Ethnobotany of Mountain Regions
Series Editors:
R. W. Bussmann · N. Y. Paniagua-Zambrana

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Ethnobotany of the Mountain Regions of Southeast Asia

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Ethnobotanical research in recent years has increasingly shifted into applied aspects of the discipline, including climate change research, conservation, and sustainable development. It has by now widely been recognized that "traditional" knowledge is always in flux and adapting to a quickly changing environment. Trends of globalization, especially the globalization of plant markets, have greatly influenced how plant resources are managed nowadays. While ethnobotanical studies are now available from many regions of the world, no comprehensive encyclopedic series focusing on the worlds mountain regions is available in the market. Scholars in plant sciences worldwide will be interested in this website and its dynamic content.

The field (and thus the market) of ethnobotany and ethnopharmacology has grown considerably in recent years. Student interest is on the rise, attendance at professional conferences has grown steadily, and the number of professionals calling themselves ethnobotanists has increased significantly (the various societies—Society for Economic Botany, International Society of Ethnopharmacology, Society of Ethnobiology, International Society for Ethnobiology, and many regional and national societies in the field currently have thousands of members). Growth has been most robust in BRIC countries.

The objective of this new series on Ethnobotany of Mountain Regions is to take advantage of the increasing international interest and scholarship in the field of mountain research. We anticipate including the best and latest research on a full range of descriptive, methodological, theoretical, and applied research on the most important plants for each region. Each contribution will be scientifically rigorous and contribute to the overall field of study.

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F. Merlin Franco
Editor

Ethnobotany of the Mountain Regions of Southeast Asia

With 418 Figures and 1 Table

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Dedicated to the folk healers of Southeast Asia

Preface

Plants assume ethnobotanical importance only when they are associated with human societies. Use of plants as medicine, food, fodder, and cultural purposes all happen in specific cultural and landscape contexts. This is a major factor often ignored by biologists studying human-plant relationship. Touting a plant as an ethnobotanically important one without providing adequate information on the societies that use them, or the context of use, distorts the picture. Chapters included in this volume provide comprehensive information on the medicinal, food, cultural, and phytochemical values of selected plant species, along with the cultural context. Gleaning out these information from published literature was not an easy task as a good percentage of published articles merely mention the plant use without specifying the community and context of its use. Also, most literature do not provide an understanding on how plant use has changed over times. Our authors have taken extra care to ensure that these information are presented, wherever possible. Another highlight of this volume is that majority of our contributing authors are budding ethnobiologists. These youngsters are poised to emerge as torch bearers of ethnobiology in Southeast Asia, and the larger Asian continent. We hope that this volume would serve as an important reference material for academics, plant lovers, and members of local communities of Southeast Asia.

Acknowledgments

This volume took birth with an invitation from Rainer W. Bussmann and Narel Y. Paniagua-Zambrana, series editors of Ethnobotany of Mountain Regions. I thank both of them for providing me the opportunity to edit the volume and also the freedom to include sections on biocultural importance of the selected species.

I express my sincere gratitude to all individual authors who have contributed to this volume. However, I should specifically place on record the important role played by Anisatu Z. Wakhidah, a young ethnobiologist from Indonesia. Her entry into the project came at a time when we had suffered a major setback with a few authors dropping out. She had helped me network with other ethnobiologists from Indonesia. Without her, this project would have taken longer to complete.

For this volume, I had the privilege to work with an extremely efficient team at Springer Nature including Eric Stannard, Johanna Klute, and Sylvia Blago. The experience and patience of Johanna and Sylvia helped a lot in troubleshooting various unforeseen glitches that arose especially during the initial stages of the project.

Special thanks to D. Narasimhan, former professor of botany at Madras Christian College, Chennai, and Santhana Ganesan of Singapore Botanical Gardens for their moral support and encouragement.

I thank the Institute of Asian Studies at Universiti Brunei Darussalam for supporting me throughout this project. Though ethnobiology is an interdisciplinary subject, in Asia it is often considered as a part of the natural sciences due to the domination of a bioprospecting narrative. I am indebted to my home institute for appreciating the interdisciplinary value of this project and permitting me to work on this.

F. Merlin Franco

Contents

Volume 1

Volume 2

Pandanus julianettii Martelli
Pandanaceae

Ary Prihardhyanto Keim and Wawan Sujarwo

Local Names

English: Forest coconut pandanus, karuka; **Indonesia:** *pandan kelapa hutan* (Indonesian standard), *hilak* (Yali), *saluke* (Wamena); **Papua New Guinea:** *karuka* (Pidgin).

Botany and Ecology

Description: *Pandanus julianettii* is a solitary tree dioecious pandan of highlands New Guinea, 120–130 cm tall, branched at least in the upper part of the stem. The species can easily be recognized by the solitary, fairly robust habit, persistent leaves, approximately globose cephalia. Prop roots present, obvious, 50–100 cm tall or more. Stem straight, grayish brown, nodules. Leaves spirally arranged in three directions (tristichously arranged), rosette in terminal of the stem; leaf lanceolate-elongate, dark green above, light green below, long and narrow, 300–1100 cm by 8–12 cm, adaxial ventral pleats absent, recurved spines present, margins with spines, fairly obvious, sharp. Male inflorescence 2 m long, bearing a series of elongate heads set one against the other, each a combination of small, whitish flowers with stamens, stamens pale creamy white; female inflorescence comprising a single globular or ellipsoidal head, less than 1 m long. Infructescence single, terminal, pendulous, approximately 1 m long. Cephalium single, terminal, pendulous, globose or fairly ellipsoidal, pale green when young turns to deep green when mature, 30–35 cm long, 25–30 cm wide, fairly massive, 5–7 kg weight; cephalium of plants at Habbema Lake, Indonesian New Guinea can reach 50 cm in diameter (see Keim et al. 2018);

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cephalium composed of numerous (approximately 1000, see French 1986) drupes, drupe when break reveals an oily bright creamy white endosperm.

Phenology: *Pandanus julianettii* is always found in cultivation (Fig. 1), which is an important field character that distinguishes the species with its closely related species, *P. brosimos* (Stone 1982, 1984; Hyndman 1984). The domesticated *karuka* is always associated with *P. julianettii*, while the wild or semi-domesticated *karuka* is associated with *P. brosimos* (Stone 1982, 1984; Hyndman 1984). *Pandanus julianettii* can be grown from seeds, suckers, or cuttings from the top of the branches (French 1986; Jebb 1992). Those trees from seeds have taller trunks, whereas trees from cuttings grow faster. It takes 5–8 years from planting to the first harvest (French 1986). The species is found in fruiting normally from December to February, but may occur in mid-year. *Pamdanus julianettii* in Pass Valley (64.8 km northeast of Wamena) were not observed in fruiting in December 2010 and January 2011 (personal observation). The species were observed in fruiting in the vicinity of Habbema Lake (41.8 km southwest of Wamena) in October 2011 (Keim et al. 2018). Thus, in the central highlands of Indonesian New Guinea, *P. julianettii* is in fruiting around mid-year up to October or at least early November. Although the seasonality may vary from one area to another, ripe cephalia may be found throughout the year (Walter and Sam 2002). As in the other members of the genus *Pandanus*, the anthesis in *P. julianettii* is also very short, which is between 2 and 4 days. As a consequence, the male inflorescence is also short-lived and rarely

Fig. 1 *Pandanus julianettii* planted near human settlement. (© Ary P. Keim)

seen. Among the Wola of Papua New Guinea only the female trees that produce fruits are cultivated; male plants are wild and found only in the forest (Sillitoe 1983; see Walter and Sam 2002). This raises the possibility that the male plants are actually the "Wild *karuka*" identified by Merrill and Perry (1940) as *P. brosimos*. This supports Stone (1984) in the observation that *P. julianettii*, *P. brosimos*, and *P. iwen* may form a complex species, and agriculturally they are cultivars representing 1000 years of cultivation and human interventions (i.e., human selections; see Stone 1982; Jebb 1992). *Pandanus julianettii* and its close ally, *P. brosimos*, and even *P. conoideus* are believed to be parthenogenic (Rose 1982). *Pandanus julianettii* can last 50–60 years (French 1986).

Distribution and Habitat: *Pandanus julianettii* is a species endemic to the central highlands of New Guinea (Stone 1982). The species is known as one of the five highland species of *Pandanus* commonly planted by the people from the central highlands of New Guinea. Others are *P. antaresensis*, *P. brosimos*, *P. conoideus*, and *P. iwen*. *Pandanus conoideus* alone is found cultivated in the lowland areas and the adjacent islands of New Guinea and the Moluccas (Keim 2009; Keim et al. 2018). The species can be found in highlands of mainland New Guinea at about 1800–2500 m altitudes (Stone 1982; French 1986). In the Jayawijaya Range, particularly within the vicinity of Lake Habbema, *P. julianettii* is found in a semi wild cultivation within the Upper Montane Forest approximately at 2000–3000 m altitudes (Fig. 2)

Fig. 2 Population of semi wild cultivation of *Pandanus julianettii* in Pass Valley, Jayawijaya Range. (© Ary P. Keim)

(Van Royen 1980; Keim et al. 2018). *Pandanus julianettii* is planted in cultivations at Pass Valley at least at 2000 m altitudes; here, *P. julianettii* is commonly found at about 2000 m and higher altitudes (personal observation).

Local Medicinal Uses

Indonesia: *Pandanus julianettii* is well known as a *Pandanus* that contains the psychoactive substances (Stone 1982; Hyndman 1984; Thomas 2000). The drupes (particularly the endosperms) have been eaten by the people of central highlands of New Guinea (both Indonesian New Guinea and Papua New Guinea) for psychoactive effects (Sinclair 1957; Webb 1960; Barrau 1962; Reay 1960; Heim and Wasson 1965; Sterly 1973; Stone 1982; Hyndman 1984; Rudgley 1998; Thomas 2000; Group 2015). The psychoactive effects have been termed as "*karuka* madness" (Stone 1982; Hyndman 1984; Jebb 1992; Ott 1993, 1996; Group 2015). Elders of Dani community used the drupes are used as an anesthetic in the past (personal observation) (Fig. 3). Endosperms extracted from baked drupes were given to

Fig. 3 Lateral section of the cephalium of *Pandanus julianettii* showing the drupes. (© Ary P. Keim)

patients to turn them unconscious, so that traditional surgical procedures can be performed. Such procedures were commonly used to treat injuries and wounds resulting from the fierce tribal wars that were common in the Baliem Valley prior to the availability of western medicine in the locality. This oral history has not been recorded before in the literature.

Phytochemistry

The bioactive components of cephalia of five species of *Pandanus*, including *P. julianettii* from Jayawijaya Range, have been studied recently by Kogoya et al. (2014). There are 35 groups of fatty acid types recorded from *P. julianettii*, of which the largest percentage (28.66%) is palmitic acid (C16:0). Various nutrient values have also been recorded per 100 g of a seed: fat calories (419.4 kcal/100 g), unsaturated fatty acid (401.4%), potassium (300.22 mg/100 g), calcium (97.20 mg/100 g), sodium (71.21 mg/100 g) with total energy of 1020 kcal (Kogoya et al. 2014). The endosperm contains pro-vitamin A and pro-vitamin C (French 1986). The substance responsible for psychoactive effects is N,N-dimethyltryptamine (DMT) (Szara 1956, 1957, 1961, 1962, 1970; Turner and Merlis 1959; Shulgin 1976; Shulgin and Shulgin 1997). DMT has been isolated from mountain *Pandanus* including *P. julianettii* and its closely related species *P. brosimos* and *P. iwen* (Hyndman 1984; see also Thomas 2000). However, N,N-dimethyltryptamine has been observed to be inactive when taken orally (Shulgin 1976). Thus, its mere presence in certain nuts of highland species of *Pandanus* (including *P. julianettii*) does not explain the altered state of consciousness produced when the nuts are ingested (Thomas 2000).

Local Food Uses

Indonesia: The endosperms extracted from the drupe are the most important plant part to be consumed and highly priced (Fig. 4) (French 1986; Jebb 1992; Milliken 2006). The seeds (especially the carbohydrate-rich endosperms) provide a valuable supplementary diet during lean months for communities depending on it (Stone 1982; Walter and Sam 2002; Keim et al. 2018). The Dani people of the Baliem Valley regard *P. julianettii* as one of the two principal species for food source; the other is *P. conoideus* (Purwanto and Walujo 1992; Arobaya and Pattiselanno 2007). The main producing area is in Pass Valley and the vicinity of Lake Habbema (Keim et al. 2018). The seeds are eaten raw, smoked or cooked after been extracted from the drupes. The Dani of Baliem Valley roast the drupes in earth ovens with heated stones known as *bakar batu* (Purwanto and Walujo 1992). When the harvest is abundant, the drupes are stored, sometimes by burying in dry soil. Buried drupes remain edible for about a year, even after germination (Walter and Sam 2002). Smoked nuts can be stored and smoked for up to 2 years; nuts may also be removed from the shells and

Fig. 4 Cephalium of *Pandanus julianettii* harvested from the vicinity of Lake Habbema with the epicarp removed. (© Ary P. Keim)

wrapped in leaves (Walter and Sam 2002). In some parts of central highland New Guinea, part of mesocarp may also be eaten raw or cooked (Walter and Sam 2002). The Dani of Jayawijaya Range mention that the only pest of *P. julianettii* is the tree kangaroos (personal observation), similar to central highlands New Guinea (French 1986). *Pandanus julianettii* is still regarded as an important food source by the people of highlands New Guinea despite the popularity of sweet potatoes (*Ipomoea batatas*; Convolvulaceae). The ability of the species to produce cephalia throughout the year for approximately 50–60 years (French 1986) contributes to food security of local communities.

Biocultural Importance

Pandanus julianettii is regarded important by the people of central highlands of New Guinea, together with *P. conoideus*, *P. brosimos*, and *P. iwen*. Its ability to continuously produce cephalia throughout the year for approximately 50–60 years contributes to food security of local communities. In the villages throughout Jayawijaya Range, this species is planted together with *P. conoideus*. Archaeological studies show that *P. julianettii* has been cultivated in central highlands New Guinea at least at the end of Pleistocene along with *P. antaresensis*, *P. brosimos*, *P. conoideus*, and *P. iwen* (St. John 1973; Haberle 1995, 1996; Cook 1999; Fairbairn et al. 2006). The beginning of cultivation of *P. julianettii* has long been a subject of debate, ranging from 26,000 to 6000 BC (Brass 1941; White et al. 1970; Golson 1991; Swadling et al. 1991; Yen 1995; Haberle 1998, 2003; Lentler and Denham 2017). Currently, the consensus is around 10,000–7400 BC (Denham 2005, 2010, 2011; Denham et al. 2003, 2004; Lentler and Denham 2017). The Wola of Papua New Guinea use the aerial roots on bark shields and the leaves for rain-capes (Sillitoe 1983). The Nduma

of Eastern Highlands Province, Papua New Guinea, use the leaves for thatching in their temporary shelters and the hollowed trunk for channeling water (Hays 1980).

Economic Importance

Indonesia: The cephalia of *P. julianettii* is traded in the local markets. Thus, the cultivation of this species is economically important. DMT has potential to be used in various medicinal applications.

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