

Celebrating
60 Years

Palms

Journal of the International Palm Society

Vol. 60(3) Sep. 2016



THE INTERNATIONAL PALM SOCIETY, INC.

The International Palm Society

Founder: Dent Smith

The International Palm Society is a nonprofit corporation engaged in the study of palms. The society is international in scope with worldwide membership, and the formation of regional or local chapters affiliated with the international society is encouraged. Please address all inquiries regarding membership or information about the society to The International Palm Society Inc., 9300 Sandstone St., Austin, TX 78737-1135 USA, or by e-mail to info@palms.org, fax 512-607-6468.

OFFICERS:

President: Ray Hernandez, 4315 W. San Juan Street, Tampa, Florida 33629 USA, e-mail subtropicofcancer@hotmail.com, tel. 1-813-832-3561.

Vice-Presidents: Jeff Brusseau, 1030 Heather Dr., Vista, California 92084 USA, e-mail jbrusseau@newportnational.biz, tel. 1-760-271-8003. Kim Cyr, PO Box 60444, San Diego, California 92166-8444 USA, e-mail kimberley.b.cyr@gmail.com, tel. 1-619-518-7402.

Corresponding Secretary: Susan Hubbell, 690 Calle César González, Apt. 2402, San Juan, Puerto Rico 00918 USA, e-mail sushubbell@aol.com, tel. 1-787-765-5711.

Administrative Secretary: Larry Noblick, Montgomery Botanical Center, 11901 Old Cutler Road, Miami, Florida 33156 USA, e-mail lnob@montgomerybotanical.org, tel. 1-305-667-3800 ext 104.

Treasurer: Tom Jackson, P.O. Box 1102, Ross, California 94957 USA, e-mail jacksot@sutterhealth.org, tel. 1-415-923-3299.

Directors: 2014–2018: Cindy Adair, Puerto Rico; Faith Bishock, Florida; Julie Cleaver Malzoni, Brazil; Kimberley Cyr, California; Walter Donovan, Australia; John Dransfield, United Kingdom; Len Geiger, California; Ray Hernandez, Florida; Horace Hobbs, Texas; Leland Lai, California; Francisco (Paco) Martí Navarro, Spain; Don Martin, California; Jill Menzel, Brazil; Fernando Roca, Peru; Tobias W. Spanner, Germany; David Tanswell, Australia. **2016–2020:** Robert Blenker, Florida; Jeff Brusseau, California; John DeMott, Florida; Gregg Hamann, California; Hareesh, India; Susan Hubbell, Puerto Rico; Tom Jackson, California; Michael Merritt, Hawaii; Romeo Montalvo, Texas; Larry Noblick, Florida; Lazaro Priegues, Florida; Michael Smukall, Florida; Grant Stephenson, Texas; Michael Valentine, Colorado; Scott Zona, Florida.

Bookstore: www.palms.org

Chapters: See www.palms.org

Website: www.palms.org

Palms (formerly PRINCIPES)

Journal of The International Palm Society

An illustrated, peer-reviewed quarterly devoted to information about palms and published in March, June, September and December by The International Palm Society Inc., 9300 Sandstone St., Austin, TX 78737-1135 USA.

Editors: John Dransfield, Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE United Kingdom, e-mail j.dransfield@kew.org, tel. 44-20-8332-5225.

Scott Zona, Dept. of Biological Sciences (OE 167), Florida International University, 11200 SW 8 Street, Miami, Florida 33199 USA, e-mail zonas@fiu.edu, tel. 1-305-348-1247.

Associate Editor: Natalie Uhl.

Guidelines for authors are available on request from the Editors, or on-line at: www.palms.org/palms_author_guidelines.cfm

Annual membership dues are US\$45.00 for Individuals (or US\$120 for three years) and include a subscription to the Journal. Donor memberships are US\$500 per year. Individual Lifetime memberships are available for a one-time fee of US\$1000. Benefactor memberships require a one-time payment of US\$2500. Subscription price is US\$45.00 per year for libraries and institutions. Dues include mailing of the Journal by airlift service to addresses outside the USA. Dues may be paid on-line at www.palms.org.

Change of Address: Send change of address, phone number or e-mail to The International Palm Society Inc., 9300 Sandstone St., Austin, TX 78737-1135 USA, or by e-mail to info@palms.org.

Claims for Missing Issues: Claims for issues not received in the USA should be made within three months of the mailing date; claims for issues outside the USA should be made within six months of the mailing date.

Periodical postage paid at Austin, TX, USA and additional mailing offices. Postmaster: Send address changes to The International Palm Society Inc., 9300 Sandstone St., Austin, TX 78737-1135 USA.

PALMS (ISSN 1523-4495)

Mailed at Lawrence, Kansas 15 Sept. 2016
© 2016 The International Palm Society

The full text of PALMS is available on EBSCO Publishing's database.

This publication is printed on acid-free paper.

CONTENTS

109 ***Attalea*: Insights into the Diversity and Phylogeny of an Intriguing Genus**

A.M. RODRÍGUEZ CASTILLO, C. GARCIA-DAVILA. K. MEJÍA & J.-C. PINTAUD

125 **Aspects and Causes of Earlier and Current Spread of *Trachycarpus fortunei* in the Forests of Southern Ticino and Northern Lago Maggiore (Switzerland, Italy)**

V. FEHR & C.A. BURGA

137 **Palms of Vietnam – a Progress Report**

A. HENDERSON & N.Q. DUNG

145 **The Argun Palm, *Medemia argun*, in the Eastern Nubian Desert of Sudan**

O.M.M. ALI

Features

Palm News	108
Announcement	144
Photo Feature	154



FRONT COVER

Attalea colenda is a gigantic species more than 30 m tall in the Pacific lowlands of Ecuador and southern Colombia, that produces a massive infructescence up to 4 m long with thousands of fruits. See article by A. M. Rodríguez del Castillo et al., p. 109.

BACK COVERS

Isolated individual of *Trachycarpus fortunei* growing on a rocky cliff above Ponte Brolla, Switzerland. See article by Fehr & Burga, p. 125.

PALM NEWS

A Message from the President

I am honored to be the newly elected president of the International Palm Society. It is humbling to be president of an organization now celebrating its 60th anniversary and with such a rich history. I want to thank past president Leland Lai for his accomplishments and for his advice and assistance going forward. I would also like to thank past presidents Horace Hobbs and Paul Craft for their encouragement. This is a position that I do not take lightly, so it is important to absorb as much as possible from those who have been there before.

I was born in Tampa, Florida, so palms were around me even before they became an active interest. It was not until a trip to Ft. Myers, Florida in the early 1990s, however, that palms truly entered my consciousness. I had heard the story of Thomas Edison's importing thousands of *Roystonea regia* to line that city's McGregor Boulevard. When the initial planting failed, he had boats bring in even more. Judging by the height of some towering specimens lining that street today, it is a safe assumption some of the original plantings are still with us. For me the story and the palm-lined streets were infectious and unforgettable. It was not long before I acquired two *Roystonea* saplings that today are quite impressive in their own right. I have been hopelessly addicted ever since.

I accepted the position as IPS president knowing there would be significant challenges. One that needs attention immediately is our financial state. As you may or may not be aware, the IPS is facing serious financial challenges in the months and years ahead. For many years now, the cost of maintaining the Society in working order has exceeded revenue. Endowment grants, the cost of publishing *Palms*, and Biennial expenses are substantial but essential for the Society's survival. If the financial crisis is not remedied in the coming years, the IPS could cease to exist. I am asking every member to recruit or sponsor a new member during the next six months. The IPS is seeking tax-deductible monetary donations; no matter the size of the gift, every little bit helps. The Society is also seeking publication sponsors for the beautiful *Palms* journal that you receive quarterly. Major donors and publication sponsors will be recognized in the pages of *Palms*.

On a brighter note, the IPS is becoming more focused on conservation. In conjunction with the Nature Conservancy, the IPS is moving ahead with the Kona Hema effort to preserve and protect endangered *Pritchardia* habitat on Hawaii's Big Island. Specifically, the conservation effort will protect wild populations of *P. lanigera*, *P. beccariana* and *P. schattaueri*. Many native Hawaiian *Pritchardia* species are endangered by habitat destruction; habitat preservation will play a critical role in saving these magnificent palms. This is the first of many conservation efforts in which the IPS will take an active role.

In closing, I would like to thank you for your confidence in me to serve the International Palm Society. Please contact me to offer suggestions or voice concerns.

RAY HERNANDEZ, JR.
President, International Palm Society
subtropicofcancer@hotmail.com

***Attalea*: Insights into the Diversity and Phylogeny of an Intriguing Genus**

ÁNGEL MARTÍN RODRÍGUEZ DEL
CASTILLO

*Instituto de Investigaciones de la
Amazonía Peruana (IIAP),
Programa de Investigación en
Biodiversidad Amazónica PIBA,
Jr. Belen Torres 135 Morales,
Tarapoto, Perú*

*Corresponding author:
angelmartinrdc@gmail.com
arodriguez@iiap.org.pe*

CARMEN GARCÍA-DÁVILA
*IIAP, Programa para el Uso y
Conservación del Agua y sus
Recursos AQUAREC,
Carretera Iquitos Nauta Km 4.5,
San Juan Bautista, Iquitos, Perú*

KEMBER MEJÍA
*IIAP, Programa de Investigación en
Biodiversidad Amazónica PIBA,
Av. Abelardo Quiñones Km 2.5,
San Juan Bautista, Iquitos, Perú*

†JEAN-CHRISTOPHE PINTAUD
*Institut de Recherche pour le
Développement, UMR
DIADE/DYNADIV, Calle 17 No.
455, Lima 27, Perú*

Ongoing phylogenetic studies are revealing surprising relationships among species, greatly challenging the classical interpretation of characters in *Attalea*, and forcing us to rethink completely the morphology of these palms.

Attalea has long been a subject of taxonomic debate (reviewed by Pintaud 2008), with a long-lasting disagreement among authors about generic concepts (either the recognition of a single, broad genus *Attalea*, or several,

smaller genera including *Attalea sensu stricto* along with *Orbignya*, *Scheelea*, *Maximiliana* and sometimes a few more monotypic ones), and also about species concepts, resulting in a wide range of species number estimates (29–67).

However, recent progress in taxonomy and phylogeny is giving clues to the understanding of this complex group of Neotropical palms.

First, phylogenetic studies by Meerow et al. (2009, 2014) firmly established the monophyly of a broad genus *Attalea*, supporting the last generic treatment (Dransfield et al. 2008). *Attalea* as now definitely circumscribed is very diverse, ranging from relatively small acaulescent species (Fig. 1) to gigantic arborescent ones (Front Cover), with a corresponding variability in organ size and complexity (Fig. 3). At the same time, the enlarged genus is well-defined by a single character: the asymmetrical tip of the pinna. This well-known characteristic is always accessible for identification, even in sterile and juvenile palms (Kahn 1990). More precisely, what corresponds normally to the pinna apex in palm leaves is in fact symmetrical, acute, but it is exceeded by a projection that develops above and on one side of it (Fig. 4A). This unilateral projection is further accentuated by a distinctive brown indument abaxially in several species (Fig. 4A & C). In some other species, the unilateral projection is glabrous or glabrescent, and it often breaks with leaf expansion or subsequent aging, leaving an

asymmetrically truncate, or more or less unequally bifid tip, with the formation of a sinus (Fig. 4B & D). Whatever the case, the pinna tip variability is most useful for species identification (Fig. 4C), even if there is some instability in some species (Fig. 4D).

Very interesting and totally unusual is also the gynoeceum evolution in *Attalea*. Palms in general, as monocots, have flowers based on a trimerous structure, with each whorl of floral parts (sepals, petals, stamens, carpels) made of three elements. Particularly distinctive is the fundamentally tricarpellate-triovulate gynoeceum of palms (Dransfield et al. 2008). This basic structure is altered in many ways to produce the great diversity of floral morphology found in the palm family. As far as the gynoeceum and its post-anthesis development is concerned, there is a general trend of reduction of the number of ovules and/or seeds per flower/fruit from three to one. This reduction is achieved by various pre-anthesis or post-anthesis processes, depending on palm lineages. A remarkable pre-anthesis modification is pseudomonomy, in which a single carpel fully develops and carries the fertile ovule, the other two aborting early in development. This condition characterizes, for

1. *Attalea plowmanii* is a subacaulescent species from western Amazonia with small infructescences bearing a dozen fruits.

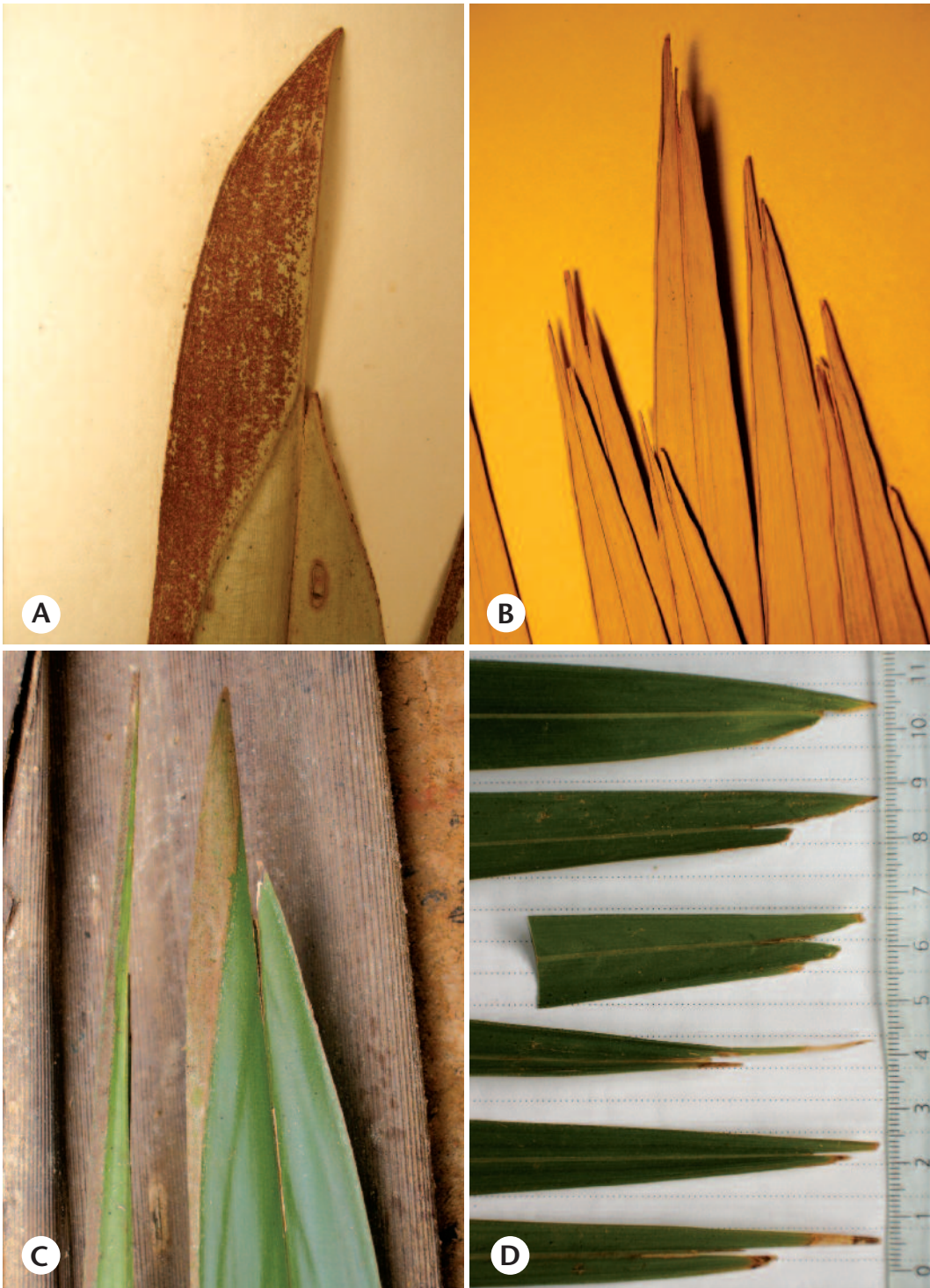




3. Variation in complexity of the morphology of *Attalea*. **A.** *Attalea eichleri*, a small acaulescent species of the southern Amazonian periphery, has a diminutive, almost spicate pistillate inflorescence with a fertile part just 10 cm long (P00118497, Weddel 2705, lectotype [P], from Brazil). **B.** *Attalea weberbaueri*, an arborescent species from the central-eastern inter-Andean valleys of Peru, has large, ramified inflorescences with over 400 rachillae and an infructescence weighting more than 30 kg.

example, the largest palm tribe, Areceae (Baker et al. 2011). Cocoseae, on the other hand, have a typical tricarpellate (syncarpous), triovulate gynoecium, forming in fruit the well-known woody endocarp with three opercula exemplified by the coconut. However, in most Cocoseae genera, a single seed develops and occupies all the space available inside the endocarp. The few not strictly one-seeded Cocoseae are *Butia* (1–3 seeds per fruit), *Barcella*, *Allagoptera* and *Parajubaea* (1 or 2 seeds) and *Attalea* (1–8 seeds). *Attalea* is therefore the only genus in Cocoseae in which there is a trend of increasing seed number, with commonly 3–6 seeds per fruit in many species (Fig. 5A) and up to 8 in some species, although others present the one-seeded fruit reduction, particularly *A. colenda* (Fig. 5B). In Cocoseae, the hard, woody endocarp is the disseminated unit or diaspore, so there is little evolutionary interest in producing multi-

seeded fruits because seedlings coming from the same fruit will compete for establishment, and at the best, a single one will develop correctly. So, why is there an increase in seed number in *Attalea* fruits? A possible explanation is co-evolution with bruchid beetles (Harms & Dalling 2000). These insects commonly reproduce on *Attalea* fruits, the developing larvae feeding on seeds (one larva per seed), and eventually the adult gets out of the endocarp leaving a characteristic circular hole (Fig. 5C & D). So, increasing seed number can be seen as a response of the palm to this parasitism to maintain diaspore efficiency (statistically, at least one seed in multi-seeded fruits remains free of parasites) while providing more reproductive sites for the insects, and conversely, bruchid parasitism can be seen as a necessary regulatory mechanism of germination, lowering seedlings mutual competition, so that an equilibrium with



4. Pinnae tip structure and shape are essential for characterization in the genus *Attalea*, and differ in each species. **A.** *Attalea allenii*, prominent falcate unilateral projection above symmetrical, acute apex, with a dark brown scaly indument continuing on pinnae side (Monsalve 1687 [CUVC], from Colombia). **B.** *Attalea exigua*, asymmetrically bifid, sinuate, glabrescent tip (P00118539, Glaziou 22267 [P], from Brazil). **C.** Comparison of pinnae tips in two sympatric species in Jenaro Herrera, Peruvian Amazon: left, *A. peruviana* with subulate projection, right *A. polysticha* with lanceolate projection. **D.** Variability of pinnae tips in a single leaf of *A. weberbaueri*.

shared benefits is achieved in that palm-insect relationship. However, in the *Attalea butyracea* complex, in which bruchid parasitism is high, one-seeded fruits are most common, with 2- or 3-seeded fruits representing 5–30% of the total within a given population. In fact, many factors, including bruchid mortality in infested fruits, and rodent predation and dispersal certainly interfere (Harms & Dalling 2000, Gálvez & Jansen 2007), so nothing is simple. The fascinating biology of *Attalea* includes many other intriguing adaptations such as neoteny in acaulescent species and functional dioecy.

Phylogeny

The molecular phylogeny of *Attalea* has been addressed partially by Meerow et al. (2009, 2014). These studies were based on a set of nuclear DNA markers belonging to the WRKY gene family. For our part, we generated a phylogeny for a sampling of species largely matching that of Meerow et al., using three new chloroplast DNA markers developed by Scarcelli et al. (2011), namely *psbK-trnS*, *rps15-ycf1* and *rrn4.5-trnN*, along with the nuclear markers PRK, PhyB and CISP4 recently used by Roncal et al. (2013) in a phylogeny of the genus *Astrocaryum*. The newly generated sequences were deposited in Genbank under accessions KP307929–307942 (PRK), KR559512–559524 (PhyB), KR559525–559540 (CISP4), KT321478–321492 (*rrn4.5-trnN*), KT321493–321508 (*psbK-trnS* and *rps15-ycf1*). Interestingly, the phylogenies of Meerow et al. and ours are highly congruent, indicating a strong signal in the phylogenetic structure of *Attalea* (Fig. 6). In both studies, *Attalea* in its broad sense is primarily divided in two well-defined clades: one corresponding to species from central and eastern Brazil belonging to the former genus *Attalea sensu stricto*, and one incorporating all other species sampled in *Attalea sensu lato*. In the later clade, the Haitian *Attalea crassispatha* is sister to all other species formerly incorporated in the genera *Orbignya* and *Scheelea*. This is interesting because while *Attalea sensu lato* is very common in both South and Central America, it is almost absent from the Caribbean islands (except from Trinidad, the flora of which is an extension of that of Venezuela). *Attalea crassispatha* is therefore very isolated both geographically and phylogenetically. Moreover, there is a consistent signal of dispersion of Cocoseae from northern South America to the Antilles in Mio-Pliocene, with the age of the separation of *Acrocomia crispa* in Cuba from South

American species estimated at 16 MYBP, the age of the divergence of *A. crassispatha* with continental species at 9 MYBP, the age of the split between *Syagrus amara* and the *S. orinocensis/stenopetala* clade at 5 MYBP, and the age of divergence of *Aiphanes minima* from *A. horrida* at 3 MYBP (Meerow et al. 2014).

In the group of species sister to *A. crassispatha*, two entities are distinct: a “babaçu” subclade including the species *A. speciosa* and its close relatives, formerly included in the genus *Orbignya*, and a subclade including all species previously belonging to the genus *Scheelea*, consistently associated with *A. cohune* and *A. guacuyule*, two closely related (and sometimes treated as synonyms) species formerly included in *Orbignya*. Adding to this the fact that Glassman (1999) treated *A. crassispatha* in the genus *Orbignya*, we can see that this former genus is indeed paraphyletic with respect to the other species sampled in this subclade. Moreover, the addition in our study of *A. tessmannii* and *A. amygdalina*, which have always been treated as part of *Attalea sensu stricto* makes this former concept of the genus polyphyletic, because these two species from the western Amazon and the Colombian Inter-Andean valleys, respectively, cluster with the *Scheelea* group and not with the Eastern-Central Brazilian *Attalea sensu stricto* clade. This phylogenetic structure indicates that the major division in the genus is geographic, beginning with the middle Miocene (20–10 MA) split between the Amazonian and Cerrado-Mata Atlantica palm floras, a signal found in several genera including *Attalea*, *Syagrus* and *Astrocaryum* (Meerow et al. 2009, 2014, Roncal et al. 2013).

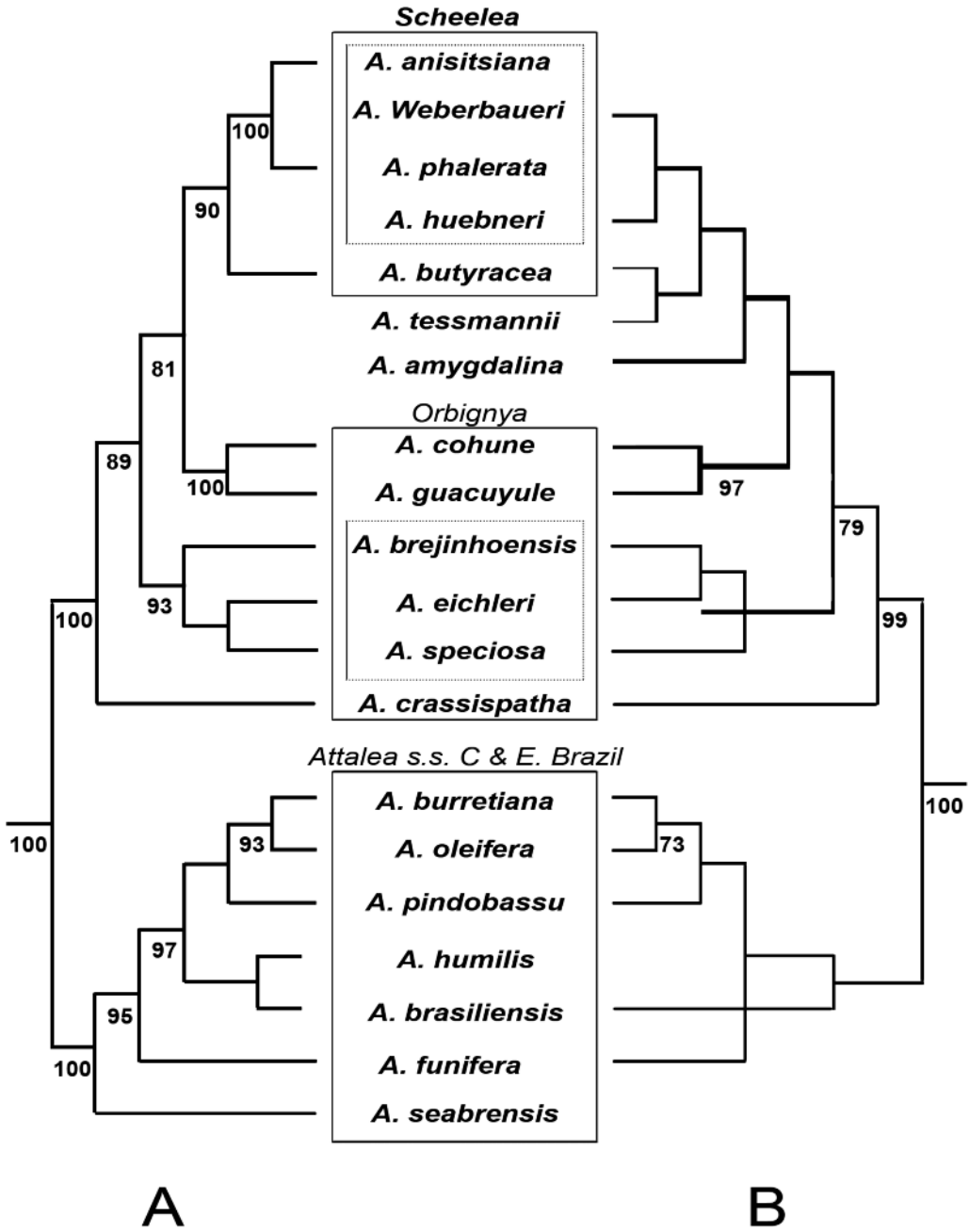
Although we now have a clearer view of the phylogenetic structure of the broad genus *Attalea*, the addition of more species in the analysis, especially the unsampled former genus *Maximiliana* is still necessary to get a complete picture of the evolutionary relationships within *Attalea*. This more complete analysis is now approaching completion (Freitas et al. in prep.).

Morphological evolution and taxonomy

The fact that the new phylogenetic data contradict the classical morphological boundaries within this group of palms implies that a new interpretation of characters, and a revised homology assessment of them, is needed. For example, the former genera *Orbignya*, *Scheelea*, *Maximiliana* and *Attalea sensu stricto* look reasonably well defined



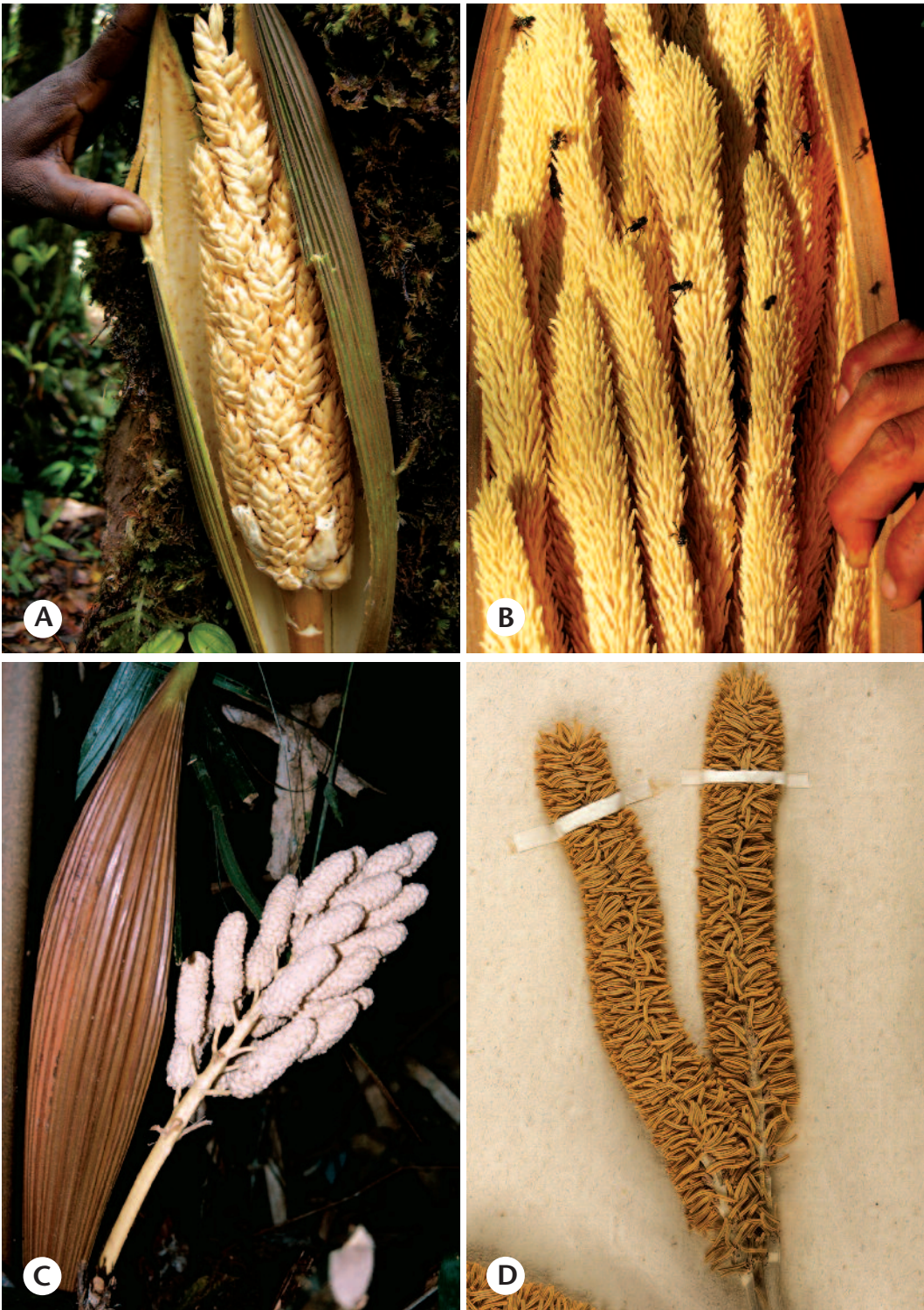
5. Seed evolution and ecology in *Attalea*. **A.** Fruits of *Attalea huebneri* laying on the ground, with a cross-section of a 5-locular, 6-seeded endocarp. **B.** Cross-section of the one-seeded fruit of *Attalea colenda*, a species showing a unique endocarp and seed structure, more reminiscent of *Cocos* or *Astrocaryum* than of other *Attalea* species, and which has been once classified in a distinct genus, *Ynesa*. **C.** Old fruits of *Attalea weberbaueri* on the ground, with an endocarp showing exit hole left by a bruchid beetle. **D.** Longitudinal section of endocarp of a heavily parasitized fruit of *A. weberbaueri*, showing bruchid beetle larva in a seed cavity.



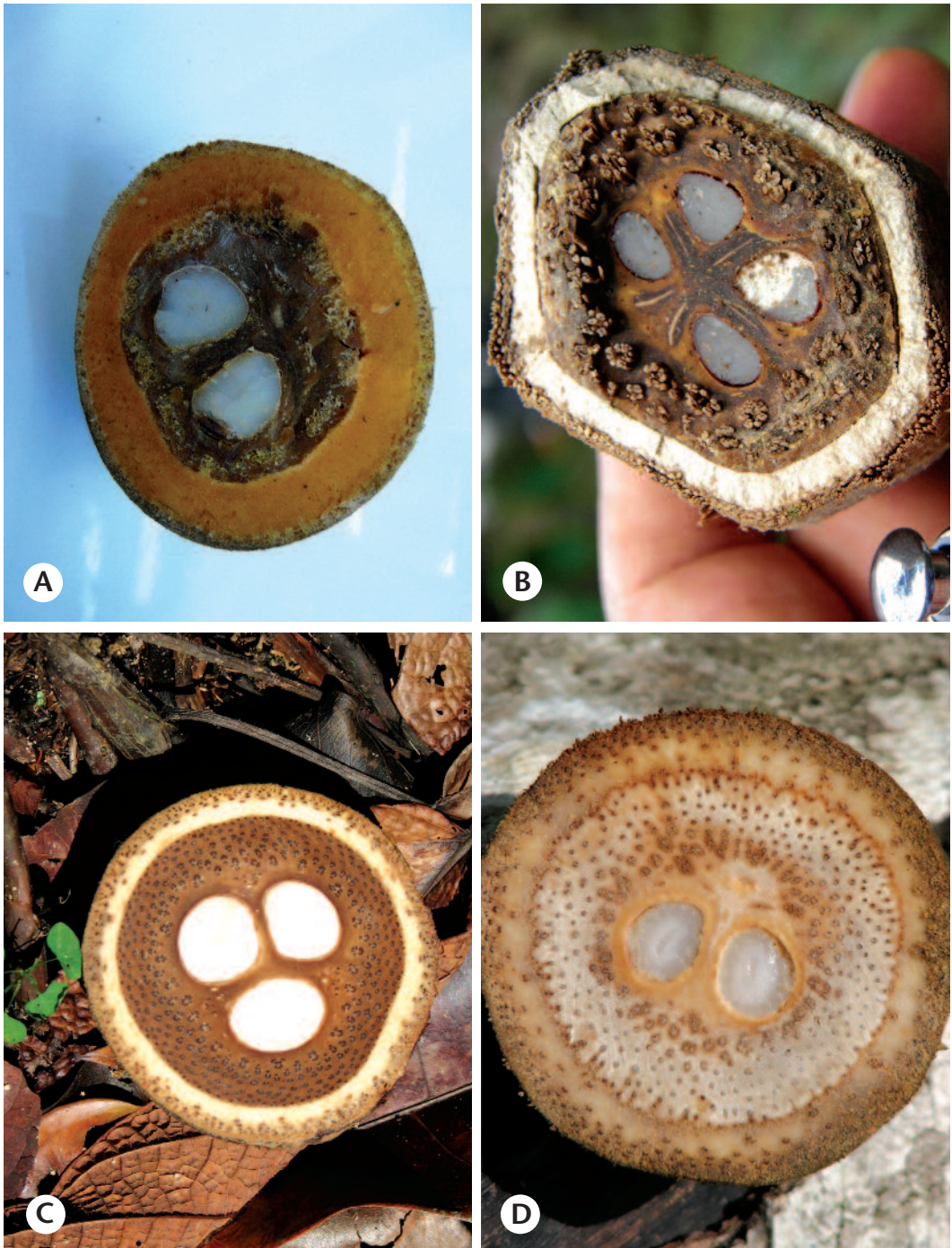
6. Phylogenetic relationships within the genus *Attalea*, comparing the topologies obtained by Maximum Likelihood analysis of nuclear WRKY genes by Meerow et al. 2009 (A), and combined chloroplast and nuclear genes in the present study (B). Figures below branches represent ML bootstrap values. Solid rectangles identify from bottom to top: the central-eastern Brazilian species previously included in *Attalea* (*sensu stricto*); the species included in *Orbignya* (with the “Babaçu” clade in dot line); and those included in *Scheelea* (with the *A. phalerata* clade in dot line).

morphologically, especially in inflorescence and floral structure (Fig. 7). Particularly intriguing is *Orbignya*, so distinctive with its characteristic coiled and enrolled anthers, and staminate flowers often tightly packed on

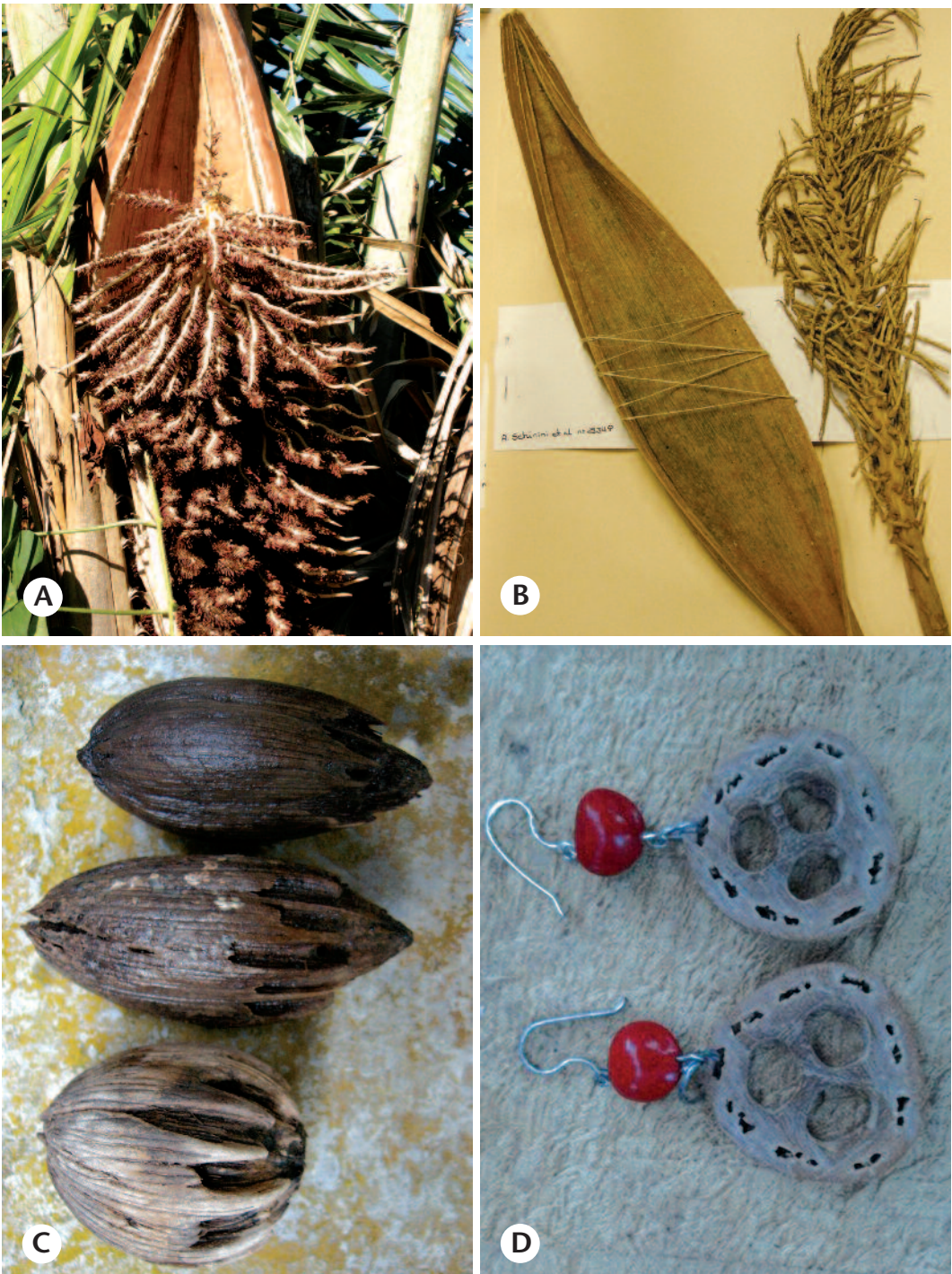
staminate rachillae (Fig. 7C), and pistillate rachillae contorted around pistillate flowers (Fig. 3A). However, since this taxon does not form a well-defined phylogenetic entity, with some species having affinities outside this



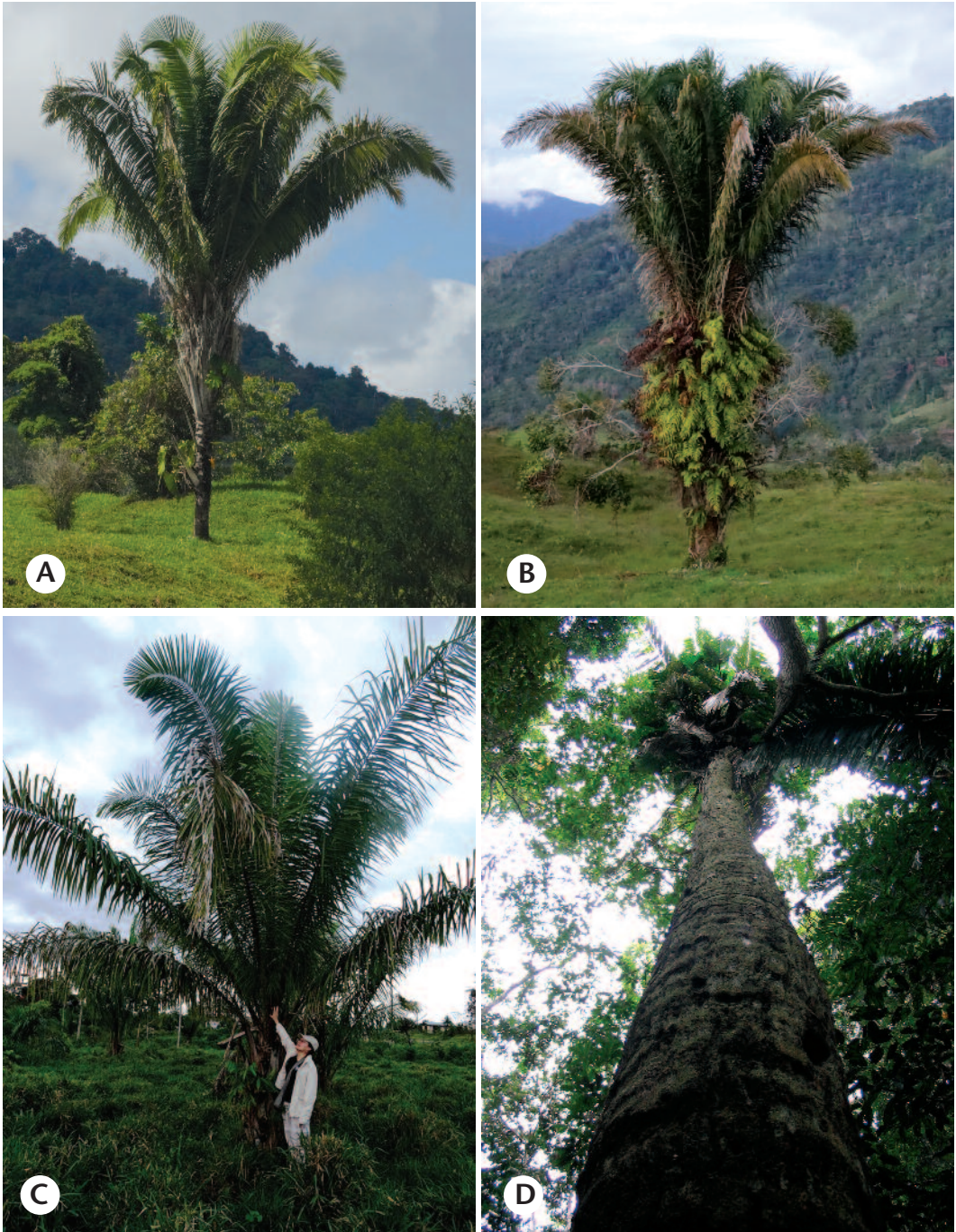
7. Diversity of inflorescences in *Attalea*. **A.** *Attalea*-type androgynous inflorescence, with a few basal, irregularly shaped pistillate flowers and numerous staminate flowers with triangular, flat petals (*A. allenii*, Quibdó, Chocó, Colombia). **B.** *Scheelea*-type staminate inflorescence with terete, fleshy petals (*A. bassleriana*, Pantoja, Loreto, Peru). **C.** *Orbignya*-type staminate inflorescence with densely packed flowers on rachillae (*A. polysticha*, Jenaro Herrera, Loreto, Peru). **D.** *Maximiliana*-type staminate rachillae with flowers having a reduced perianth and long, linear anthers (*Maximiliana maripa*, P01886492, *J. Triana* 734 [P], from Colombia).



8. Cross sections of fruits reveal a great morphological diversity and provide essential characters for species identification and delimitation of groups of allied species. *Attalea phalerata* complex: A. *Attalea huebneri* showing extremely thick, fleshy and juicy orange mesocarp at maturity, endocarp with large fiber clusters forming one peripheral circle, locular septa not marked; B. *Attalea moorei*, showing dry, white mesocarp and prominent fiber clusters forming 2 or 3 internal circles in the endocarp, locular septa marked; seed cavities widely separated with margin not thickened in both species. *Attalea butyracea* complex: C. *Attalea bassleriana* showing concentric small fibrous bundles of increasing size centripetally in the endocarp, and closely arranged seed cavities with thickened margin; D. *Attalea plowmanii* with the same structural characteristics as the anterior but with paler and superficially grooved endocarp (margin irregular in cross section). All species have a prominent fibrous exocarp.



9. Some characteristics of the *Attalea phalerata* complex. **A.** Staminate flowers are generally unilaterally arranged abaxially on staminate rachillae (except in *A. princeps* with a mostly spiral arrangement), and inflorescences have generally a thick peduncular bract, here in *Attalea moorei* in Peru. **B.** *Attalea anisitsiana* however has an unusually thin peduncular bract although it has the other distinctive characters of the *Attalea phalerata* complex (Schinini 29348 [G], from Paraguay). **C.** Endocarps can be variously shaped depending on fruit compression during development in infructescence, but are always prominently sculptured proximally and striate by the imprints of closely adherent internal mesocarp fibers, here in *Attalea huebneri* in Peru. **D.** Endocarps with large fibrous clusters forming one or few circles, and widely spaced seed cavities create aesthetic patterns used for fine handicrafts, here from *Attalea princeps* in Bolivia.



10. Some distinctive species in the *Attalea phalerata* complex. **A.** *Attalea moorei*, widely distributed in eastern Peru and adjacent Brazil and Bolivia, is unusual in having sessile leaves with perfectly regularly arranged pinnae all along rachis. **B.** *Attalea weberbaueri*, endemic in the inter-Andean valleys of central-eastern Peru, has the more common condition of sessile leaves with pinnae clustered in the proximal 2/3 of rachis. **C.** *Attalea princeps*, of the south-western Amazon and adjacent Andean foothills, is unusual in having distinctly petiolate leaves but, like the two former species, it is relatively short-trunked and likes semi-open vegetation under seasonally dry climates. **D.** *Attalea huebneri* is remarkable for its very tall habit. This extremely old specimen from Jenaro Herrera, Peru, is about 45 m tall. Although the crown looks small from ground level, each leaf is 12 m long. *Attalea huebneri* is also unique in distribution and ecology in the *Attalea phalerata* complex, occupying the wettest parts of the western Amazon in Brazil, Peru and Colombia, where it grows in *igapo* and *varzea* forests, often in association with *A. bassleriana*.



11. *Attalea moorei* × *phalerata*, here in Madre de Dios, Peru, probably occurs rather commonly in the vast area of sympatry of the two parent species in south-eastern Peru, Acre in Brazil and Pando in Bolivia.

group, these characters cannot be used as an evidence of exclusive common ancestry (synapomorphies). Moreover, with its peculiar and distinctive inflorescence and floral

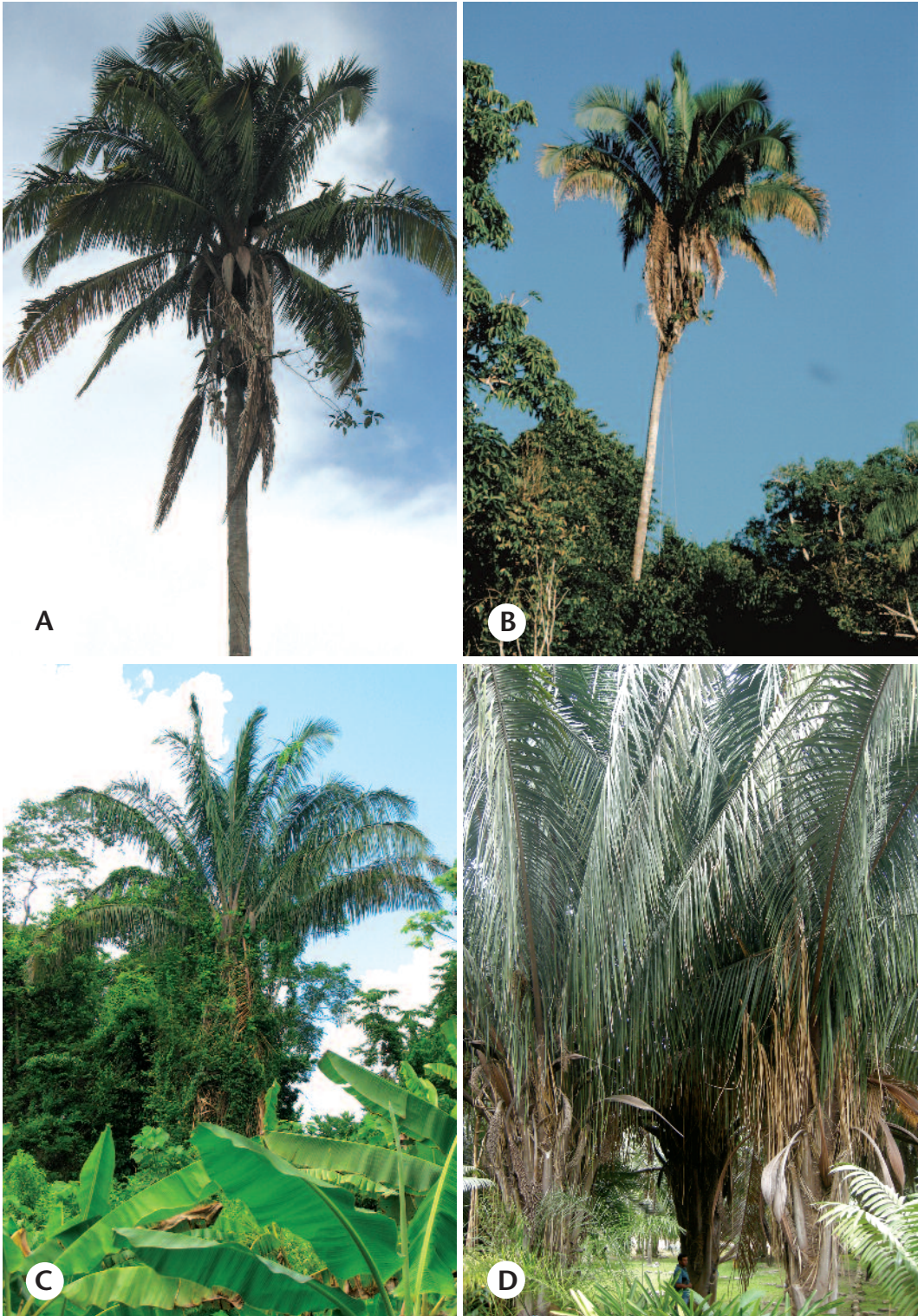
morphology, *Orbignya* looks like a derived entity, while its species tend to be basal in the subclades of the phylogeny. Even more disturbing is the consistent association, with



12. *Attalea moorei* × *weberbaueri*, is a rare hybrid occurring in a narrow fringe of sympatry of the parent species in the central-eastern Andean foothills of Peru.

different phylogenetic markers, of *A. butyracea* and *A. tessmannii*, two species that hardly share any obvious common character. However, *A. tessmannii* has been regarded as an outlier in the former *Attalea sensu stricto* concept, because it has spirally arranged staminate flowers on

rachillae, a condition unusual in this entity essentially characterized by the unilateral arrangement of these flowers. On the contrary, the spiral arrangement of staminate flowers is shared with *A. butyracea* (formerly *Scheelea*), which is phylogenetically consistent.



13. Some species in the *Attalea butyracea* clade. **A.** *Attalea peruviana*, distinctive among similar species by the elongate petioles (western Amazonia). **B.** *Attalea bassleriana* with sessile leaves and pinnae waxy-glaucous abaxially (western Amazonia). **C.** *Attalea tessmannii*, showing long-petiolate leaves with clustered pinnae (western Amazonia). **D.** *Attalea macrocarpa* with a roof-like regular arrangement of pinnae in proximal part of rachis (north-eastern coast of Venezuela).

In order to re-evaluate in detail the morphology of *Attalea* and its significance, we have established a list of morphological descriptors with 700 items, each one composed of one or few related characters (more than a thousand in total), that we are currently using to describe fully many species directly in the field and to compare with the partial herbarium material. This arduous task is beginning to give good rewards, in particular in the *Attalea phalerata* complex, which spans most of the South American continent and appears to be very well defined as a group, both phylogenetically (Fig. 6) and morphologically (Figs. 8 & 9). At the same time there are clear-cut morphological differences, along with distinctions in ecology and distribution among included species, i.e., *A. phalerata sensu stricto*, *A. anisitsiana*, *A. weberbaueri*, *A. moorei*, *A. princeps*, *A. huebneri* among others (Fig. 10). Recognizing these different species provides much more biological information than considering all of them as variations within a single, broad *A. phalerata* species (Henderson et al. 1995), a lumping view that is, however, valid because all these entities form a monophyletic group and are inter-fertile when occurring sympatrically (Figs. 11 & 12). More studies are still needed to provide a complete systematic treatment of the *Attalea phalerata* complex with the alternative, splitting view, but it can be estimated that it is a group of about 10 distinct species.

A similar approach can be applied to the *Attalea butyracea* clade, but it is a still more complex group that includes morphologically similar species like *A. rostrata*, *A. osmantha*, *A. macrocarpa*, *A. peruviana*, which resemble closely *A. butyracea sensu stricto*, but also species which have been regarded sometimes as synonyms of *A. butyracea* despite having a clearly different morphology (*A. bassleriana*, *A. plowmanii*), and species that had never been suspected to have a link with *A. butyracea* but that appear closely allied to it in phylogenetic analyses like *A. tessmannii* (Fig. 13) and *A. insignis* (Cintia de Freitas, pers. comm.). *Attalea huebneri* has been considered as a synonym of *A. butyracea* by Henderson et al. (1995) but our work showed that it is in fact allied to *A. phalerata*.

Altogether, the information unravelled by recent work rises more questions than it provides answers to, and makes research on this intriguing genus that was described two hundred years ago (Kunth in Humboldt et al.

1816), and is still little understood, even more exciting.

Acknowledgments

Field work and phylogenetic studies were funded by: Programa Nacional de Innovación para la Competitividad y Productividad PNICP/Innovate Peru "Biología, ecología y prospección química de palmeras promisorias del género *Attalea* en la Amazonía peruana" 185-FINCYT-IB-2013, FP7-PALMS "Palms harvest impacts in tropical forests", IRD PPR AMAZ "Attadyn" project, IIAP-PIBA, and Grant of Excellence from the Franco-Peruvian Foundation (French Embassy in Peru) to the first author. We thank the following herbaria for access to their collections: Museum National d'Histoire Naturelle MNHN-Paris (P), Conservatoire et Jardins Botaniques de la ville de Genève CJBG (G), Herbario Luis Sigifredo Espinal-Tacson, Universidad del Valle, Cali (CUVC).

This work has been possible thanks to the contributions of many collaborators. We are particularly grateful to the following persons: Henrik Balslev, Birgitte Bergman, Rodrigo Bernal, Rodrigo Camara-Leret, Marie Couderc, María de Fátima Sánchez, Evandro Ferreira, Gloria Galeano, Cintia Gomez de Freitas, Andrew Henderson, Marc Jeanson, Francis Kahn, Eva Ledezma, Nandy Macedo-Vásquez, Betty Millán, Danielle Mitja, Natalia Molina, Rommel Montúfar, Monica Moraes, Larry Noblick, Helmut Rengifo Novoa, Vanessa Rojas-Fox, Julissa Roncal, Lázaro Santa-Cruz, Philip A. Silverstone-Sopkin, Víctor Sotero Solís, Fred W. Stauffer and Pedro Vásquez-Ocmín.

While preparing this manuscript J.C. Pintaud died; *Attalea* was the group to which he devoted greatest efforts in recent years, and this manuscript is a tribute to his excellent career.

LITERATURE CITED

- BAKER, W.J., M.V. NORUP, J.J. CLARKSON, T.L.P. COUVREUR, J.L. DOWE, C.E. LEWIS, J.-C. PINTAUD, V. SAVOLAINEN, T. WILMOT AND M.W. CHASE. 2011. Phylogenetic relationships among arecoid palms (Arecaceae: Arecoideae). *Annals of Botany* 108: 1417–1432.
- DRANSFIELD, J., N.W. UHL, C.B. ASMUSSEN-LANGE, W.J. BAKER, M.M. HARLEY AND C.E. LEWIS. 2008. *Genera Palmarum – The evolution and classification of palms*. Royal Botanic Gardens, Kew, Richmond, 732 pp.

- GÁLVEZ, D. AND P.A. JANSEN. 2007. Bruchid beetle infestation and the value of *Attalea butyracea* endocarps for neotropical rodents. *Journal of Tropical Ecology* 23: 381–384.
- GLASSMAN, S.F. 1999. A taxonomic treatment of the palm subtribe Attaleinae (tribe Cocoeae). *Illinois Biological Monograph* 59. University of Illinois Press, Urbana, Urbana, IL.
- HARMS, K.E. AND J.W. DALLING. 2000. A bruchid beetle and a viable seedling from a single diaspore of *Attalea butyracea*. *Journal of Tropical Ecology* 16: 319–325.
- HENDERSON, A., G. GALEANO AND R. BERNAL. 1995. *Field Guide to the Palms of the Americas*. Princeton University Press, Princeton, NJ.
- HUMBOLDT, A., A. BONPLAND AND C.S. KUNTH. 1816. *Nova genera and species plantarum* 1: 198–318.
- KAHN F. 1990. Identification of Amazonian palm genera from vegetative characters. *Principes* 34: 199–207.
- MEEROW, A.W., L. NOBLICK, J.W. BORRONE, T.L.P. COUVREUR, M. MAURO-HERRERA, W.J. HAHN, D.N. KUHN, K. NAKAMURA, N.H. OLEAS AND R.J. SCHNELL. 2009. Phylogenetic analysis of seven WRKY genes across the palm subtribe Attaleinae (Arecaceae) identifies *Syagrus* as sister group of the coconut. *PLoS ONE* 4(10): e7353. doi:10.1371/journal.pone.0007353.
- MEEROW, A.W., L. NOBLICK, D.E. SALAS-LEIVA, V. SANCHEZ, J. FRANCISCO-ORTEGA, B. JESTROW, K. NAKAMURA. 2014. Phylogeny and historical biogeography of the cocosoid palms (Arecaceae, Arecoideae, Cocoseae) inferred from sequences of six WRKY gene family loci. *Cladistics* doi: 10.1111/cla.12100.
- PINTAUD, J.-C. 2008. An overview of the taxonomy of *Attalea* (Arecaceae). *Revista Peruana de Biología* 15(suppl. 1): 55–63.
- RONCAL, J., F. KAHN, B. MILLÁN, T. COUVREUR AND J.-C. PINTAUD. 2013. Cenozoic colonization and diversification patterns of tropical American palms: evidence from *Astrocaryum* (Arecaceae). *Botanical Journal of the Linnean Society* 171: 120–139.
- SCARCELLI, N., A. BARNAUD, W. EISERHARDT, U. TREIER, M. SEVENO, A. D'ANFRAY, Y. VIGOUROUX AND J.-C. PINTAUD. 2011. A set of 100 DNA primer pairs to study population genetics and phylogeny in Monocotyledons. *PLoS ONE* 6(5): e19954. doi:10.1371/journal.pone.0019954.

Aspects and Causes of Earlier and Current Spread of *Trachycarpus fortunei* in the Forests of Southern Ticino and Northern Lago Maggiore (Switzerland, Italy)

VINCENT FEHR
Vordersteig 3
8200 Schaffhausen,
Switzerland
vincentfehr@bluewin.ch

AND

CONRADIN A. BURGA
Dept. of Geography
University of Zurich-Irchel
Winterthurerstrasse 190
8057 Zürich, Switzerland

During 2013 and 2014, we investigated the process of the spreading of evergreen broad-leaved (laurophyllous) species in the deciduous forests of southern Ticino (Switzerland) and neighboring northern Lago Maggiore (Italy). The mild climate of this region allows a diversity of exotic plants to thrive outdoors. Most noticeable is the Chinese windmill palm (*Trachycarpus fortunei*), cultivated in almost every private garden and park around the lakes of southern Switzerland. This palm species has been spreading into the nearby forests for decades. Our research deals with several aspects of the spread of *Trachycarpus fortunei* in the investigated region, such as the occurrence within the vertical layer of the forest structure since earlier surveys. The ecological conditions in which this palm species thrives best in the research area are analyzed. In addition, we discuss possible causes that may have contributed to the spread of *Trachycarpus fortunei*, such as the environmental dynamics of the past 40 years as global warming and anthropogenic impacts.

To discuss the spread of the Chinese windmill palm (*Trachycarpus fortunei*), an introduction to the actual vegetation and physical environment of the research area, is appropriate for a better understanding. The

research area is part of the Insubric region, which includes the south alpine Piedmont region of the Alps in Italy and southern Switzerland. In geobotanical terms, Insubric refers to the region between Lake Orta and

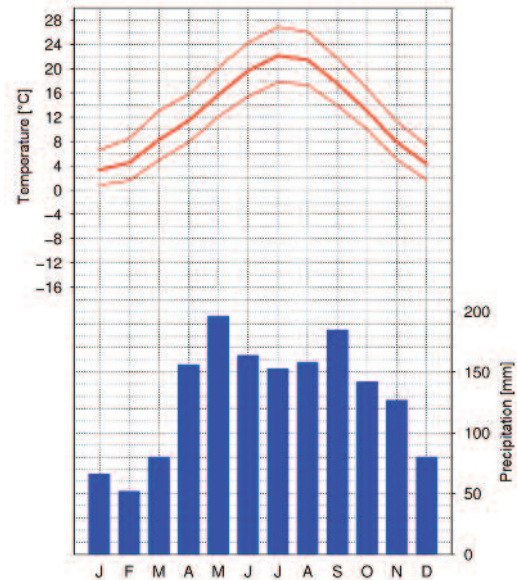
Lake Maggiore below 600 m altitude and is characterized by special climate conditions and vegetation.

Vegetation

The Insubric region can be considered as a transitional zone between the biogeographic region with temperate climate and deciduous, frost-resistant forests and the biogeographic region with warm temperate climate and evergreen broad-leaved (laurel-) forests (Klötzli 1988, Walter & Breckle 1999). The deciduous part of the Insubric forest in the research area consists of oaks (*Quercus petraea*, *Q. pubescens*), linden (*Tilia cordata*, *T. platyphyllos*), field maple (*Acer campestre*), European ash (*Fraxinus excelsior*), (sub-)Mediterranean, thermophilic species such as manna-ash (*Fraxinus ornus*), hop hornbeam (*Ostrya carpinifolia*) and sweet chestnut (*Castanea sativa*, introduced ca. 2000 BC) and alien species like the false acacia (*Robinia pseudoacacia*) (Lüdi 1944, Burga & Perret 1998, Steiger 2010). In comparison with other parts of the world with similar climatic conditions (e.g., southeastern USA, eastern China), only a few evergreen species are native in the Insubric region. These include holly (*Ilex aquifolium*), ivy (*Hedera helix*), spurge laurel (*Daphne laureola*), boxwood (*Buxus sempervirens*) and rarely European yew (*Taxus baccata*). During warm interglacial periods, many other evergreen species were common in the research area (Hantke 1978, 1980, 1983), but glaciation forced them to migrate further south. Many found it impossible to resettle in the Insubric region when the Ice Age ended ca. 10,000 years ago (Burga & Perret 1998).

Since the end of the 1980s, an increasing number of alien evergreen species have been observed spreading into the lower forests of southern Ticino and neighboring Italy (Gianoni et al. 1988, Carraro et al. 1999, Walther 2000, Schildknecht et al. 2008). The majority originate from regions with evergreen (laurel-) forests, occurring, for example, in East Asia and the Colchis (Georgia), and were introduced as ornamental plants from the 17th century onwards (Schröter 1956). This process of spread of foreign, thermophilic, evergreen, broad-leaved (laurophyllous) trees and shrubs is generally called laurophyllization (Gianoni et al. 1988).

The most conspicuous exotic species in the research area is the Chinese windmill palm (*Trachycarpus fortunei*). In 1936, self-seeding of *Trachycarpus fortunei* was noted for the first time in southern Ticino by Schröter (1936).

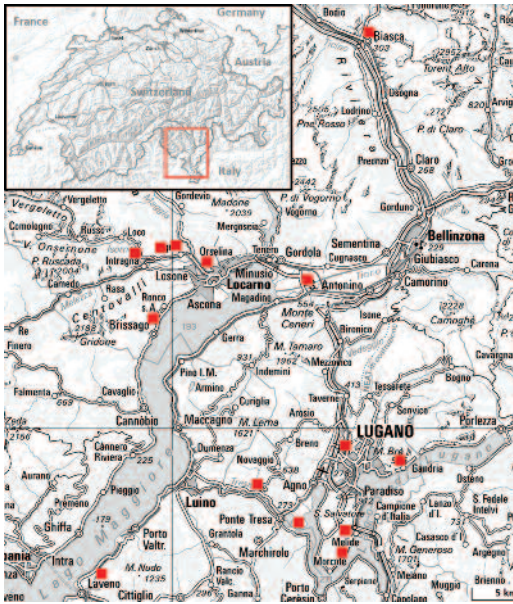


1. Climate diagram of Lugano, 1981–2010. Thick red line: average temperature [°C]; thin red lines: Average max. and min. temperatures [°C]; blue bars: total precipitation [mm]. Source: MeteoSchweiz.

Twenty years later, he reported that the Chinese windmill palm on the Brissago Islands had spread to the same extent as native species (Schröter 1956). In the 1960s and 1970s, the windmill palm established itself in the herb layer (Zuber 1979). In 1988, juvenile palms were found in the shrub layer of forest sites with favorable climatic conditions (Gianoni et al. 1988). From the 1990s, *T. fortunei* was observed advancing into the tree layer in a few areas (Walther 2000, Küttel 2001). The laurel tree (*Laurus nobilis*), the cherry laurel (*Prunus laurocerasus*) and the false camphor tree (*Cinnamomum glanduliferum*) also spread widely. For forest sites, where the laurophyllous species occur strongly, the new forest community of the Insubric laurel forest (Laurisilva insubrica) was defined (Carraro 2010). Since August 2014, the Swiss Federal Office for the Environment has listed *Trachycarpus fortunei* as an invasive species with high potential to spread in southern Ticino. It is considered to inhibit rejuvenation of indigenous tree species. *Trachycarpus fortunei* rarely spreads around Lake Geneva (Info Flora 2014).

Climate

The Insubric climate is characterized by mild, dry and sunny winters and high precipitation rates between April and November (Fig. 1). The summers are warm and sunny and



2. Map of the research area. Red squares: sites with vegetation records. Source: Swisstopo, modified.

thunderstorms are frequent, often accompanied by intense rainfall. The Alps shelter the Insubric region from cold surges from the north and east during winter. Additionally, the Insubric lakes have a moderating influence on the night-time temperatures during winter. An average of ca. 2000 annual hours of sunshine is recorded within the region. The average annual rainfall varies between 1500 mm and 1900 mm (Urfer et al. 1979, Aschwanden et al. 1996). An

overview of different temperature parameters at three stations in the research area and one in Zurich on the north side of the Alps is given in Table 1. Unless otherwise stated, the climate data originate from MeteoSchweiz and represent the 30 annual means from 1981–2010.

Research area and methods

In 14 sites in southern Ticino and the northern region around Lago Maggiore in Italy, 46 vegetation records were carried out between October 2013 and May 2014 (Fig. 2, Fehr 2014). The criteria for selection of a site were (1) the occurrence of laurophyllous species, (2) establishment of records along a vertical and/or horizontal transect, and (3) accessible sites. Areas away from the direct influence of the Insubric lakes were examined (Fehr 2014).

The flora of the sites was recorded using a modified Braun-Blanquet scale (Braun-Blanquet 1964). Consequently the coverage of every plant species in each canopy layer was estimated and the plant community of the record was determined. The exact number of individuals of *Trachycarpus fortunei* and laurophyllous species was recorded, and their height was estimated. The pH value of the soil was determined as well as the altitude, the slope and the distance from gardens.

Results and discussion

The Chinese windmill palm (*Trachycarpus fortunei*), the laurel tree (*Laurus nobilis*) and the

Table 1. Overview of different temperature parameters, 1981–2010 and (1961–1990), at three stations in the research area and one in Zurich on the north side of the Alps.

Southern Ticino	Location	Average annual temp. [°C]	Average temp. July [°C]	Average temp. January [°C]	Freezing days [n]	Ice days [n]
Locarno-Monti	Lake proximity	12.4 (11.5)	21.9 (20.7)	3.4 (2.7)	30.1 (35.4)	0.8 (1.5)
Lugano	Lake proximity	12.4 (11.6)	22.1 (21.1)	3.3 (2.6)	27.6 (34.8)	0.7 (0.8)
Magadino	Magadino plain, frost pocket	11.4 (10.5)	21.7 (20.6)	0.9 (0.2)	94.4 (98.7)	1.1 (2)
North side of the Alps						
Zürich/Fluntern	Station of the Swiss Plateau	9.3 (8.5)	18.6 (17.6)	0.3 (-0.5)	74.9 (88.3)	23.7 (25.9)

Source: MeteoSchweiz



3. Seedlings of *Trachycarpus fortunei* in the herb layer.

cherry laurel (*Prunus laurocerasus*) are widespread in the research area. The false camphor tree (*Cinnamomum glanduliferum*), the thorny olive (*Elaeagnus pungens*), the Japanese honeysuckle (*Lonicera japonica*) and the holm oak (*Quercus ilex*) are spreading at some sites. No new or reintroduced species were detected. The lauropyhllous species are also spreading at sites away from the lakes.

Vertical distribution of *Trachycarpus fortunei* in the forest layers

To analyze the degree of naturalization of *T. fortunei*, its occurrence in different vertical forest layers on a total of 46 vegetation records

was examined. The results are represented in Table 2. In 14 records *T. fortunei* is absent. In 10 records it was detected only in the herb layer (Fig. 3), with an average coverage of 6.4%. In 10 records *T. fortunei* occurs in the shrub layer (Figs. 4 & 5) and covers about 21.2%. In 12 records the palm was encountered in the tree layer (Fig. 6) with an average coverage of 11.4%.

The spread of *T. fortunei* has advanced very quickly over the last 30 years. During the monitoring period, *Trachycarpus fortunei* has already penetrated into the tree layer, and many individuals are fertile (Fig. 7). It is

Table 2. Occurrence of *Trachycarpus fortunei* in the different vertical forest layers.

Occurrence of <i>T. fortunei</i> in the vegetation records	Number of records	Coverage [%]	Total number of palm individuals detected in 46 records
Absent	14	-	-
Herb layer (< 0.5 m)	10	6.4	> 500
Shrub layer (0.5–4 m)	10	21.2	0.5–2 m: 77; 2–4 m: 52
Tree layer (> 4m)	12	11.4	4–6 m: 17; 6–10 m: 23; >10 m: 5



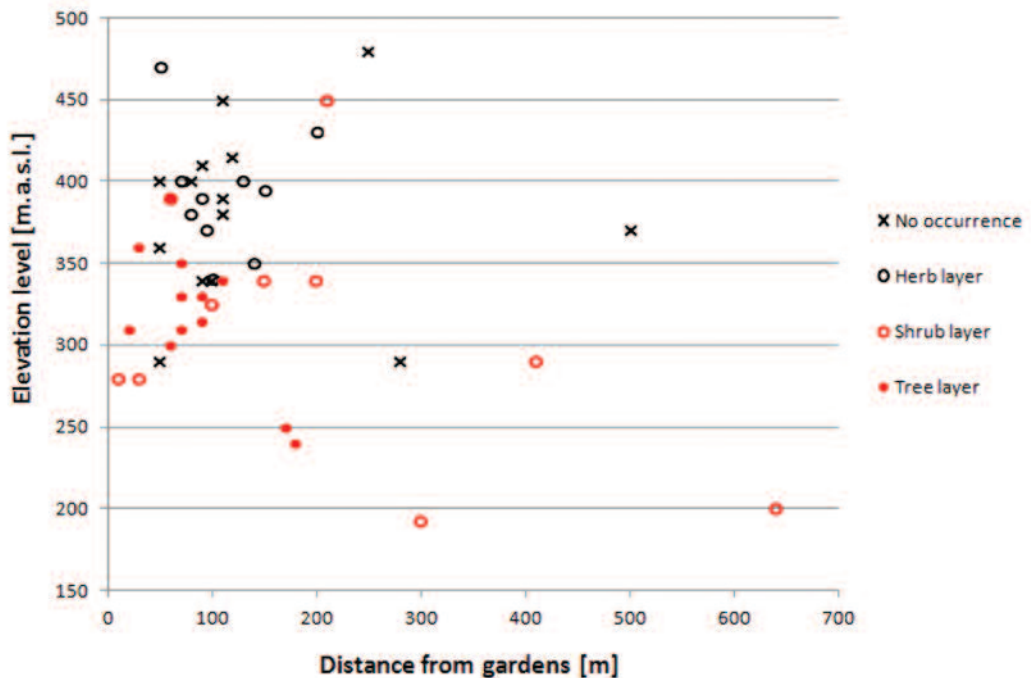
4 (top). Many individuals of *Trachycarpus fortunei* are present in the shrub layer near Manno. 5 (bottom). *Trachycarpus fortunei* dominating the shrub layer on a site on the Monte Caslano.

naturalized in the research area, as the spread no longer depends on cultivated individuals. In earlier surveys (Walther 1995, Küttel 2001),

T. fortunei was found primarily in the herb and shrub layers; only a few individuals penetrated the tree layer (Gianoni et al. 1988).



6 (top). *Trachycarpus fortunei* has penetrated into the tree layer near Melide. 7 (bottom). *Trachycarpus fortunei* fruiting near Caldè (IT).



8. Degree of naturalization of *Trachycarpus fortunei* depending on elevation level and distance from gardens.

Range shift of *Trachycarpus fortunei*

In Fig. 8, the classified vegetation records in relation to the height above sea level and the distance from gardens are represented. The highest density of *Trachycarpus fortunei* can be observed in a belt of about 150 m around settlements and within 390 m.a.s.l. Reasons for this are the favorable climatic conditions and the short distance from the seed source (large quantity of fertile, mature plants in gardens).

Altitude and distance from gardens tend to correlate negatively with each other, meaning that *T. fortunei* is found in high altitudes only near gardens but farther away from them at low altitude sites. With increasing distance and altitude, the prominence of *T. fortunei* decreases. The marginal occurrences are always small groups growing up to an altitude of 470 m.a.s.l. (and sometimes even higher) and at remote sites. The proximity to the seed source seems to have a major influence on the spread. It is assumed that the dispersal of seeds is mainly made by blackbirds (Schröter 1936).

Ecological aspects of the spread of *Trachycarpus fortunei*

Trachycarpus fortunei is usually detected in canyons and streambeds on forest sites (Fig. 9). In such areas, the soil tends to be moist most of the year and therefore germination

conditions are beneficial for the windmill palm. The palm is also able to colonize the wet alluvial forest soil of the Magadino Plain (Fig. 10). In the Centovalli between Ponte

9. *Trachycarpus fortunei* growing near a streambed near Verscio.





10. Juvenile individual of *Trachycarpus fortunei* in the Magadino Plain growing on alluvial forest soil.

Brolla and Verscio, the windmill palm is spreading in full sun on south-facing rocky slopes with shallow soils. It is likely that water lines enable them to thrive on this seemingly unfavorable site, but most of the palms show deficiency symptoms such as small crowns consisting of fewer leaves of which the oldest ones are a yellowish color. No preference for acidic or alkaline soils was observed.

Although *T. fortunei* is very tolerant to shade, such conditions leads to extremely long and thin petioles (> 2.5 m) compared with individuals growing in full sun (Fig. 11).

Deer are the likely cause of damaged leaves. A group of deer was encountered twice during fieldwork grazing exceptionally close to settlements. It is possible that during winter the evergreen leaves of the windmill palm represent an important source of nourishment for them.

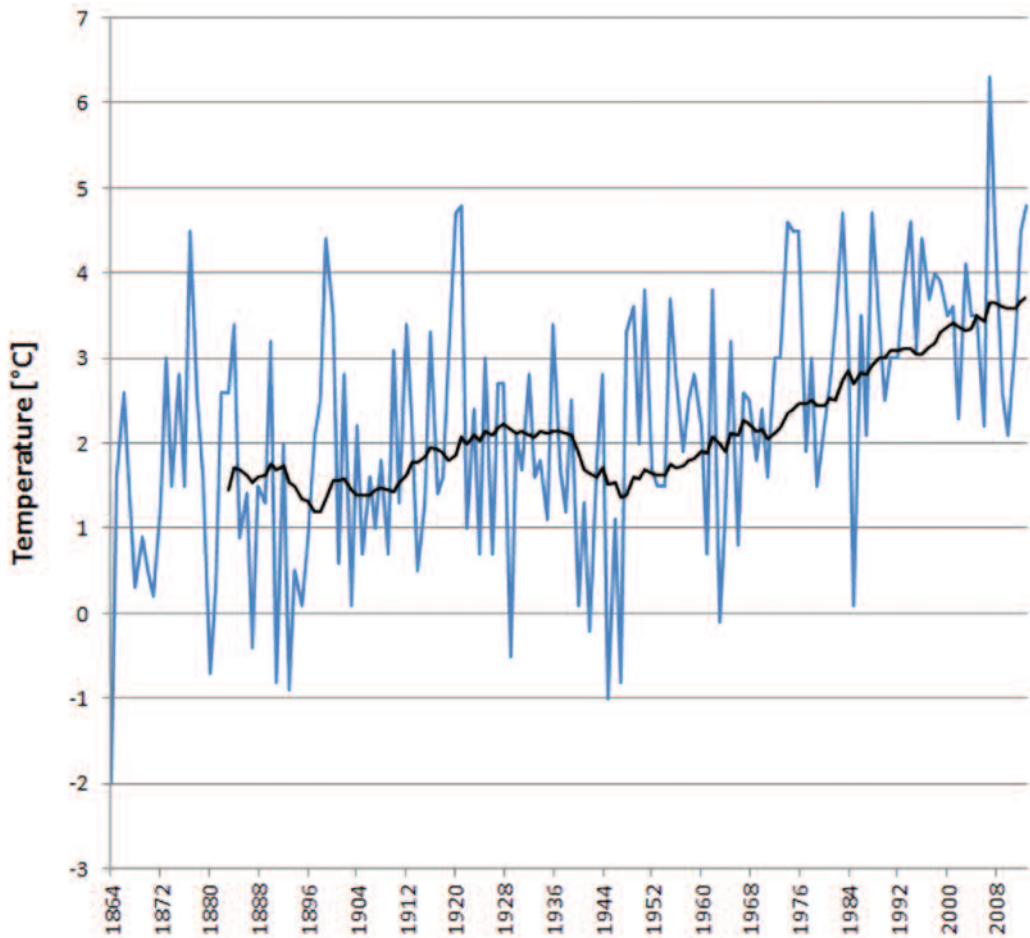
Causes of the spread

The first individuals of *Trachycarpus fortunei* were brought to the Insubric region in the 17th century by the Borromean family and were planted on the Isola Madre (Walther 2000). At the end of the 19th century the Chinese windmill palm was widely cultivated around the Insubrian lakes, but the broad spread of the palm into the forests started much later at the end of the 1980s. Global warming is

commonly considered as the main cause of the spread over the past 40 years (Carraro et al. 1999, Walther 2000). The extent to which the changing climatic conditions of the last

11. Individual of *Trachycarpus fortunei* with very long petioles growing in a shady spot.





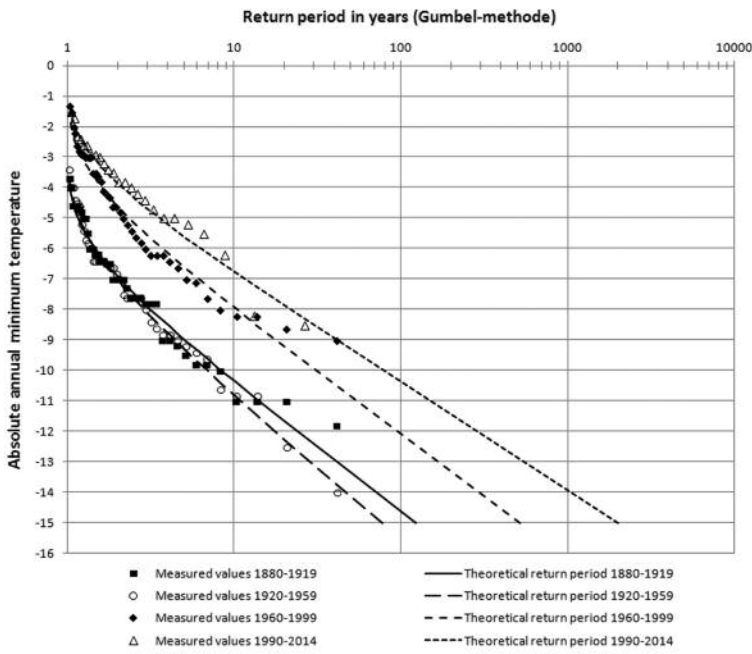
12. Average January temperature (blue line), moving 20-year average (black line), linear trend (black dashes) in Lugano.

decades have contributed to the spread and whether direct anthropogenic factors may have had an influence will be discussed in this section.

From 1864 until 1970, the average temperature of the coldest month (January) in Lugano fluctuated between 1.2°C and 2.2°C; from 1970 it increased fairly constantly to about 3.7°C today (Fig. 12). The number of frost days also decreased: in the period 1865–1960, an average of 65 frost days per year was measured; from 1980 to 2013, only 27 days were counted.

Regarding the average temperature of January, Walther et al. (2007) assumed that a minimum of 2.2°C was required for the spread of *T. fortunei*. This value is based on the climatic conditions on the northern limit of *T. fortunei* in its natural habitat (Walther et al. 2007). In Lugano, this value is reached nearly every year from 1970 onwards, correlating perfectly with the first appearance of *T. fortunei*. However, it

is questionable if the average temperature of the coldest month from the natural habitat in eastern China can be adapted to the research area, since it is not the average temperature that limits the spread of *T. fortunei*, but absolute temperature minimum values. And these minimum values cannot be derived from the average temperature in the natural habitat of the native region and transferred to the special climatic case of southern Ticino and Insubria, which has exceptionally moderate absolute temperature minimums due to the shelter of the Alps. Several juvenile windmill palms spreading in the forest of the Magadino Plain, where the average temperature in January reaches 0.9°C (1981–2010), support this argument. It is also possible that the free ecological niche, which has existed since the last Ice Age ended, allows the establishment of *T. fortunei* under worse conditions than in the natural habitat, where competition with native evergreen plants may be higher.



13. Absolute minimum temperatures of Lugano represented as a function of the theoretical return period of four different time intervals calculated with the Gumbel method.

In Fig. 13, the absolute minimum temperature of Lugano since 1880 is represented as a function of the theoretical return period of four different time intervals calculated with the Gumbel method. This method of probability theory is commonly used in predicting the chance that an extreme natural event will occur. We can see that values of about -10°C occurred every eight years between 1880 and 1959. Between 1960 and 1999, the temperature theoretically reached -10°C every 30 years, but between 1990 and 2014, only every 80 years. The theoretical return period for -15°C between 1880 and 1959 is 100 years; between 1990 and 2014, it is 2000 years. It can therefore be concluded that absolute minimum temperature values have become more moderate during the last decades but have never dropped into the lethal range for *T. fortunei* since measurements started in this area. The absolute minimum temperature measured in Lugano was -14°C in 1929, a temperature that windmill palms normally survive unscathed or with only minor damage. This is demonstrated by several juvenile windmill palms (approx. 1 m in height) growing in the forest close to the weather station of the Magadino Plain, where temperatures in winter 2012 dropped to -16°C . During the field work in summer 2013, all were found unscathed with healthy leaves.

Further evidence underlines that the climatic conditions in proximity to the Insubrian lakes

have always been sufficient for the spread of the windmill palm since records began, such as the cultivation of other plant species since the 19th century that are much more sensitive to cold than *T. fortunei*, like for example *Brahea armata* (blue hesper palm), *Cinnamomum glanduliferum* (false camphor tree), *Eucalyptus globulus* (Tasmanian blue gum), *Jubaea chilensis* (Chilean wine palm) and several *Citrus* species.

If changing climate conditions are not the crucial factor for the spread of *T. fortunei* from the 1980s onwards, what other factors could be the cause?

The spread of alien plant species depends on the propagule pressure (Williamson & Fitter 1996). Since the 1960s, settlement areas have increased continuously on the slopes around the Insubrian lakes of Ticino and Lago Maggiore area (Küttel 2001). Consequently, the number of cultivated, fertile windmill palms growing in gardens has also increased significantly. The fact that *T. fortunei* is spreading most densely near gardens strengthens the argument of increased propagation related to population and settlement growth as a major cause.

Furthermore, management of the forest could have had a major influence on the spread (Zäch 2005). After the Second World War, the reduced use of forests allowed the recovery of the herb layer, and as a result, windmill palm

seedlings were able to establish and grow up to the tree layer.

The evaluation of the direct influence of global warming on the process of laurophyllization is an approximation only, since it is an exceptionally complex issue. One problem is the handling of temperature limit values related to plants, as the cold hardiness of a species is also determined by further factors such as humidity, wind and insulation. The most significant difficulty is the separation of natural signals (climatological aspects relating to plant ecology) from anthropogenic impacts.

Conclusions

Trachycarpus fortunei is widespread in the research area. The highest density of individuals was detected at an altitudinal belt 150 m around gardens below 390 m.a.s.l. At further distances from gardens and at higher altitudes, they were found in isolated, scattered groups. In many forest sites, *T. fortunei* has penetrated into the tree layer and many individuals are fertile. In previous surveys, they were mostly found in the herb and shrub layer, with further spreading depending on mature, cultivated individuals. *Trachycarpus fortunei* thrives on moist forest sides, usually along streambeds, and they are also able to colonize wet alluvial soils. They are rarely found on rocky slopes with shallow soils.

Although the spread of *T. fortunei* correlates unmistakably with the significant continuous warming over the last 40 years, these changed climatic conditions may not be considered the key factor for its spread. Absolute minimum temperatures, which are considered to be a limiting factor, were moderate enough before the time of the significant warming to enable its spread. But it is unquestionable that the warmer conditions gave laurophyllous species a competitive advantage over native plant species, allowing them to settle at higher altitudes and consequently accelerating the process of laurophyllization. It is very likely that *T. fortunei* and other evergreen species will continue to spread, and semi-evergreen forest sections will increase strongly in the research area. Very little is yet known about the impact of *T. fortunei* and laurophyllous species on the present ecosystems. Therefore, further research is needed in this field.

Acknowledgments

We thank Prof. Dr. Michael W. I. Schmidt from the Dept. of Geography of the University of Zurich for the great support of the Master

Thesis of Vincent Fehr, on which this paper is based. We would also like to thank Sunna Seithel, Jean-Luc Fehr and Claudio Geyer for their assistance in field work.

LITERATURE CITED

- ASCHWANDEN, A., M. BECK, C.H. HÄBERLI, G. HALLER, M. KIENE, A. ROESCH, R. SIE AND M. STUTZ. 1996. *Klimatologie der Schweiz* (Jahrgang 1996). *Klimatologie 1961-1990*, Heft 2, Band 1 von 4. Bereinigte Zeitreihen, die Ergebnisse des Projekts KLIMA90 Band 1: Auswertungen, SMA Zürich.
- BRAUN-BLANQUET, J. 1964. *Pflanzensoziologie*. 3. Auflage, Springer, Wien.
- BURGA, C.A. AND R. PERRET. 1998. *Vegetation und Klima der Schweiz seit dem jüngeren Eiszeitalter*. Ott Verlag, Thun.
- CARRARO, G., P. GIANONI AND R. MOSSI. 1999. Climatic influence on vegetation changes: A verification in regional scale of the laurophyllisation. In: F. KLÖTZLI AND G.-R. WALTHER (eds.). *Conference on recent shifts in vegetation boundaries of deciduous forests, especially due to general global warming*. Monte Verità; Proceeding of the Centro Stefano Franscini, Ascona, Birkhäuser, Basel.
- CARRARO, G., F. KLÖTZLI, G.-R. WALTHER, P. GIANONI AND R. MOSSI. 1999. Observed changes in vegetation in relation to climate warming. Final report NRP31. Vdf Hochschulverlag ETH Zürich.
- CARRARO, G. 2010. *Le tipologie forestali del Cantone Ticino e loro tendenze evolutive*. Dionea S.A., Locarno.
- FEHR, V. 2014. *Aspekte der Laurophyllisierung der Wälder im Gebiet Südtessin (CH) - Lago Maggiore (IT) und die globale Erwärmung*. Masters thesis, Dept. of Geography of the University of Zürich.
- GIANONI, P., G. CARRARRO AND F. KLÖTZLI. 1988. Thermophile, an laurophyllen Pflanzenarten reiche Waldgesellschaften im hyperinubrischen Seengebiete des Tessins. *Ber. Geobot. Inst. ETH, Stiftung Rübel, Zürich* 54: 164–180.
- HANKE, R. 1978, 1980, 1983. *Eiszeitalter*, 1-3, Ott Verlag, Thun.
- INFO FLORA. 2014. *Schwarze Liste und Watch-List (State August 2014)* [<https://www.infoflora.ch/de/flora/neophyten/listen-und-infoblätter.html>] Accessed on 09.12.2015.

- KLÖTZLI, F. 1988. On the global position of the evergreen broad-leaved (non-ombrophilous) forest in the subtropical and temperate zone. Veröff. Geobot. Inst. ETH, Stiftung Rübel, Zürich 98: 169–196.
- KÜTTEL, K. 2001. Vegetationskundliche Untersuchungen zur Ausbreitung immergrüner exotischer Gehölze im Luganese. Diploma thesis, Dept. of Geography of the University of Zürich.
- LÜDI, W. 1944. Die Waldgeschichte des südlichen Tessin seit dem Rückzug der Gletscher. Ber. Geobot. Forsch. Inst. Rübel 1943: 12–71.
- METEOSCHWEIZ 2014. Klimadiagramme von Locarno-Monti und Lugano. [http://www.meteoschweiz.admin.ch/web/de/klima/klima_schweiz/klimadiagramme.html] Accessed on 09.12.2015.
- SCHILDKNECHT, P., C.A. BURGA, G. CARRARO, M. FELBER, M. MEYER-GRASS AND I. CESCHI. 2008. Monte Caslano (Malcantone, Tessin, Schweiz). Vegetationskarte 1:2'500, geologische Karte. Malcantone Tursimo, CH-6987 Caslano.
- SCHRÖTER, C. 1936. Flora des Südens. Rascher Verlag, Zürich.
- SCHRÖTER, C. 1956. Flora des Südens. 2. Auflage, edited by E. Schmid. Rascher Verlag, Zürich.
- STEIGER, P. 2010. Wälder der Schweiz. 4. Auflage, hep-Verlag, Bern.
- URFER, C.H., G. GENSLER, F. AMBROSETTI AND E. ZENONE. 1979. Regionale Klimabeschreibungen, 2. Teil: Alpennordhang, Graubünden und Alpensüdseite. Klimatologie der Schweiz, 2. Beih. Ann. Schweiz. meteorol. Anst. (Jahrg. 1978).
- WALTER, H. AND S.-W. BRECKLE. 1999. Vegetation und Klimazonen, 7. Auflage. UTB, Verlag Ulmer, Stuttgart.
- WALTHER, G.-R. 1995. Ausbreitung und Grenzen laurophyller Arten im Südtessin. Diploma thesis, ETH Zürich.
- WALTHER, G.-R. 2000. Laurophyllisation in Switzerland. PhD thesis, ETH Zürich.
- WALTHER, G.-R., E.S. GRITTI, S. BERGER, T. HICKLER, Z. TANG AND M.T. SYKES. 2007. Palms tracking climate change. *Global Ecol. Biogeogr.* 16: 801–809.
- WILLIAMSON, M.H. AND A. FITTER. 1996. The characters of successful invaders. *Biological Conservation* 78: 163–170.
- ZÄCH, R. 2005. Ökologie und Ausbreitung von Neophyten auf dem Monte Caslano im Südtessin. Diploma thesis, Geobot. Inst., ETH Zürich.
- ZUBER, R.K. 1979. Untersuchungen über die Vegetation und die Wiederbewaldung einer Brandfläche bei Locarno (Kanton Tessin). PhD thesis, ETH Zürich.

Palms of Vietnam – a Progress Report

ANDREW HENDERSON
*New York Botanical Garden
Bronx, NY 10458, USA*

AND

NGUYEN QUOC DUNG
*Forest Inventory and Planning
Institute
Thanh Tri, Hanoi, Vietnam*

When we began our survey of the palms of Vietnam in 2007, we thought there might be about 60 species in the country. That was based on the most recent treatment of the palms by French colonial botanists, published in 1937 (Gagnepain & Conrard 1937). How wrong we were! We have now made 12 field trips and collected about 750 palm specimens. Based on these, we now recognize 23 genera and 105 species from Vietnam. Of these we have described 33 new species and one new genus – with no end in sight! In this article, we report on our most recent field trip in October 2015.

Our first stop was Ba Be National Park, about 200 km due north of Hanoi, in Bac Kan province. Along the road we saw millions of *Livistona*, ones we call *L. jenkinsiana* and *L. saribus*, growing next to each other. Perhaps we have to start using the name *L. speciosa* instead of *L. jenkinsiana*, based on the obovoid fruits of this species (see Barfod et al. 2010). Ba Be turned out to be a disappointing place for palms, although *Caryota maxima* was quite common, as was *Calamus henryanus*.

After returning to Hanoi we made a one-day trip to Tam Dao, a granite mountain just north of Hanoi. Again there were few palms, but some beautiful *Caryota obtusa* were growing in

the mist. These two species of *Caryota* are common in many places in Vietnam, and easy to distinguish by the pendulous leaves spaced along the upper part of the stem in *C. maxima*, and the flat, triangular leaves of *C. obtusa* crowded at the top of the stem (Fig. 1).

Our next stop was Ha Giang province, in the extreme north of Vietnam. We drove to the small town of Meo Vac, near the border with China. It is an area of spectacular scenery and hair-raising roads. Along the way, we saw several cultivated plants of a species of *Trachycarpus*, and one, small, solitary plant growing on a completely deforested hillside. Based on images, Toby Spanner kindly



1 (top). *Caryota obtusa* (left, at Tam Dao) and *Caryota maxima* (right, at Ba Be). 2 (bottom). *Calamus albidus* near Meo Vac; grayish lower surfaces of leaflets, and fruits.

confirmed these as *Trachycarpus fortunei*. The main purpose of our visit to Meo Vac was to look for an unusual species of *Calamus*. A colleague had sent us an image of this palm,

and we could see that it was obviously something new for Vietnam. It turned out to be *Calamus albidus*, a species known from across the border in Yunnan, China. It grows



3 (top). New species of *Calamus* from Kon Tum; leaf and fruits. 4 (bottom). *Licuala manglaensis* (left) and *Pinanga kontumensis* (right).

in large clumps and has leaflets that are grayish on the lower surface, and beautiful fruits with the scales covered with reddish-brown hairs (Fig. 2). Local people reported that in each clump, the largest stem dies after fruiting,

replaced by smaller stems in the same clump.

Our next stop was Kon Tum province, a long drive south of Hanoi. We were interested in an area where the recently completed Ho Chi



5. An acaulescent species of *Pinanga*. Inset, fruits, with the soil removed.

Minh Highway passes through undisturbed montane forest. We had visited this area in 2013 and had collected a small *Calamus* but had found only sterile plants. We were luckier this time and found fruiting plants. It is no doubt an unusual new species (Fig. 3).

Superficially it looks a lot like any other *Calamus*, but this one has some unique characters. It is the only *Calamus* we know that has spicate partial inflorescences (both male and female) and fruits with ruminant endosperm and a slimy sarcotesta. It is like

6. Left, *Lanonia centralis*. Right, *Licuala bachmaensis*.



many other Vietnamese palms in having highly unusual morphology. It is also remarkable that from this tiny area of forest, just a few kilometers along either side of the Highway, four, completely distinct, newly discovered species of palm occur – our new *Calamus* as well as *Calamus kontumensis*, *Licuala manglaensis*, and *Pinanga kontumensis* (Fig. 4). How many other such places are there are along the Ho Chi Minh Highway, a new road from Hanoi to Ho Chi Minh City, with over half the 1800 km distance through undisturbed forest?

We returned from Kon Tum along the road from Mang La to Quang Ngai. We decided to stop and have a look in a piece of forest near the road. Here we found an amazing *Pinanga*, with very short, clustered stems and subterranean flowers and fruits (Fig 5). We had to dig to collect them! This species seems most similar to one we had described earlier from southern Vietnam, *Pinanga cattienensis*, but that species grows at much lower elevations and much further to the south.

Our next stop was Da Nang. Our purpose here was to look for a species of *Calamus*. Earlier this year, one of us (Henderson) had seen a specimen in the Paris herbarium consisting of a small *Calamus*, collected in 1927 by J. and

M. Clemens and said to come from “rocky hills near Tourane” (the colonial name for Da Nang). It is obviously an undescribed species with very unusual morphology. We were not too optimistic about finding this palm, after so long a time, with so vague a locality, and near so large a city. We thought the most likely place was the famous Marble Hills between Da Nang and Hoi An. Despite much searching we did not find the palm, although local people told us that a rattan used to grow there, many years ago. We decided to look in the nearby Son Tra Nature Reserve. There are lots of palms there, growing on lots of rocky hills, but we did not find our *Calamus*. However, there were many other species, including *Licuala bachmaensis* and *Lanonia centralis* (Fig. 6).

From Da Nang we drove north. Just before the Hai Van pass we noticed a sign for a waterfall area just off the road, called Suoi Luong. Although these waterfall places are where people go for picnics, they are always interesting because there is often forest along the rivers, even though it is usually highly disturbed. We were not disappointed. The first palm we saw was *Chuniophoenix suoitienensis* (Fig. 7), recently described from a very similar locality, Suoi Tien, more than 500 km to the south near Nha Trang (Henderson 2015). There were also many plants of *Rhapis laosensis*

7. *Chuniophoenix suoitienensis* at Suoi Luong.





8 (top). *Livistona jenkinsiana* in Phong Nha-Ke Bang. 9 (bottom). New species of *Rhapsis* in Phong Nha-Ke Bang.

growing at Suoi Luong along the rocky banks of the river.

From Suoi Luong we continued over the Hai Van Pass and down to Bach Ma National Park.



10. Phong Nga-Ke Bang National Park. The *Rhapis* grows at the bases of the limestone cliffs.

Here our friend Mr. Quyet, a retired rattan collector who lives near the Park, had collected *Calamus spiralis* for us. We have been interested in this palm for several years. It is a most unusual species of *Calamus* in possessing both a flagellum and a cirrus, and is known from only one tiny locality about five hours' walk southwest of the Park headquarters. It is another example of a Vietnamese palm with highly unusual morphology.

From Bach Ma we continued to Phong Nga-Ke Bang National Park. In the garden of our hotel, *Livistona jenkinsiana* was fruiting (Fig. 8). The Park is a wonderful place, famous for its rugged, limestone scenery, huge caves, and subterranean rivers. Our quarry here was a species of *Rhapis* that we knew grew along a road that goes through the park and on to Laos, Route 20. During the war this road was a branch of the Ho Chi Minh Trail and was heavily bombed. You can still see the craters in the forest near the road. We stopped at a small temple near the start of the road, the Temple of the Eight Girls. Here, on 14 November 1972, eight girls, all under 20 years of age and part of a volunteer force that maintained the Trail, sheltered from the bombing in a cave. A bomb caused a large rock to fall and block the entrance to the cave, trapping the girls inside. Although the would-be rescuers could hear their cries for help, the rock was too big to move.

We were fortunate to find the *Rhapis* in both flower and fruit. It is a dwarf palm, scarcely one meter tall with leaves with only a few segments (Fig. 9). It grows along the bases of limestone cliffs (Fig. 10), in apparently pure limestone rock. We were able to confirm it as a new species, apparently related to two other Vietnamese species, *Rhapis puhuongensis* and *R. vidalii*, but differing in its youngest leaves which are silvery-gray on the lower surface. We were happy to find this palm because one of us has been revising the genus (with IPS support), and this species was the last piece of the puzzle (Henderson 2016). It is curious that many *Rhapis* species have such local distributions. Despite apparently large areas of suitable habitat, they seem to occur in only a few, limited areas.

From Phong Nga-Ke Bang we returned to Hanoi. Although we had not collected many specimens on this trip, we had made up for this in quality – three potential new species and one new country record for Vietnam – with still no end in sight!

Acknowledgments

This field trip was funded by the National Geographic Society. Earlier field work in Vietnam, and the revision of *Rhapis*, has been funded by the International Palm Society.

LITERATURE CITED

- BARFOD, A., J. DOWE AND P. SUKSATHAN. 2010. Major Jenkins' Fan Palm in Thailand. *Palms* 54: 109–118.
- GAGNEPAIN F. AND L. CONRARD. 1937. Palmiers. Pages 946–1056 in H. LECOMTE (ed.). *Flore Générale de l'Indo-Chine*. Vol. 6. Masson Paris.
- HENDERSON, A. 2015. A revision of *Chuniophoenix* (Arecaceae). *Phytotaxa* 218: 163–170 (also available online at <http://www.mapress.com/phytotaxa/content/2015/pt00218p170.pdf>).
- HENDERSON, A. 2016. A revision of *Rhapis* (Arecaceae). *Phytotaxa* 258: 137–152 (also available online at <http://www.mapress.com/j/pt/article/view/phytotaxa.258.2.3>).

Announcement

In line with the rising costs of journal production and distribution, IPS membership dues will increase, the first increase in many years. Effective January 1, 2017, the new membership rates will be as follows:

Annual Individual Membership \$55.00
Three Year Membership \$150.00
Institutional/Library Subscription \$55.00

A recent meeting of the IPS Board of Directors identified the crucial need for enlisting the support of donors in order to ensure the continued survival of the organization. While the IPS accepts donations at any level, the Board identified three levels of giving that will be recognized in a published acknowledgement of major benefactors: Silver \$500.00, Gold \$1,000.00 and Platinum \$5,000.00.

Furthermore, the IPS is seeking sponsors for each issue of PALMS. Sponsors, which may be individuals, families or organizations, will be acknowledged in the issues they underwrite. The cost of sponsorship is \$7,000.00. If you wish to give to the IPS, please contact IPS President Ray Hernandez at subtropicofcancer@hotmail.com or IPS Treasurer Dr. Tom Jackson at JacksoT@sutterhealth.org or use the “Donate” button on www.palms.org.

The Argun Palm, *Medemia argun*, in the Eastern Nubian Desert of Sudan

OSMAN M.M. ALI

*The Institute of Environmental Studies,
The University of Khartoum,
Sudan*

osmirghani@yahoo.co.uk

The Argun palm, *Medemia argun* (Mart.) Wurttt. ex H. Wendl., is a dramatic single-stemmed tree palm, growing 30–50 feet (10–16 m) tall (Fig. 1) with fan-shaped leaves that are glaucous and have bright yellow petioles armed with spines (Fig. 2).

First discovered in the Nubian Desert in northern Sudan in 1837, it was initially named as a species of *Hyphaene*, then moved to its own genus. Then, in 1859, living specimens of *Medemia argun* were linked to fruits in Egyptian tombs of the Fifth Dynasty (ca. 2500 BC) including the celebrated tomb of Tutankhamun (Ibrahim & Baker 2009). Although *Medemia* is now regarded as a monotypic genus, a second species, *M. abiadensis* was described by Wendland and included by Andrews (1956) in the flora of Sudan in the White Nile, but it remains somewhat controversial whether this is actually a separate species or a synonym of *M. argun*. Very recently, Darbyshire et al. (2015) in their annotated list of the plants of Sudan and South Sudan listed *M. abiadensis* as a synonym of *M. argun*.

Medemia argun is endemic to the upper valley of the River Nile in Egypt and Sudan. The palm was once more widespread but is now restricted in Sudan to the Nubian Desert east of the River Nile. This region is so arid that consecutive years pass without any rain. Though the terrain is harsh with many rocky features, the Nubian Desert is characterized by a network of seasonal water courses that drain into and form the large Wadi Gabgaba (Fig. 3). These wadis can run with flash-floods coming from seasonal rainfall in the Red Sea Hills. El Amin (1990) reported that *Medemia argun* extends to North Kurdufan in Sudan, a claim that is yet to be confirmed. Within this context the author has made several environmental impact assessment field trips to various parts of North Kordofan but has not come across the Argun Palm.



1. Single-stemmed Argun palm, *Medemia argun*, with fan-shaped leaves.



2. Bright yellow petioles armed with spines and dead male inflorescences.

The palm was considered extinct in the wild until its rediscovery in Sudan in 1995 (Gibbons & Spanner 1996) in small fragmented populations. According to the International Union for the Conservation of Nature (IUCN) Red list Category and Criteria, the Argun Palm is Critically Endangered B1+2c ver. 2.3 (2010).

Medemia argun is characterized by a skirt of dry leaves that persist below the crown (Fig. 4). The palm is dioecious, and the female tree bears numerous plum-shaped fruits that are purple-black when ripe (Figs. 5 & 6). The fruit flesh is very thin and surrounds a large seed enclosed in a pyrene (stone). Once the fruit has dropped to the ground, the hot soil and

weather cause the pericarp to dry and wrinkle (Fig. 7).

During fieldwork in 2015, the author came across some trees with two stems arising from the ground. It is not certain whether these are branches of one tree or two separate trees growing from two adjacent seeds (Fig. 8).

Assessment of the Argun palm in the light of recent visits

The author visited the Eastern Nubian Desert twice, once in 2011 and again in November 2015, as part of environmental impact assessment studies for gold mining activities in Block 16, which is one of the concessions of

3. A dry seasonal water course in the Eastern Nubian Desert.





4. A skirt of dry leaves persists below the crown.



5. Clusters of plum-shaped fruits.

gold-mining companies. In both years he came across populations of the Argun palm. The site is in the Red Sea State about 180 km NE of Abu Hamad (34°00'–34°30'E, 20°00'–21°00'N). Block 16 is characterized by Precambrian Basement Complex rocks and sandy deposits and alluvial soils in the wadis (seasonal water courses).

During the second visit, more sites were visited and measurements were made of tree girth, height, density, association and growth status. Height of the mature trees is about 7–9 m, and the girth at breast height is 90–110 cm. There are large variations in the population density with a range of about 4–10/100 m² with large empty spaces.

The Argun palm has been found in association with other woody and herbaceous species. Woody trees include *Capparis decidua*, *Maerua crassifolia*, *Balanites aegyptiaca*, *Acacia seyal*, *A. ehrenbergiana*, *A. tortilis* and *Calotropis procera*. The understory vegetation is more dense within and along the small seasonal water courses and includes *Panicum turgidum*, *Aerva javanica*, *Tribulus terrestris*, *Farsetia* spp, *Aristida mutabilis*, *Morettia canescens*, *Cleome scaposa*, *Citrullus colosynthis*, *Cassia sena*, *Fagonia cretica* and *Euphorbia forsskalii*.

In trying to assess the current status of the Argun palm in the Sudanese Nubian Desert, the author made the following observations: the tree is widely distributed and not restricted to one site (Fig. 9). Although the survey was confined to Block 16, there were reports from

artisanal miners that the tree also inhabits other wadis. The sites inhabited by Argun consist of a system of small wadis and smaller water courses that converge to form a larger wadi that eventually contributes to the large Wadi Gabgaba. Although dead trees are present, there are numerous young trees forming a spectrum of growth ages from seedlings to saplings and plantlets to young and old trees (Fig. 10). Many fruiting trees bear dense clusters of ripe fruits, and newly fallen mature fruits are frequently encountered among the dried up old fruits from previous seasons.

In some upstream sites, the water-flow seems to have come in such strong flashfloods that large dead trunks and leaves have been washed

6. Ripe fruits.





7. Newly fallen mature fruits among dried up, old fruits from previous seasons (inset).

away downstream and stopped only by the stems of live trees. Although some old trees have been burnt there are no signs of systematic burning or cutting. There are no villages or residents within the Argun sites.

All the above observations indicate that the Argun population is intact, stable and at the moment sustainable.

About 30 km south of Abu Hamad, the author came across a solitary Argun tree growing on the edge of a dry water course towards the

River Nile. This tree has many apparently basal shoots. These have probably grown from seeds brought by flash floods from the upper wadis. This could be the most southern sighting of Argun in Sudan.

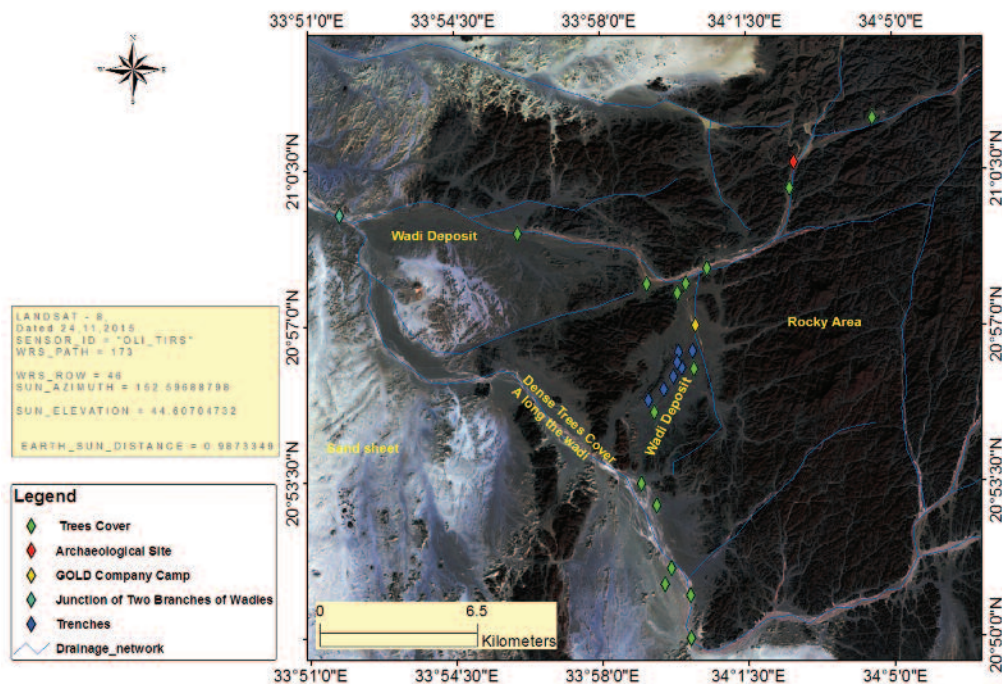
Potential threats to the Argun population

Despite the above observations, there are some factors that could pose threats to the survival of the Argun population:

At one site, sand had been blown and deposited around the trees (Fig. 11). If the

8. Branched Argun trees or separate trees growing from adjacent seeds.





9. Map showing seasonal drainage system, gold-mining activity and archaeological sites in Block 16.

process continues the palms will be threatened by being buried, or the wadi could change its course and deprive the Argun palms of water. Gold-mining is the current most important activity in this once pristine area. This was started by artisanal miners, but later the government began to control exploitation and almost all the Eastern Nubian Desert in Sudan

(between the River Nile and the Red Sea) has now been demarcated and leased as concessions for national and foreign gold companies. It is unfortunate that the only region in the world where *Medemia argun* grows naturally in the wild is now a theater of gold mining activities. The region, once protected by inaccessibility and harsh con-

10. Individuals of *Medemia* of various ages in a wadi.





11. Sand blown and deposited around Argun trees.

ditions, is now open to human beings unaware of a unique and endangered tree. The artisanal miners use Argun wood for cooking and for making shelters. However, this is a short-term activity, and most of the wood used is from dead trees. Tailings from artisanal mining could obstruct natural draining systems and modify the original landscape. Gold-mining companies in the area seek water by drilling boreholes. One of the exploration wells is within a site where there are a few Argun trees. The expected impact on the Argun will be minimal and localized. However, with several proposed boreholes, the impact could be significant if the location of the well is within a denser population. Another activity carried out by the company is the digging of exploration trenches. Luckily, all visited trenches are in higher, rocky ground away from the nearest Argun site. The mining companies, and in particular through their young, enthusiastic geologists and engineers, could play a role in preserving and protecting the Argun community. This could be through certain initiatives and activities such as:

The company's presence may eventually drive off the artisanal miners. Their staff could make Argun enclosures within their concession. The author has already discussed the idea with them and received a positive response. Ground water could be used to irrigate trees around the site, for germinating seeds and for the establishment of Argun nurseries. One geologist is willing to start collecting fruits and send them to the author in Khartoum

University to conduct germination experiments. The mining companies have produced the most recent geological and topographical maps of the area, which could be used to delineate the Argun population and its extent. There is an urgent need to organize awareness campaigns among the artisanal miners as well as the mining companies of the importance of the Nubian Argun palm and the need to protect it.

Mining companies could be contacted to host future scientific expeditions. The two obstacles that have hindered any proposals to study the Argun community in the eastern Nubian Desert of Sudan are inaccessibility to the site and where to stay. With the mining companies, at least those for which the IES has conducted environmental impact studies, access has become easy, and accommodation could be made available, or at least the scientific expedition could set camp nearby. One particular company is enthusiastic to collaborate now that it has grasped the idea that their concession has more than gold in it. They believe the prospect of being linked with such a globally interesting conservation endeavor is exciting.

The area is also rich in remains of what seems to be an extensive Neolithic human occupation represented by tombs, settlements, graves and rock inscriptions (Castiglioni & Castiglioni 1998). The area is also significant as a wintering ground for the Sociable Lapwing *Vanellus gregarius*, a migratory bird that breeds

in northern and central Kazakhstan and south-central Russia. This bird species is rated as Critically Endangered within the IUCN Red List of Threatened Species (IUCN 2010, del Hoyo et al. 1996). It was, in fact, during a Sociable Lapwing survey conducted by the Sudanese Wildlife Society in April 2011 that *Medemia* was encountered in the Nubian Desert west of Wadi Gabgaba, east of Station 5 of the Abu Hamad Wadi Halfa Railway (21°00'507"N, 33°01'215"E) (pers. comm.).

The way forward

The once remote, harsh and inaccessible habitat of *Medemia* has become more easily reached due to the presence of the mining companies. One can drive from Khartoum to Block 16, for example, a distance of over 800 km, in one day. The opportunity to go and do real field work for the study and documentation of Argun has never been better than today.

The Eastern Nubian Desert could afford a unique platform where archaeologists, wildlife experts and botanists could join effort. The conservation effort will be welcomed and supported by regional bodies such as the Egyptian Environmental Affairs Agency and the Horn of Africa in Ethiopia as well as the international bodies such as the IUCN and Royal Botanic Gardens Kew in the United Kingdom.

Acknowledgments

The author extends his deepest thanks to Mr. Mohamed F. Almawla Idris for joining the author in the field trip. The valuable

contribution of Mr. Idris and Dr. Alawyea Alawad (El Nilein University) in identifying the flora in the study area is highly appreciated. Thanks are also extended to the engineers of Zat Al-Imad Gold Mining Company for escorting the author to the Argun sites and to Dr. Abdelrahim A. Salih (University of Khartoum) for GIS and figure preparation.

LITERATURE CITED

- ANDREWS, F.W. 1956. The Flowering Plants of the Sudan. vol. III. T. Buncle & Co., Arbroath, Scotland.
- CASTIGLIONI, A. AND A. CASTIGLIONI. 1998. L'el Dorado dei Faraoni. Institute Geografico. De Gostini. Italy.
- DARBYSHIRE, I., M. KORDOFANI, I. FARAG, R. CANDIGA AND H. PICKERING (eds.). 2015. The Plants of Sudan and South Sudan: An Annotated Checklist. Royal Botanic Gardens, Kew, United Kingdom.
- DEL HOYO, J., A. ELLIOTT AND J. SARGATAL. 1996. Handbook of the Birds of the World. Vol. 3: Hoatzin to Auks. Lynx Edicions, Barcelona.
- EL AMIN, H. M. 1990. Trees and Shrubs of the Sudan. Ithaca Press, Exeter. England.
- GIBBONS, M. AND T.W. SPANNER. 1996. *Medemia argun* lives. Principes 40: 65–74.
- IBRAHIM, H. AND W.J. BAKER. 2009. *Medemia argun* – past, present and future. Palms 53: 9–21.
- IUCN 2010. Red List of Threatened Species. Version 2014.3.

Photo Feature



Cabbage palm (*Sabal palmetto*) at the westernmost edge of its natural range in the Florida Panhandle. This palm is growing in a marsh in St. Andrews State Park, south of Panama City, Florida, 30°07'34.88"N, 85°44'01.51"W, and is believed to predate nearby landscape plantings. Photo by Jono Miller (cabbagepalm@gmail.com), who is collecting any interesting natural or cultural history information regarding this species.

