California. For a few very large, complex genera (e.g., *Astragalus*), keys to some infraspecific taxa occur after the description of their respective species.

Conventions Applying to Descriptions

All Descriptions. Descriptions address variation among Californian members of a taxon, with information pertaining only to (some or all) members of that taxon occurring outside California

enclosed in square brackets. Space constraints did not allow for addressing all characters for all taxa or even for addressing in descriptions all characters addressed in the associated keys, except in taxa of low diversity. Characters judged by authors to be most important in identification of component taxa were given priority for inclusion. For a given taxonomic level (e.g., species within a genus), characters are addressed in the same sequence from description to description, primarily to facilitate comparisons between taxa.

Characteristics are addressed at the highest rank at which they apply universally and are not repeated in lower-level descriptions, both to save space and to aid in learning diagnostic features of taxa at different ranks. In the description of a taxon, if a character state is indicated to be generally true, that means it is present in over half of the included taxa; in the descriptions of the included taxa, the character is then addressed only for those differing from the general state. This is the so-called gen rule. Also, at the species level and below, if a state exists in over half — but not all — of the included individual plants, the abbreviation "gen" is used.

Exceptional or rare character states (both quantitative and qualitative) of a taxon are often set off by parentheses, without mention of rarity of the condition if the context is unambiguous. Parentheses also are used for explanatory purposes or to aid in interpretation of complex statements (see below).

Descriptive information is organized into fields, most of which are headed and highlighted by all-capital, bold-face abbreviations of a major organ or structure (most descriptions include ST, stem; LF, leaf; INFL, inflorescence; FL, flower; FR, fruit; SEED, seed). In some cases, such headings are given to specialized, complex, or compound structures as well (e.g., SPORANGIA, SEED CONE, STAMINATE INFL, DISK FL, PISTILLATE FL).

Each statement within a field is a noun (plant part) followed by its modifiers; a given noun is being described up to the place where another noun appears, at which point it becomes the noun being modified. Adjectives follow the nouns they modify and different kinds of punctuation are used to make descriptions clear. For example, in the field for flowers (a primary noun), statements about sepals, petals, stamens, and carpels (secondary nouns) are separated by semicolons, leaving only commas and word order as ways to ensure clarity between the semicolons. Where a complex description might be ambiguous, parentheses or other clarifying punctuation may be present: e.g., "FR 3–4 mm, ovoid; segments 10–14, margins winged, tips bristly (or segments 8–9, margins rounded, tips glabrous)." Note that the tertiary noun "tips" refers to the secondary noun "segments," not to the previous tertiary noun "margins" or the even more removed primary noun "FR."

Within descriptions, plant parts are addressed from lower to upper on the plant, and from proximal to distal on a plant part.

Articles and conjunctions are generally used only where their absence would create ambiguity. For example, the statement, "LF: blade lanceolate, margins ciliate, bases, tips tapered . . ." means that the leaf blade bases (as well as tips) are tapered and should not cause the user to wonder if an adjective modifying "bases" has been dropped inadvertently.

Descriptions of Families. Family names are based on the name of an included genus (though not necessarily a genus represented in California), to which is added the termination "-aceae." Some that do not conform to this format were in wide use from (or before) the time of Linnaeus and appear in *TJM 2* treatments only in parentheses after the family name of conventional form, i.e., Apiaceae (Umbelliferae), Arecaceae (Palmae), Asteraceae (Compositae), Brassicaceae (Cruciferae), Fabaceae (Leguminosae), Lamiaceae (Labiatae), and Poaceae (Gramineae). A common or colloquial name is given for each family, based on what is used primarily in California; many families (and other taxa) have more than one common name and in some cases more than one is given here, if more than one is likely to be familiar to users of this book.

For each family, approximate numbers of genera and species worldwide are indicated. Overall geographic range also is summarized. Where appropriate, notes on significance to humans also are included (nutritional, medicinal, agricultural, horticultural value; toxicity). A reference (or two) often is given in brackets, primarily as an entry into the literature, so that a more recent, less relevant citation may be indicated rather than an older, more relevant citation, if the former includes a reference to the latter. Sometimes additional notes are given, including summaries of recent changes in classifications (e.g., lumping or splitting of families, genera), as well as special information to keep in mind in using the treatment that follows.

After each family description, scientific editors are indicated in order of handling of the manuscript and/or relative contribution.

The general form of the descriptions of families is the same as that for species (see below).

Descriptions of Genera. If a family comprises only one genus, the family description serves as the genus description. In such cases, as well as for genera in families with more than one genus, the number of species and the overall geographic range of the genus are given, as well as any importance to humans, followed by the derivation of the genus name (in parentheses), an appropriate reference (or two) in brackets, and sometimes additional notes, such as important information to know in using the key and included descriptions.

A common name (printed in Times-Roman SMALL CAPITALS) is indicated if one exists. As with families, the general form of the description is the same as that for species (see below).

Descriptions of Species, Subspecies, and Varieties. Descriptive conventions not already covered above are addressed here; except as specified, they generally apply to family and genus descriptions as well.

Scientific Names. All plant names below the level of genus, collectively termed "scientific names," are in *italics*, to indicate they are latinized; they comprise a genus name followed by one epithet (for a species), forming a "binomial," or two epithets (for a subspecies or variety, that is, infraspecific taxa), yielding a "trinomial." Trinomials appear intact for species represented in California by only one of its included infraspecific taxa; for species with more than one infraspecific taxon in the flora, only the rank of such infraspecific taxa and the associated epithets are indicated, at the beginning of each description. Genus names begin with a capital letter, whereas epithets for taxa at the level of species and below do not.

Names of taxa considered native to California are in bold-face italic ***Times-Roman***; names of alien taxa (naturalized plants as well as waifs) are in italic *Helvetica*, without bolding; names of the few taxa of uncertain status (native or naturalized) are in bold-face italic ***Helvetica***.

The etymology of genus names is given after the genus description; for the meanings of epithets there are a number of references online.

Authors of Plant Names. Epithets in scientific names appearing at the beginning of descriptions are followed immediately by an abbreviation of the name of the person(s) who validly published the name, in standardized form. Otherwise, author citations are given only for names that do not appear in such positions. Author citations serve in part to distinguish between two or more scientific names of exactly the same form (genus name and epithets the same), in cases where they refer to different plants, although this kind of problem does not occur very frequently. Author citations also help to locate the original description or other supporting material. *Authors of Plant Names* (1992), compiled at The Herbarium, Royal Botanic Gardens, Kew, serves as the standard for author abbreviations here, as updated online in The International Plant Names Index (IPNI).

Common Names. Long before scientific names were used, people used names in their native languages to refer to plants that were important to them. These have been called colloquial or common names, and those in English are sometimes called English names. Such common names are included here, if their usage has continued. In addition, common names that have been used in the California Native Plant Society's *Inventory of Rare and Endangered Plants of California* are generally included here. These taxa often are referenced elsewhere in the literature only by their common names, which may have been invented recently. Although common names in plants are not subject to regulation and may be used for more than one taxon, they do not need to change when the scientific name of a taxon changes, as happens for example when a species is transferred to another genus. All common names for taxa at the level of species and below are printed here in Times-Roman SMALL CAPITAL letters.

Chromosome Numbers. Chromosome numbers have been considered to be essential components of floristic works since their use in taxonomy first rose to prominence, in about the 1940s. However, those included here should not be taken as definitive. Because this book is intended primarily for use in the field, priority was given to verifying information about the plants that could be determined with the naked eye, aided or not by a hand lens. In other words, whereas morphological data were scrutinized by both authors and editors in preparing treatments for inclusion here, cytological data were mostly determined by workers other than our authors, and simply are being reported here from primary sources. A common problem with these reports is the failure to indicate the specimens used to obtain counts; that is, the frequency with which a voucher specimen is not cited (a problem that has lessened through time). This can be a serious problem, for example, when taxonomic concepts change, one species is recognized as two, and it is not known, without a specimen to consult, to which of the resulting species the previously reported count applies. Another problem is the small number of plants often sampled to determine chromosome numbers, which therefore may vary more than is indicated.

Given the value of chromosome numbers for understanding evolutionary patterns and processes in plants, they are included here where reported, for over 50% of the taxa, as an aid to researchers, with the above cautions. Absence of indicated chromosome numbers also should help to focus attention on which taxa remain uncounted, so that botanists can prioritize their efforts.

Habitats, Elevations, Geography. Accounts of habitats, elevations, and geographic areas where a taxon is expected to occur are included primarily to help predict where it may be found. Secondarily, such information may help to corroborate the identity of a plant thought to belong to a particular taxon based on other descriptive information. Many plant taxa occur in a wide range of habitats, so distributional information may be of limited value in predicting locations of populations and confirming identifications, while for plants of narrow distribution the information may be highly useful in both regards.

A limited number of terms used to characterize habitats, including vegetation, are included in treatments and in the glossary. These terms are defined generally and are not intended to represent a rigorous system of habitat or vegetation classification, which is beyond the scope of this book. For more detailed and/or alternate treatments of vegetation and habitats of Californian plants, and for discussion of environmental factors that influence the occurrence of plants in California, the following two works are recommended: *A Manual of California Vegetation* (Sawyer et al., 2009; California Native Plant Society, Sacramento) and *Terrestrial Vegetation of California* (Barbour et al., 2007; University of California Press, Berkeley).

Elevational ranges of taxa (in meters; a conversion scale to feet is near the back of the book, after the index) are approximations, mostly based on data from herbarium specimens. As with habitats, the information is perhaps most useful for predictive or identification purposes if taxa occur within a nar-

row range of values. Elevational ranges, even if highly accurate, may not reflect potential ranges under current climatic conditions.

Geographic Range Statements. A four-tiered hierarchical geographic system was developed for *TJM* (1993), primarily to allow for the presentation of geographic ranges in a way that is more biologically meaningful than doing so by county (the more traditional way), and to save space as well. The four-tiered system also is used here, with significant refinements (see Geographic Subdivisions and associated maps, also inside the front cover). The Consortium of California Herbaria aided description and refinement of geographic ranges for many taxa, in part by facilitating discovery of outlying records and pinpointing specimens worthy of close scrutiny by authors.

Occurrences of a given taxon within its geographic range are further restricted by elevation and habitat, as noted above. At the most general, "CA" means that a taxon occurs in all three floristic provinces in California (though not necessarily all counties in California), but within that area the taxon may be especially rare or common, depending on the elevations and habitats indicated for it. So too, "CA-FP" (California Floristic Province) as a sole area of occurrence means that the taxon should not be expected in "GB" (Great Basin Province) or "D" (Desert Province), but might be found anywhere within each of the geographic units that constitute the CA-FP where the appropriate elevations and habitats occur.

In general, all areas indicated for a taxon in California are documented by herbarium specimens, with notable exceptions. Alien taxa, for example, are of limited interest to many collectors and therefore tend to be undercollected (except by people studying them and concerned about their spread), so observational data as well as reports of occurrence in the literature were sometimes accepted in lieu of voucher specimens; additionally, alien taxa with currently expanding ranges are generally indicated to be expected elsewhere. Geographic subunits from which native taxa have been reported or are expected but for which no specimens have been seen are followed by a question mark (e.g., "s SNH, SNE, w DMoj?"), and should be given high priority by collectors.

Synonyms, Misapplied Names, Unresolved Variants. Including references to all names that have ever been applied to vascular plants in California (i.e., to provide a complete synonymy for each of over 7,600 terminal taxa) is impractical in a single, field-portable floristic manual. Instead, all names used for accepted, recognized taxa in *TJM* (1993) are accounted for in some way here, in most cases by using them as the accepted name for a taxon or by listing them as synonyms of such names, but in some cases by indicating they have been used by mistake, either by misinterpretation of the rules of nomenclature or by misidentification of plant material (misapplied names), or by indicating them to represent unclearly or questionably differentiated variants (unresolved variants). The Index to California Plant Names (an online resource of the Jepson Flora Project) includes much more extensive coverage of names previously applied to California vascular plant taxa and the status of such names.

Synonyms (based on either the same or a different type specimen; that is, nomenclatural or taxonomic synonyms, respectively), followed by misapplied names, appear in brackets after the statement of geographic distribution.

Unresolved variants are those about which an author wishes to remain noncommittal with respect to taxonomic recognition. They are included after the brackets containing synonyms and misapplied names, along with a very brief diagnosis and geographic range (if different from the species). This account is noncommittal in form (e.g., "If recognized taxonomically, smaller, denser plants from higher elevations assignable to *Planta pumila*"). The wording used in *TJM* (1993) (e.g., "Smaller, denser plants from higher elevations have been called *Planta pumila*") often has been avoided because of the common, incorrect practices of treating such names as accepted names or as synonyms; they are neither.

The number of unresolved variants treated here is considerably smaller than the number treated in *TJM* (1993), primarily because of changes in taxonomic concepts (e.g., the recognition and inclusion of cryptic taxa here) and the fact that research conducted since *TJM* (1993) has resolved many of these issues, elevating some unresolved variants to full taxonomic treatment (as varieties, subspecies, or species) while reducing others to synonymy. Authors were strongly encouraged to keep the number of unresolved variants here to a minimum, by giving a high priority to resolving them one way or another, but in some cases it was not possible to complete the research necessary in time for inclusion here.

Notes. Notes that address unresolved taxonomic problems, hybridization and intergrading variation in general, difficulties or clues in identification, threats from human activity as well as from other plants and animals, and other topics appear near the end of descriptions, after any synonyms and before the following information.

Toxicity. Some California plants (e.g., poison hemlock, poison oak, Klamath weed) are seriously toxic, causing deaths or illness in humans or livestock. Fuller & McClintock's (1986) *Poisonous Plants of California* (University of California Press) overviews plants that are both major and minor sources of poisoning. Plants that have been toxic to animals or people in California (or are expected to be) are noted with an all-capital "TOXIC." Usually, more specific information is included as well, e.g., "TOXIC to livestock from concentrated oxalates"; "TOXIC: resin on lvs, sts, frs causes severe contact dermatitis; one of the most hazardous pls in CA"; or "TOXIC: ingested seeds, lvs, bark may be fatal to humans, livestock."

Commonness and Rarity. Formal designations of invasive, non-native taxa, and native taxa of special concern, including those that are rare, threatened, or endangered, are not provided in *TJM 2* because such rankings are potentially dynamic. Instead, symbols are applied in *TJM 2* treatments to call attention to particular invasive taxa or native taxa of special concern. For more information on the status of the indicated taxa (and perhaps others that are not indicated with a symbol), the reader should contact the agencies and organizations mentioned in the following paragraphs.

Native Taxa of Special Concern. A ★ symbol is applied to taxa as recognition of their inclusion in the California Native Plant Society's (CNPS's) *Inventory of Rare and Endangered Plants of California* (8th Edition), lists 1–4. That set of lists includes all vascular plant taxa that are legally listed as rare, threatened, or endangered by the State of California or the U.S. Fish and Wildlife Service. A limited number of taxa, proposed for inclusion in the CNPS Inventory, also received the ★ symbol.

Invasive Non-native Taxa. The ◆ symbol is applied to taxa as recognition of their inclusion in (1) the Pest Ratings of Noxious Weed Species and Noxious Weed Seed, developed by the State of California, Department of Food and Agriculture, Division of Plant Health and Pest Prevention Services (July, 2010) and/or (2) the 4500 Noxious Weed Species list from Section 5004 of the Food and Agricultural Code. All names with an internal rating of A, B, C, or Q were considered. The ◆ symbol is applied to taxa that occur in California or are considered to be of probable risk of establishment in the state. Some taxa included in the above-mentioned lists are not treated here because they either do not occur in California or their arrival and/or naturalization in the state is unlikely. The ❖ symbol is applied to taxa not included in the above-mentioned state or federal lists, but included in (1) the California Invasive Plant Inventory Database (December 2010) developed by the California Invasive Plant Council (Cal-IPC) and/or (2) the Priority Species List of the Bay Area Early Detection Network (December 2010). Neither symbol ◆ nor symbol ❖ is applied to native taxa.

Flowering/Coning Time. For angiosperm species, subspecies, or varieties, the time period, usually in months (abbreviated to three letters) but sometimes in seasons, when flowers are known to be

present on the plants are presented at the end of the description (the words "flowering time" do not appear). For *Ephedra,* the time periods refer to the presence of cones.

Horticultural Value. Information about horticultural value and growth requirements, included for many native taxa in *TJM* (1993), is not included here, but the Jepson Flora Project's database of such information may be accessed online.

Things to Remember When Using This Book

Coverage. Make sure the organism you wish to identify is included in *TJM 2*. Only vascular plants that are native, naturalized, or active waifs in California may be identified using this book; excluded are all bryophytes, lichens, algae, fungi, animals, and non-living things (see introduction to Key to California Vascular Plant Families for information on distinguishing vascular plants from other organisms).

Reproductive Condition. With rare exceptions, reproductive parts are needed for accurate identification of California vascular plants, whether the unknown is a pteridophyte (indusia, sporangia, spores), gymnosperm (cones, seeds), or angiosperm (flowers, fruit). Aquatic plants in vegetative condition may be identified to family using *TJM 2* but most keys herein require access to reproductive states.

Glossary. Sometimes difficulty in using the keys and descriptions is attributable to the fact that a term has been defined in a way that might seem unusual; check the glossary as a possible solution. Unfamiliar terms that are not included in the glossary may be defined only in descriptions of the relevant family or genus, if those terms do not apply to other taxa in California.

Notes. If an element of a key or description is not making sense, check the notes under the descriptions of relevant families, genera, or species. For example, the number of flowers indicated for *Persicaria*, 1–14, may appear much too low, given that the inflorescence in the genus generally has hundreds of flowers. In a note under the family description, it is stated that "fl number is per fl cluster or involucre, unless otherwise stated."

Gen Rule. If a plant characteristic is not mentioned in a taxon description, information on that state should be sought in descriptions of higher-level taxa to which the plant belongs. As noted above, in the description of a taxon, if a character state is indicated to be generally true, it means it is present in over half of the included taxa; in the descriptions of the included taxa, the character is then addressed only for those taxa differing from the general state. For example, if "stamens gen 5" is stated in the genus description, in the descriptions of species and below the character is not addressed if the state is 5, but it is addressed for those taxa for which the number of stamens is other than 5.

Assumptions. Unless stated otherwise, number of flowers is per inflorescence, of petals is per flower, of seeds is per fruit (if per chamber, that is specified), etc.

Parentheses. In morphological descriptions and keys, parentheses enclose character states that are rare to uncommon, without qualification if the context is unambiguous, as well as explanations of foregoing statements and exceptions to those statements.

Square Brackets. In morphological descriptions, square brackets enclose information pertaining only to members of a taxon (but not necessarily to all members of that taxon) occurring outside of California. If used in keys, square brackets enclose explanatory information, as opposed to rare or exceptional states (in parentheses).

Keys with only 2 Taxa. Character states appearing in keys with only 2 taxa are not repeated in the descriptions of those taxa, as a space-saving measure.

ABBREVIATIONS AND SYMBOLS

Abbreviations

The abbreviations below were selected because they save considerable space, are relatively unambiguous, and are easily remembered. They are used throughout this book, with the exception of introductory material. Words not appearing below are not abbreviated, except that the official, two-letter, postal abbreviations for states in the United States are used. Abbreviations that appear in both lowercase and capital letters are indicated. Periods are used only where their absence could cause confusion. Entries referring to parts of California are marked with asterisks and discussed more fully under Geographic Subdivisions of California (p. 35).

AB = Alberta, Canada
Afr = Africa
Am = Americas (w hemisphere), America(n)
ambig. (or nom. ambig.) = nomen ambiguum, ambiguous name; name commonly used by mistake for more than one taxon
ann = annual

b = born
Baja CA = Baja California
BC = British Columbia, Canada
bien = biennial

c = central
CA-FP = California Floristic Province*
C.Am = Central America(n)
Can = Canada
CaR = Cascade Range*
CaRF = Cascade Range Foothills*
CaRH = High Cascade Range*
CCo = Central Coast*
ChI = Channel Islands*
cm = centimeter, 0.01 meter
Co. = County
cos. = counties
cult = cultivated, cultivation
cv. = cultivar, cultivated variety
CW = Central Western California*

D = Desert Province*
diam = diameter
dm = decimeter, 0.1 meter
DMoj = Mojave Desert*
DMtns = Desert Mountains*
DSon = Sonoran (Colorado) Desert*

e = east(ern)
e-c = east-central
esp = especially
Eur = Europe
exc = except, excluded, excludes, excluding

f. = form, forma; son of (L.f. means son of Linnaeus, see Authors of Plant Names)
fl, fls (FL, FLS) = flower(s), floral, flowering
fld = flowered
FNANM = Flora of North America North of Mexico
fr (FR) = fruit

GB = Great Basin Province*
gen = generally, mostly, usually, over half (e.g., petals gen red in genus description means over half of subordinate taxa have red corollas, with the rest requiring that petal color be addressed)
geog = geographic(al, ally), geography
GV = Great Central Valley*

illeg. (or nom. illeg.) = nomen illegitimum, illegitimate name; name validly published but otherwise not conforming to the rules
incl = included, includes, including
ined. (or nom. ined.) = nomen ineditum, unpublished name; name not published or not validly published
infl, infls (INFL, INFLS) = inflorescence(s)
inval. (or nom. inval.) = nomen invalidum, invalid name; name not validly published according to the rules

KR = Klamath Ranges*

lf (LF) = leaf
lfless = leafless

lflet = leaflet
lfy = leafy
lvs (LVS) = leaves
lvd = leaved

m = meter
MB = Manitoba, Canada
MP = Modoc Plateau*
Medit = Mediterranean
Mex = Mexico
misappl. = misapplied; name used incorrectly for a CA plant, through misidentification and other means
mm = millimeter, 0.001 meter (µm, a micrometer, is 0.0001 meter, previously also called a micron)
(M)mtn(s) = (M)mountain(s)

n = north(ern)
n-c = north-central
N.Am = North America(n)
NB = New Brunswick, Canada
NCo = North Coast*
NCoR = North Coast Ranges*
NCoRH = High North Coast Ranges*
NCoRI = Inner North Coast Ranges*
NCoRO = Outer North Coast Ranges*
ne = northeast(ern)
NL = Newfoundland and Labrador, Canada
notho- = prefix indicating that a taxon is the result of hybridization, when at least one of the parental taxa involved is known or can be postulated, affixed to the term denoting the rank at which that taxon is recognized; e.g., nothosubspecies
NS = Nova Scotia, Canada
NT = Northwest Territories, Canada
nud. (or nom. nud.) = nomen nudum, naked name; name naked usually in the sense of lacking a description with its publication

NW = Northwestern California*
nw = northwest(ern)

occ = occasionally
ON = Ontario, Canada
orn = ornamental
orth. var. = orthographic variant; variant spelling of a name

PE = Prince Edward Island, Canada
per = perennial herb
pl(s) (PL) = plant(s)
PR = Peninsular Ranges*

QC = Quebec, Canada

rej. (or nom. rej.) = nomen rejiciendum, rejected name; name prohibited by legislation

s = south(ern)
s-c = south-central
S.Am = South America(n)
SCo = South Coast*
SCoR = South Coast Ranges*
SCoRI = Inner South Coast Ranges*
SCoRO = Outer South Coast Ranges*
ScV = Sacramento Valley*
se = southeast(ern)
sect(s). = section(s) (abbreviated only as taxonomic rank)
SK = Saskatchewan, Canada
s.l. = sensu lato, in the broad sense; broad circumscription of a taxon
SON = Sonora, Mexico
SN = Sierra Nevada*
SNE = East of Sierra Nevada*
SNF = Sierra Nevada Foothills*
SNH = High Sierra Nevada*
SnBr = San Bernardino Mountains*
SnFrB = San Francisco Bay Area*
SnGb = San Gabriel Mountains*
SnJt = San Jacinto Mountains*
SnJV = San Joaquin Valley*
sp. = species (singular)
spp. = species (plural)
s.s. = sensu stricto, in the narrow sense; narrow circumscription of a taxon
st(s) (ST(S)) = stem(s)
subg. = subgenus, subgenera
subsect(s). = subsection(s)
subsp. = subspecies (singular)
subspp. = subspecies (plural)
superfl. (or nom. superfl.) = nomen superfluum, superfluous name; name for a taxon that has an earlier, legitimate name
SW = Southwestern California*
sw = southwest(ern)

Teh = Tehachapi Mountain Area*
temp = temperate(s), temperate zone(s)
TJM (1993) = *The Jepson Manual,* 1993 edition
TR = Transverse Ranges*
trop = tropical, tropic(s), tropical zone(s)

US = United States

var. = variety
vars. = varieties
vs = versus

w = west(ern)
w-c = west-central
W&I = White and Inyo Mountains*
WTR = Western Transverse Ranges*
Wrn = Warner Mountains*

yr(s) = year(s)
YT = Yukon, Canada (Yukon Territory)

Symbols

The following symbols are used whenever possible. Most are quantitative, referring to number, height, length, width, etc., while "±" may be qualitative as well, referring to color, fusion, symmetry, etc. Note that "<<," "<," "=," ">," and ">>" do not include the concepts of "greatly exceeded by," "exceeded by," "held at the same level as," "exceeding," and "greatly exceeding," respectively, as defined in *TJM* (1993). Here, these concepts are expressed in words. The symbols "<<," "<," "=," ">," and ">>" are restricted in meaning to "much less than," "less than," "equal to," "greater than," and "much greater than," respectively, in length, or height (or width or diameter if qualified as such). Those symbols also may be used in the sense of "fewer than" (rather than "less than") or "more than" (rather than "greater than") if qualified as referring to counts rather than dimensions. Use of these symbols to include the ideas of "exceeding" or "exceeded by" confuses the concepts of absolute length and what it means for one structure to exceed another or not.

<< much less than (or much fewer than, if qualified as numeric)

< less than (or fewer than, if qualified as numeric)

≤ less than or equal to (or fewer than or equal to, if qualified as numeric)

= equal to, equal, equals (e.g., "sepals = petals" or "blade = petiole," but not "sepals equal" in the sense of sepals all equal to each other)

≥ greater than or equal to (or more than or equal to, if qualified as numeric)

> greater than (or more than, if qualified as numeric)

>> much greater than (or much more than, if qualified as numeric)

0 none, absent

1 solitary, in context of arrangement of sporangia, cones, flowers, or inflorescences

\+ 1) after a number or range of numbers, it means "or more" (e.g., "6–10+ mm" means "6 to 10 or more mm"); 2) between words (e.g., plant structures, word elements in etymologies) it means "plus" (e.g., "tube + throat 12–16 mm" means that the tube and throat taken together are 12–16 mm)

± more or less, approximately, nearly, rather, slightly, somewhat (e.g., ± sessile may include sessile)

° degree of angle, compoundedness, or branching

× multiplication sign, meaning "times" or indicating hybridity when used with taxon names; meaning "cross" when used in plant descriptions (e.g., ×-section)

\- hyphen, for: compound adjectives (e.g., 5-lobed, saucer-shaped, needle-like, red-brown, glandular-hairy, ovate-elliptic); in common names that are inconsistent with current taxonomy (e.g., Douglas-fir because *Pseudotsuga* is not currently included in *Abies*, fir), or in common names that are used as adjectives (e.g., lodgepole-pine forest, but not forest of lodgepole pine); to indicate (as a double hyphen or en-dash) quantitative ranges (e.g., "lvs 5–8 mm"); and to indicate intermediacy in condition (e.g., "lvs ovate-elliptic" means the leaves are intermediate between ovate and elliptic). Qualitative (non-quantitative) ranges are expressed with the word "to": "lvs ovate to elliptic" means the leaves range in shape from ovate to elliptic, possibly including ovate-elliptic

[ ] 1) square brackets enclose information in descriptions pertaining only to members of a taxon (but not necessarily to all members of that taxon) occurring outside of California, in addition to delimiting pertinent literature and nomenclatural/taxonomic synonyms; 2) in descriptive parts of keys, square brackets are sometimes used to delimit information that provides additional clarification or explanation, where use of parentheses might be confusing; 3) square brackets enclosing names in keys refer to taxa (generally waifs) with descriptions that appear only online

( ) parentheses enclose information in keys and descriptions that is only rarely to uncommonly true [e.g., tree (2)4–10 m]; less frequently, they enclose explanations of, elaborations of, or exceptions to foregoing descriptive information; if the word "rarely" appears within parentheses, it is because without it the enclosed information could be interpreted in one of these other ways

μm micrometer, 0.0001 meter (previously also called a micron)

★ rare and/or endangered native taxon; see Conventions (p. 10) for further explanation

◆ weedy, alien taxon; see Conventions (p. 10) for further explanation

❖ weedy, alien taxon; see Conventions (p. 10) for further explanation