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Annual report of the Geobotanical Institute ETH (1998)

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1 Introduction

1998 was a very full and active year in the Geobotanical Institute but without any major reorganisations or staff changes. In July the *International Congress of Ecology* took place in Florence and many members of the Institute presented papers or posters. Prof. Andreas Gigon organised the symposium "Case studies of success in nature conservation in Europe" and Prof. Krystyna Urbanska the symposium "European dimensions in restoration ecology".

There were two Institute excursions in 1998. Mr. Stefan Wahl organised an excursion to the Pfalz in Germany which was attended by 26 members of the Institute. In October 15 members of the Institute participated in an excursion to the Seychelles which was organised by Dr. Karl Fleischmann. This excursion was of great scientific interest, and the group undertook several studies concerning the invasion of native forests by alien species (see *Travel Report*). As a result of this excursion, it has been decided to develop a research programme in the Seychelles, and the first two diploma students will carry out their work there during 1999.

The newly established *Kompetenzzentrum Pflanzenwissenschaften* held a one day symposium in December 1998, and Prof. Barbara Roy presented a lecture describing some of the work of the Institute.

There were several staff changes during 1998. Claudia Heinze, who had worked as secretary at Zollikerstrasse for several years, left and her place was taken by Stefanie Rebstein. Kathrin Bucher was appointed as a 40%

secretary at Gladbachstrasse. Annegret Pickhardt resigned as managing editor of the journal *Perspectives in Plant Ecology, Evolution and Systematics* and her place was taken by Dr. Karl Fleischmann. It was necessary to terminate the 50% technical position of Stephan Locher with the Stiftung Rübél for financial reasons. The change was also in keeping with the policy of the Stiftung Rübél not to provide technical support for ETH activities.

2 Staff of the Institute

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Prof. Dr. Ken SATO, Hokkai-Gakuen University, Faculty of General Education, Sapporo, Japan (1.4.–31.12.98)
Pille URBAS, Universität Tartu, Estland (10.8.–30.9.98)

3 Research

3.1 OVERVIEW

The research of the Geobotanical Institute is focused on four main directions: plant ecology, plant evolution and systematics, mycology and archaeobotany; the main interests of the research groups are described below.

3.2 RESEARCH FIELDS

SECTION PLANT ECOLOGY

Group 1: Community and Ecosystem Ecology
(Prof. Dr. P.J. Edwards, Dr. C. Abivardi, Dr. J. Kollmann, Dr. P. Ryser)

- Ecosystems on a landscape level and GIS
- Agroecology
- Ecosystem processes: nutrient budgets, herbivory and other biotic interactions
- Physiological and ecological traits of plants
- Ecology of seed dispersal

Group 2: Plant Ecology and Conservation Biology
(Prof. Dr. A. Gigon, Dr. D. Ramseier)

- Ecological stability: concepts and case studies
- Competition, positive biotic interactions, and coexistence of plants
- Biodiversity and nature conservation

Group 3: Restoration Ecology

(Prof. Dr. K.M. Urbanska)

- Population processes and their relevance for restoration
- Primary and secondary safe sites above the timberline
- Seed dispersal and seedbanks in disturbed and undisturbed high-altitude sites

Group 4: Vegetation Science

(Prof. Dr. F. Klötzli, Dr. S. Güsewell)

- Resilience and dynamics of nutrient-poor wetlands
- Patterns and processes of forest communities (including tropical forests)
- Dynamics of tropical savannas
- Vegetation change induced by global warming

SECTION EVOLUTION AND SYSTEMATICS

Group 1: Evolutionary Ecology

(Prof. Dr. B.A. Roy)

- Which role do pathogens play in structuring plant populations and communities?
- Is there a trade-off between resistance to pathogens and tolerance to physical stress?
- Investigation of hypotheses on coevolution between pathogens and hosts: the roles of host species, their distribution and ecology.

Group 2: Plant Systematics and Evolution

(Dr. M. Baltisberger, Prof. Dr. E. Landolt, Dr. A. Widmer)

- Speciation and population genetics in complex genera (*Draba*, *Ranunculus*, *Stachys*), population genetics

- Microevolution and genetic adaptation in a changing environment
- Plant-pollinator interactions
- Monographic revision of the Lemnaceae
- The flora of the city of Zürich

Group 3: Evolutionary Mycology

(Dr. A. Leuchtmann)

- Biodiversity and population biology of *Epichloë* and *Acremonium* grass endophytes
- Sexual systems of *Epichloë* species in the context of the evolution of symbioses between grasses and endophytes

Group 4: Systematic Mycology

(Prof. Dr. E. Horak)

- Plants and fungi (ectomycorrhizae, saprophytes) in various habitats of the northern and southern hemisphere
- Monographic revision of several genera of the Agaricales (*Crepidotus*, *Galerina*) and Boletales (*Boletellus*)

SECTION ARCHAEOBOTANY

(Dr. C. Jacquat)

- Investigation of fossil plants in archaeological excavations in Switzerland and Jordan (history of agricultural grasslands and adventitious plants)

3.3 NEW RESEARCH PROJECTS 1998

(title, source of funding; research assistant(s); project leader)

- Precision management of small cereal fields – Alliance for Global Sustainability. AVINA Foundation; P.J. Edwards & C. Abivardi (including P. Stamp, W. Richner & colleagues of Tokyo University).
- Studies on possible implementation of selected plant products against Australian species of *Helicoverpa* on cotton. Council of

- Scientific and Industrial Research Organization (CSIRO) and NSW Agriculture (Australia); C. Abivardi & R. Mensah (Australian Cotton Research Institute, Narrabri/Australia).
- Investigation of secondary plant compounds for field control of the potato moth (*Phthorimaea operculella*). The Hermon Slade Foundation (Canberra/Australia); C. Abivardi & G.M. Gurr (Orange Agricultural College, University of Sydney, Orange/Australia).
 - Testing speciation mechanisms in orchids with molecular and ecological methods. ETHZ; M. Soliva; A. Widmer & B.A. Roy.
 - The role of the transmission mode for grass endophyte evolution. Schweizerischer Nationalfonds; D. Brem; A. Leuchtman.
 - The plant tissue N:P ratio as a tool to assess the nutrient limitation of wetland primary production, at the plant as well as the vegetation level. Marie Curie Research Training Grant, Environment and Climate Programme European Commission; S. Güsewell; J. Verhoeven & W. Koerselman.
 - The role of island dynamics in the maintenance of biodiversity in an Alpine river system. ETHZ; S. Karrenberg, L. Bottinelli & D. van der Nat; P.J. Edwards, J.V. Ward, J. Kollmann & K. Tockner.
 - Systematics and Ecology of *Entoloma* in the southern Appalachians (USA). Hesler Fund, University of Tennessee, Knoxville, TN (USA); E. Horak.
 - Agaricales of the Hawaiian Islands: Entolomataceae, Cortinariaceae. USA NSF Project DEB-93300874 (1996–1998). Part 1: *Entoloma*, *Galerina* and allied genera, <http://www.galerina.entoloma.sfsu.edu/hawaiian/Agaricales.html>; E. Horak.
 - Basidiomycetes of the Greater Antilles: Entolomataceae, Cortinariaceae. USA NSF Project 94–66 (1996–2000); Monograph of

Pluteus (Agaricales): in preparation; E. Horak.

- Biodiversidad en el NW de Patagonia: Mycota (Agaricales, Boletales). Consejo Nacional de Investigaciones, Argentina, Proyecto 25852-97 (1997–1998); E. Horak.
- Agaricales and Boletales of Indonesia (USA). USA NSF Project 11544000 (1997–2002), Mycoflora Agaricales-Boletales, s.l. <http://www.Mycena.sfsu.edu>; E. Horak.

Excursion of the Geobotanical Institute ETH to the Seychelles 1998 – a travel report

Karin LEE, Karl FLEISCHMANN, Gian-Reto WALTHER, Johannes KOLLMANN & Peter J. EDWARDS

This excursion to the Seychelles was initiated by Karl Fleischmann, who did his PhD thesis on “Problems with invasive alien plants on the islands of Mahé and Silhouette, Seychelles” at the Geobotanical Institute 1992–1997 (cf. Fleischmann *et al.* 1996; Fleischmann 1997, 1999). The purpose of the excursion was to introduce the flora and vegetation of the tropics to members of the Institute, to continue research in the Seychelles, and to make new contacts with the authorities who are responsible for nature conservation on the islands. The excursion party consisted of Manuela DiGiulio, Peter Edwards, Karl Fleischmann, André Grundmann, Ralf Heckmann (guest), Johannes Kollmann, Karin Lee, Patrizia Meile (guest), Dieter Ramseier, Kathrin Rentsch, Roger Stupf, Karin Ullrich, Stefan Wahl and Gian-Reto Walther.

Sunday–Monday, 4th–5th October

We flew with Air France/Air Seychelles via Paris to Mahé. After landing in Mahé, we were transported on two pick-ups to our lodgings. The accommodation was on the south-

east side of the island at Pointe au Sel in the guesthouse "Fairyland". This small hotel is built right next to the sea and offered a first-class opportunity to admire the beauty of the island with its reefs close to the foreshore, interesting coastal granite formations and diverse beach vegetation. The cars that we had rented to explore the island were brought to the guesthouse later in the morning. On the day of our arrival we acclimatised ourselves to the tropical conditions and got a first impression of the coastal plant species along the beaches of the peaceful Baie Lazare and Anse Intendance with its high waves (Fig. 2). In the evening we enjoyed the delicious creole dishes set before us by Fairyland's cook.

Tuesday, 6th October

In the morning we drove to Victoria, a rather small city which is the capital of the country. Karl Fleischmann had a long discussion with people from the Ministry of Foreign Affairs and the Conservation Department to prepare our fieldwork in the forests of Mahé. Unfortunately, there seemed to be an acute danger of unpleasant encounters with escaped convicts who were hiding in some of the forest sites. The authorities agreed to let us visit Montagne Posée (palm forest of La Réserve) and the inselberg Mont Sébert, but the intended excursion to Congo Rouge, a typical rain forest site on the northwest slope of the highest mountain, Mont Seychellois, was apparently not possible. Afterwards we visited Victoria's small but impressive botanical garden where among other striking plants we saw a first (planted) group of the famous *Lodoicea maldivica*. We also had the chance to observe flying foxes near their roosts.

In the afternoon we went to Anse Soleil, from where we climbed a steep glaciais formation close to the beach. The term "glaciais" describes exposed rock outcrops which emerge as

inselbergs from the surroundings, and which are famous for their unique habitats supporting a high level of endemism (cf. Fleischmann *et al.* 1996). Here we had a first introduction into the flora and vegetation of this particular habitat (e.g. the shrubs *Canthium bibracteatum*, *Memecylon eleagni*, *Ochna ciliata*, *Pandanus balfourii*, *Paragenipa lancifolia*) and of the surrounding lowland forest (canopy trees: *Adenanthera pavonina*, *Calophyllum inophyllum*, *Ficus nautarum*, *Tabebuia pallida*, *Terminalia catappa*). The potential of some introduced species to invade even rather hostile habitats on the glaciais was impressive; the bird-dispersed *Cinnamomum verum* and *Chrysobalanus icaco* are particularly abundant (nomenclature of plant species follows Friedman 1987).

After we had descended from the hot and sparsely vegetated cliffs and rocks, we spent the late afternoon at Anse Soleil. While snorkelling we noticed that most corals were bleached or dead although the fish fauna was rich; the same picture was found at several other sites. The strong decline of the corals around the Seychelles might be caused by unusually high temperatures of the sea in 1998 due to El Niño.

Wednesday, 7th October

Our second excursion was to an intermediate mountain forest on Montagne Posée (La Réserve; some 400 m a.s.l.; Fig. 1). These beautiful palm forests have experienced little human impact and therefore harbour a high diversity of native species, among others the endemic palms *Phoenicophorium borsigianum*, *Deckenia nobilis*, *Nephrosperma vanhouteana*, *Roscheria melanochaetes*, *Verschaffeltia splendida*, and magnificent specimens of *Pandanus seychellarum*. Of the native dicotyledonous trees, *Campnosperma seychellarum*, *Dillenia ferruginea* and *Northea hornei* were quite rare; furthermore, only few seedlings of these spe-



Fig. 1. Palm-rich mountain forest in La Réserve. *Phoenicophorium borsigianum* was the most prominent species; the palm trees produce a dense litter layer which apparently inhibited recruitment of other tree species.

cies were found. These trees, together with the endemic palms, must have been the dominant canopy species in the original forests, but today they are substituted in many places by the introduced *Adenantha pavonina*, *Sandoricum indicum* and *Albizia falcata*. To assess the degree of invasion by neophytes (*Cinnamomum verum*, *Chrysobalanus icaco*, *Psidium littorale*), we surveyed the occurrence of adults and seedlings of all woody species along a trail transect of over 800 m in length.

In the evening we enjoyed a beach picnic at Anse Louis on the northwest coast of Mahé.

Thursday, 8th October

On this day we visited the famous inselberg Mont Sébert, southeast of Victoria. We pas-

sed some small settlements on the edge of the forests, still on the lower regions of the mountain, where diverse homegardens were cultivated. The way through the forests and shrublands was difficult because most paths were overgrown. Last but not least we had to climb up a steep rock wall to get access to the ridge of the inselberg. On this site we found more endemics such as *Erythroxylum seychellarum*, *Excoecaria benthamiana*, *Mimusops seychellarum* and *Nepenthes pervillei*. Mont Sébert offers a good impression of the unique features of the harsh climatic conditions and edaphic factors on inselbergs (Fig. 3). This site is one out of three places in the Seychelles where the endemic small tree *Medusagyne oppositifolia* grows, a unique species which constitutes a family of its own. From the top of the mountain we had a breathtaking view over the coastal plain to the islands Île de Cerf and Île Ste Anne, which lie partly within a large marine nature reserve (Fig. 4).

On the same day Peter Edwards and Karl Fleischmann gave a public lecture in Victoria on current research topics concerned with problems of invasive plants in the Seychelles. They also explained the main goals of our excursion. On this occasion contacts were made with Nirmal Jivan Shah, the representative of the BirdLife Project which is supported by the World Bank. These contacts resulted in two new diploma projects for students of the Geobotanical Institute, who will work from May 1999 for six months on the vegetation of two nature reserves on the islands of Cousin and Cousine.

Friday–Sunday, 9th–11th October

Six members of the group went by boat to Silhouette island, about 10 km northwest of Mahé. The excursion to this secluded and unspoiled island was not easy and needed some preparations, since tourists are not allowed to

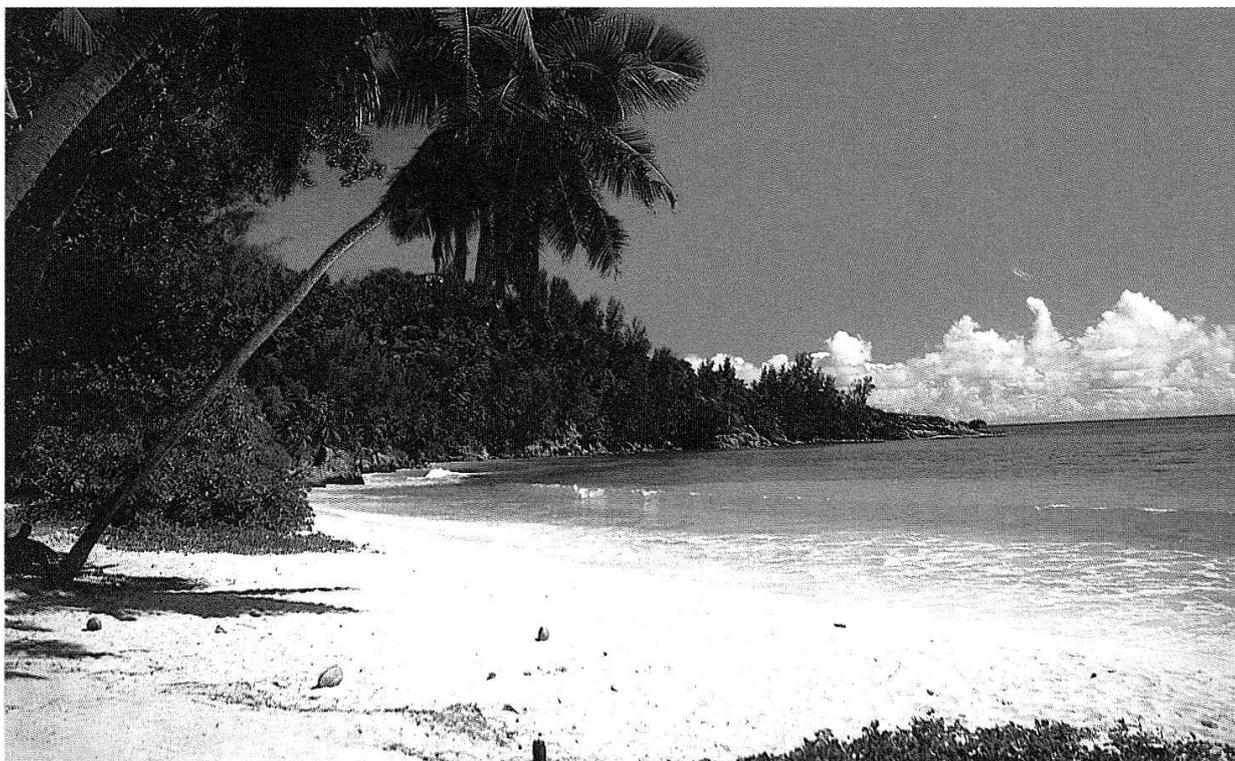


Fig. 2. Coastal vegetation on Mahé at Anse Intendance. Typical for the coastal plain are (partly abandoned) coconut plantations and scattered stands of Calophyllum inophyllum, Casuarina equisetifolia and Guettarda speciosa. Scaevola sericea forms a band of dense scrub close to the beach, fringed by the beautiful creeper Ipomea pes-caprae.



Fig. 3. Sparse glacia vegetation on the inselberg Mont Sébert (Lophoschoenus hornei, Pandanus multispicatus, and the invasive Alstonia macrophylla).

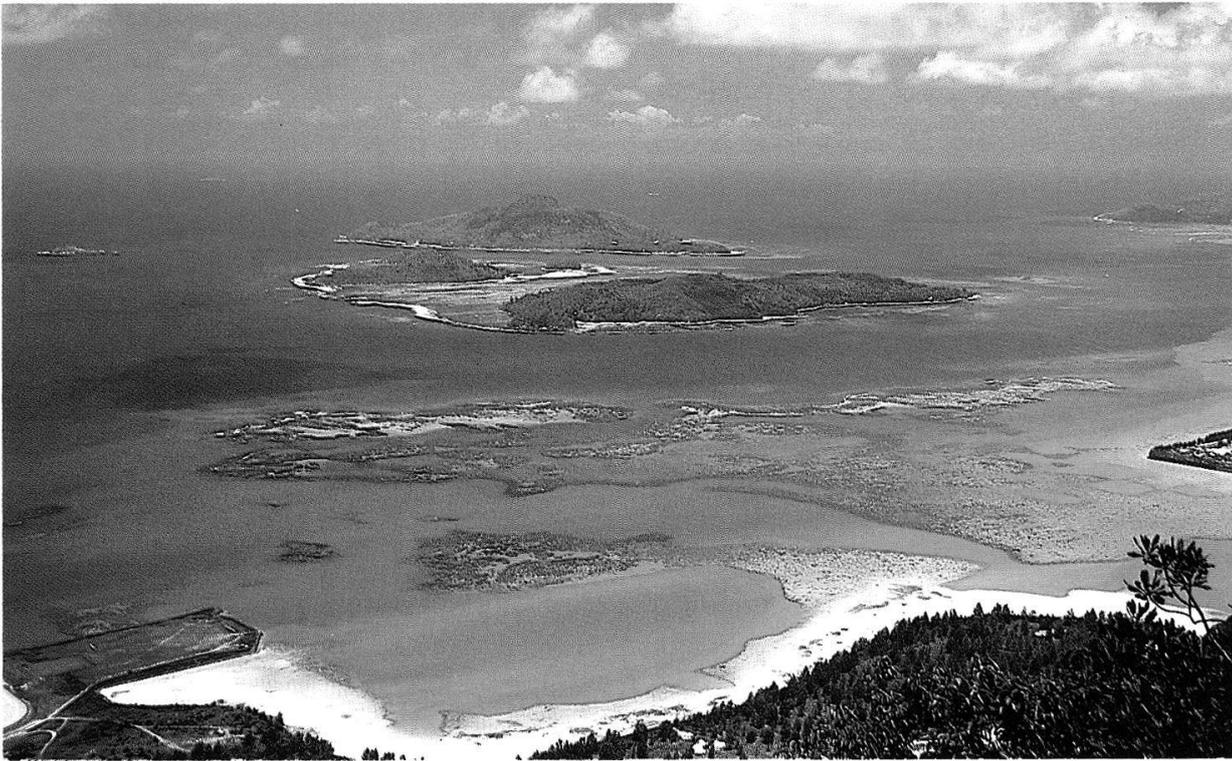


Fig. 4. View from Mont Sébert over the islands Île de Cerf and Île Ste Anne, northeast of Victoria.

All photos: G.-R. Walther



*Fig. 5. View from Pot à Eau to Mont Dauban (Silhouette). Conspicuous plants are *Dillenia ferruginea*, *Northea hornei*, *Glionnetia sericea*, *Cinnamomum verum* and *Dicranopteris linearis*.*

visit the island without special permission. Fortunately, Marie-Thérèse Purvis from the Ministry of Education helped us a great deal in organising this trip. Essential food had to be taken from Mahé, and the accommodation in the village school of La Passe was rather basic; however, the reception on the island was friendly.

The encounter with the mountain mist forest at Pot à Eau and the dry forest above Grande Barbe was impressive. The excursion to Pot à Eau (410 m a.s.l.) was very strenuous because the old paths were completely overgrown and orientation was difficult. Our local guide got lost in the middle of the climb, and then simply refused to go on and left us to our own devices to find a possible climbing route to the summit. Therefore, we did not actually know whether the way through the thick jungle would bring us to our goal until shortly before we reached the summit of Pot à Eau (Fig. 5). On the way back we recorded the trees along an approximately 1.5 km long trail transect from the summit of the Pot à Eau down to "Jardin marron". Jardin marron is an abandoned garden, laid out by the French settler family Dauban who took possession of the island at the beginning of the 19th century. In this place, besides batchouli, cola nuts, rubber, cinnamon und coconuts, a number of *Lodoicea maldivica* from Praslin were planted. Today the garden is overgrown and the *Lodoicea* trees have formed a part of the forest canopy. The surrounding forests were stocked with merchantable timber such as *Adenantha pavonina*, *Albizia lebeck*, *Sandoricum indicum* and *Tabebuia pallida*.

As in other parts of the islands we had the impression that human influence has strongly diminished in the last decades and that most forest stands are in an advanced successional stage with an increasing proportion of native

species. However, the consequences of intensive farming (e.g. cinnamon plantations) are still very evident. We have no clear idea whether the invasive species will loose more ground as the succession proceeds, but cinnamon will certainly remain a well established member of most forest communities.

We had only a short time on Silhouette and therefore worked on Sunday as well. Differences in vegetation between the windward and leeward sides of the island were analysed by means of another trail transect from La Passe right across the island to Grande Barbe. Furthermore, a detailed analysis of forest structure was carried out in a secondary palm forest above La Passe. The results gave an insight into differential species mortality of native and introduced species and the current and probably future regeneration of the forest within this area.

On Sunday evening the small group returned to Mahé by helicopter.

Monday, 12th October

After the introductory excursions of the first week we felt sufficiently confident about species identification and could begin with the actual project work. One group investigated age structure and forest regeneration in two palm forests at La Réserve (stand structure analysis); the other group worked on the invasion by neophytes on Mont Sébert. On this site GPS-mapping became necessary because no precise maps were available. This inselberg rises from a secondary forest that is made up of mainly invasive, exotic species (cf. Fleischmann *et al.* 1996). The chosen transects advanced along a gradient with increasing isolation from the secondary forest towards the rather isolated rear of the inselberg.

The late afternoon and evening were spent on the Anse Soleil in the company of Monsieur Gajetan, a native of the island and long-

term acquaintance of Karl Fleischmann. Monsieur Gajetan offered us grilled fish and Calou, an alcoholic drink made out of palm juice. We had a most pleasant evening by the fire surrounded by the sounds of the sea and the rattling noise of the palm trees.

Tuesday, 13th October

During the day we concluded the field work in the second forest stand at La Réserve. In the evening some of us went to see the paintings in the gallery of the painter Michael Adams.

Wednesday, 14th October

We left Fairyland in the morning and drove to Victoria where we had a quick look around the town, and especially the colourful market. It was fascinating to see the many different faces originating from the various races that have populated the Seychelles over the years. We then embarked to Praslin on a sailing boat that was hopelessly overloaded and lying dangerously deep in the water. Luckily the weather was good and the sea calm. Even though we had some interesting moments observing flying fish and frigate birds, we were nevertheless glad to berth in the port of Praslin. Our group was picked up by car and brought to our lodgings, "Tropique Villa" and "Villa de Mer". The hotels were close to the beach but dense sea grass and turbid water put us off bathing. We subsequently learned that sharks are frequently observed in the flat areas of the foreshore reefs. Later in the afternoon we discussed the research plans for the following days on Praslin.

Thursday, 15th October

Our study area was in the famous forest reserve of Vallée de Mai. We made a detailed stand structure analysis on six permanent plots (each 20 m x 20 m) which were established in 1985 by an expedition from Oxford



Fig. 6. Infructescence of *Lodoicea maldivica* in the national park Vallée de Mai (Praslin).

University. We were helped with the relevés by five people from the Conservation Department under the supervision of Mr. Lindsey Chong-Seng, the co-author of the book "Flowers and trees of Seychelles". A comparison of our results with the first survey is currently under preparation as the first scientific publication of our excursion. Vallée de Mai is a National Park that has been designated by UNESCO as a world heritage site. It is famous for its Coco de Mer palm (*Lodoicea maldivica*) that grows in large numbers and produces the largest seed in the world (Fig. 6).

We spent the late afternoon at Anse Lazio, one of the most beautiful beaches of the islands.

Friday, 16th October

We continued our work in Vallée de Mai, and visited Fond Diable in the afternoon. Fond

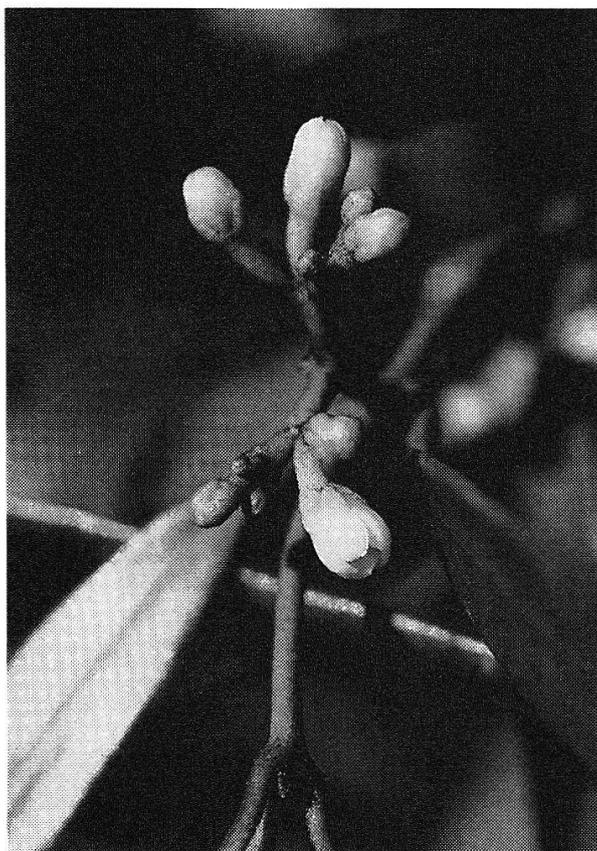


Fig. 7. Flowers of the rare endemic climber *Secamone schimperiana* (Fond Diable, Praslin).

Diable is a highly eroded glaciais in the north-east of Praslin with weathered cliff formations. Large quartz crystals can be found lying around on the ground. It was an unusual, seemingly archaic landscape with a wonderful view towards the islands Curieuse and Aride. This glaciais is again rich in endemic shrubs and trees, among others the extremely rare *Secamone schimperiana* (Fig. 7).

In the evening, Mr. Raimond de Silva, a former student of Karl Fleischmann and previously employed by the Foreign Office, gave us a talk on the economic situation of the Seychelles which led to a most lively discussion.

Saturday, 17th October

The last day on the Seychelles was free to be spent individually. Some went to one of the beautiful beaches of Praslin where a diversity

of marine life could be observed. Others decided to return to the Vallée de Mai to photograph the degree of canopy cover on the six plots with a fisheye camera which allows to determine the diffuse light climate, and to mark out the plots more permanently.

In the evening we had a farewell picnic at Anse Petit Gerlin, a site where the construction of a new hotel is threatening local breeding sites of turtles. We observed some of these animals on their way up the beach.

Sunday, 18th October

Early in the morning we left our hotels to go to the nearby small airport. There were a few raindrops which made us realise that during our two-week stay it had only rained lightly twice. This is unusual for these tropical islands but was certainly very helpful for our work.

We flew to Mahé in a small aeroplane of Air Seychelles where we boarded on Air France which brought us back to Zurich via Paris.

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4 List of publications 1998

4.1 PERSPECTIVES IN PLANT ECOLOGY, EVOLUTION AND SYSTEMATICS

In 1998 the first volume of the new journal of the Stiftung Rübél *Perspectives in Plant Ecology, Evolution and Systematics* was published. A total of 14 original monographs and review papers were published with a total length of 290 pages. The first issue appeared in June and the second issue in December. The background to the new journal and its objectives are described in the preface to the first issue. Initial reactions to the new journal have been very positive. It was presented at various international scientific meetings including the *International Congress of Ecology* in Florence. As a result we have received several offers of papers and there has been a steady increase in subscriptions.

The managing editor of the journal is Dr. Karl Fleischmann and the editor in chief is Prof. Peter J. Edwards. There is an editorial board of six members from ETH and the universities of Zürich and Bern. It is the policy of the editorial board to set the highest international standards and this is reflected in a rigorous refereeing procedure. Several papers were rejected as not reaching the required standards.

4.2 VERÖFFENTLICHUNGEN DES GEBOTANISCHEN INSTITUTES ETH, STIFTUNG RÜBEL, ZÜRICH (1998)

Volume 129

Gigon, A., Langenauer, R., Meier, C. & Nievergelt, B. Blaue Listen der erfolgreich erhaltenen oder geförderten Tier- und Pflanzenarten der Roten Listen – Methodik und Anwendung in der nördlichen Schweiz.

4.3 BULLETIN OF THE GEBOTANICAL INSTITUTE ETH, 64 (1998)

Articles

- Widmer, Y. Soil characteristics and *Chusquea* bamboos in the *Quercus* forests of the Cordillera de Talamanca, Costa Rica. 3–14.
- Landolt, E. *Lemna yungensis*, a new duckweed species from rocks of the Andean Yungas in Bolivia. 15–21.
- Güsewell, S. Does mowing in summer reduce the abundance of common reed (*Phragmites australis*)? 23–35.
- Weibel, U. Habitat use of foraging skylarks (*Alauda arvensis* L.) in an arable landscape with wild flower strips. 37–45.
- Brülisauer, A. & Klötzli, F. Notes on the ecological restoration of fen meadows, ombrogenous bogs and rivers: definitions, techniques, problems. 47–61.

Research notes and projects

- Agendia, P., Fonkou, T., Sonwa, D. & Kengne, I.M. The appearance of two duckweed species in sewage effluents in Yaoundé (Cameroon), and their possible use for sewage treatment and feed production. 63–68.
- Bratteler, M. & Widmer, A. Untersuchungen zur *Trollius-Chiastocheta*-Interaktion in kleinen, isolierten Pflanzenpopulationen. 69–76.
- Güsewell, S., Koerselman, W. & Verhoeven, J.T.A. The N:P ratio and the nutrient limitation of wetland plants. 77–90.
- Bollens, U., Güsewell, S. & Klötzli, F. Zur relativen Bedeutung von Nährstoffeintrag und Wasserstand für die Biodiversität in Streuwiesen. 91–101.
- Widmer, A., Soliva, M., Roy, B.A. & Erhardt, A. Testing speciation mechanisms in orchids with ecological and molecular methods. 103–107.

4.4 FURTHER PUBLICATIONS

A Publications in refereed journals

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