



# Flower-visiting insects at the Kafa Biosphere Reserve

Hans-Joachim Flügel

## Highlights

- For the first time in the Kafa BR, an insect assessment was conducted with the focus on flower ecology.
- Approximately 300 insect specimens were recorded, of which approximately 50% could be determined to the species level.
- Identification to the species level was hampered by the absence of identification literature and reference collections for Ethiopian insects. Therefore, a more detailed statement on species composition and possible biodiversity highlights is currently not possible.
- The results of the assessment suggest that the Kafa BR is home to several endemic species, but more studies are needed to substantiate this finding. Most of the endemic species found seem to occur in the Afromontane rainforest.
- Ten species of the fly family Diopsidae were found, four of which are new to science.
- It is still unknown which insect species are the original pollinators of the coffee tree. This should be investigated by comparing wild *Coffea arabica* stands to cultivated stands, such as those found at Participatory Forest Management (PFM) sites.
- It is reasonable to assume that coffee production in plantations and PFM sites could be increased by introducing original pollinator species. Identifying the original coffee pollinators could thus considerably enhance coffee plant productivity at managed sites.

## 1. Introduction

Literature on flower-visiting insects for Ethiopia is very scarce. Field guides for flower-visiting insects do not exist for Ethiopia; instead, we relied on guides to butterflies and thick-headed flies for the entire African continent and sub-Saharan Africa. The nomenclature

and taxonomy of these books are partially outdated. Very few studies of flower-visiting insects have been conducted in Ethiopia, and there were no comprehensive inventories for the Kafa BR before this study (Berecha et al. 2015).

## 2. Materials and Methods

### 2.1. Study area

The study sites for flower-visiting insects included Afromontane forests (wild coffee forests), bamboo for-

ests, secondary forest, ruderal vegetation, river banks and wetlands.

**Table 1:** Characteristics and nomenclature of the study areas within the Kafa BR

No.	Code	Area	Woreda	Habitat	Sites
1	BA	Bonga	Adiyo	Bamboo forest/riverine vegetation	Bamboo forest
2	BK	Bonga	Adiyo	Montane forest	Boka Forests
3	KO	Bonga	Gimbo	Montane forest	Komba Forests
4	AW	Bonga	Decha	Montane forest/riverine vegetation	Awurada Valley
5	AG	Bonga	Gimbo	Wetland	Alemgono Wetland
6	SHO	Bonga	Gimbo	Wetland	Shoriri Wetlands
7	MA	Bonga	Decha	Montane forest	Mankira Forest
8	GO-wet	Boginda	Gawata	Wetland	Gojeb Wetland
9	GO-riv	Boginda	Gawata/Gimbo	River/floodplain forests	Gojeb River
10	BO	Boginda	Gawata	Montane forests	Boginda forests
11	BG	Bonga	Gimbo	Settlement	KDA Guesthouse and surroundings

### 2.2 Sampling methods

We used a variety of sampling methods and trap types:

#### Sweeping net

A sweeping net is used to catch insects visiting herbs, grasses or flowers. A piece of solid cloth or gauze is mounted on a metal frame, which is attached to a pole. This is the most common method for detecting pollinating insects. To obtain a representative sample, all newly arriving visitors are intercepted on a group of flowering plants of the same species for a thirty-minute period.

#### Light trap

Many insects are attracted by light. When conditions are ideal, large numbers of insects can be caught. The ideal conditions are temperatures above 18°C, little or no moonlight and little wind. A variety of light sources can be used, such as white light or black light (ultraviolet light). For the assessment, a light trap was

provided by the Ethiopian Insect Project. A generator was used to power white light bulbs, set in front of a white sheet and a gauze light tower brought from Germany. Insects were removed from the sheet using a collection vial and an aspirator.

#### Yellow dish trap

Yellow dish traps mimic yellow flowers and attract flower-visiting insects. These insects fall into the liquid killing agent. Sometimes flying insects not attracted by colour fall into the dishes by chance.

#### Malaise trap

Malaise traps are a special kind of flight interception trap for collecting insects with positive phototropism. Malaise traps are one of the first choices for an ex-

tended survey such as an ATBI (all-taxa biodiversity inventory), targeting a wide range of taxa. If properly placed for several weeks or months in the right season, malaise traps can provide a representative sample of the flying insects in the area.

Following the national regulations and protocols of the Ethiopian Biodiversity Institute (EBI), samples were prepared and exported to Germany, with the main objective of further identifying the species and completing the species list.

### 2.3 Data analysis

The samples collected during the field expedition contained insects of almost all taxonomic ranks. Samples were further identified via a systematic process. First, the samples were sorted by specimen and labelled with information on the circumstances under which they were collected, such as locality, habitat type, biotope, coordinates, altitude, capture time, etc. If possible, the genitals of the insects were prepared before needling, along with body parts such as legs, wings, mouths, etc., so they were clearly visible for the determination process. After this process, the samples were sorted by order, family and, if possible, by genera and species.

Due to the lack of information, none of the Ethiopian Hymenoptera Terebrantia (apart from the Chalcidoidea), none of the Diptera Nematocera and only a minority Diptera Brachycera were able to be determined through morphological characteristics alone. Captive specimens from these groups will undergo genetic analysis at a later date in collaboration with Dr Axel Hausmann from the Bavarian State Collection of Zoology (Munich).

To determine the remaining groups, the following international experts will be consulted.

#### For Diptera Brachycera:

- Conopidae: Dr J.-H. Stuke, Oldenburg University,
- Diopsidae: H.R. Feijen, Naturalis Biodiversity Centre, Leiden, Netherlands
- Pipunculidae: Dr C. Kehlmaier, Zoological Museum Dresden, Germany
- Psychodidae: Dr R. Wagner, Institute for Biology, Kassel, Germany
- Syrphidae: Dr A. Symank, Federal Agency for Nature Conservation, Bonn, Germany
- Sarcophagidae: J. Velterop, Enschede, Netherlands
- Tephritidae: Dr A. Freidberg, Department of Zoology, Tel Aviv, Israel

#### For Hymenoptera Aculeata:

- Apoidea, Apidae, Andrena: E. Scheuchl, Ergolding, Germany
- Colletes: Dr M. Kuhlmann, Department of Life Science, Natural History Museum, London, UK,
- Halictinae: A. Pauly, Royal Belgium Institute of Natural Science, Department of Entomology, Brussels, Belgium
- Xylocopa: G. Hölzler, Vienna, Austria,
- Apoidea, Vespidae: Dr J. Gusenleitner, Biologiezentrum Linz, Austria
- Hymenoptera Terebrantia, Chalcidoidea: Dr L. Krogmann, Stuttgart State Museum of Natural History, Germany
- Hymenoptera Symphyta: Dr R. Koch, Naturkundemuseum Berlin, Germany

#### For other groups:

- Coleoptera, Staphylinidae: M. Schülke, Berlin, Germany
- Lepidoptera (only moths): Dr A. Hausmann, Zoologische Staatssammlung München, Germany
- Heteroptera (partim): Dr J. Deckert, Naturkundemuseum Berlin, Germany

Due to the lack of relevant literature and collection references for Ethiopian insects, a significant number of species will have to be identified at a later date, which is likely to take some time.

### 3. Results and Discussion

The presence of entomofauna depends on a variety of factors such as seasonality, habitat fragmentation and human settlements. The fact that the excursion was conducted during dry season, the short duration of the fieldwork and the high variability of habitats precluded gathering extensive results and drawing definite conclusions about flower-visiting insects in the Kafa BR. A study of the canopy layer of the Afromontane rainforest could provide new and valuable findings for the Kafa BR, but we were unable to conduct one due to time constraints.

We found that the area outside the core zones is dominated by ruderal flora; habitats with other flowering plants and associated visitors were scarce.

#### 3.1. Results classified as per collection methods

##### Sweeping net

Compared to other collection methods, in most habitats relatively few insects were caught near sweeping grasses and herbs. These included Ensifera, Coleoptera, Heteroptera, Auchenorrhyncha, Hymenoptera and Lepidoptera. However, specimens from several highly abundant groups were collected at wetland sites, e.g. leaf beetles of the genus *Altica* on *Rumex*, Diopsidae (Diptera) and *Tetrix* (Orthoptera). Hence, this classic collection method is especially recommended for open landscapes such as wetlands. In forest sites, spiny shrubs limit the application of sweeping nets.

##### Light trap

The following insect groups were caught in Kafa BR by using light traps: Ensifera, Caelifera, Coleoptera, Heteroptera, Auchenorrhyncha, Lepidoptera, Hymenoptera, Diptera, Ephemeroptera, Isoptera and Plecoptera. Various moth families were also caught.

Despite the full moon during the sampling period, which presumably diminished the effect of the light trap, large numbers of insects were attracted to the trap at various sites, for example at the bridge near Enderacha. Light traps are the most important technique for collecting nocturnal Lepidoptera, and we recommend using them in future studies.

##### Yellow dish trap

Yellow dish traps are used for insects that visit yellow flowers in particular. The yellow dish traps mainly caught Diptera Brachycera (e.g., Syrphidae, Sarcophagidae, Muscidae), beetles and Hymenoptera Aculeata.

#### 3.2 Results classified as per habitats

##### Bamboo forest

The bamboo thickets are dominated by bamboo (*Arundinaria alpina*) interjected with individual rain-forest trees. Many flies were detected in the layers of ground vegetation, mainly Tipulidae (Diptera Nematocera) and Syrphidae (Dipt. Brachycera) of the genus *Melanostoma*. Other insect groups were very rare.

##### Wetlands near bamboo forest

The wetlands close to the bamboo thickets are adjoined by pastures (i.e., grassland) with *Hypericum* shrubs and large herbs from *Bothriocline schimperi* (Asteraceae). Insects were abundant in this habitat. Some bees from the genus *Colletes* were found on cf. *Lotus discolor*. They are oligolectic to this plant species and may be new to science.

##### Moist evergreen montane forest containing wild *Coffea arabica*

Clearings and forest edges in particular exhibited rich (flowering) herbaceous vegetation, attracting numerous insects. Diurnal butterflies were mostly found at waterholes for their mineral intake. The Afromontane forests seem to be home to far more diverse insect species than the other investigated habitats, but the number of individuals is much lower. This might be due to the low density of certain plant species and the distance between them.

##### Wetlands

All the investigated wetlands exhibited a rich array of Orthoptera, Diptera and Heteroptera, but we were unable to find many Hymenoptera Aculeata due to the lack of flowering plants.

##### Disturbed habitats

The fallow areas and disturbed habitats contained numerous flowering herbaceous plants, which greatly helped our study. The yellow flowering Asteraceae *Guizotia scabra* was dominant in the open fallow land, while *Bothriocline schimperi*, a purple flowering Asteraceae, mostly occurred at the forest edges. The flowering vegetation, and hence the pollinating insects, were richest in areas where shrubs had already settled, providing higher structural diversity.

### 3.3 Recorded insect groups

There are likely to be about 300 species among the acquired specimens from identifiable groups. First results can be presented for nine species of wasp (Vespididae) and four species of thick-headed fly (Conopidae). Table 4 provides a list of insect families and estimated number of species. The dominant species was the honeybee subspecies *Apis mellifera* ssp. *simensis* (Meixner et

al. 2011). The honeybee is mainly cultivated in the Kafa BR in a traditional manner (Shenkute et al. 2012). In addition, numerous hoverfly (Syrphidae) species were detected on flowers. Methods such as the sweeping net and light trap revealed other insects such as beetles (Coleoptera), bugs and Cicadinae.

## 4. Conclusions and Recommendations for Conservation and Monitoring

To properly assess flower-visiting insects in the Kafa BR, the relationship between certain plant species and their pollinators must be further investigated. Individual plant species for which a close relationship with specific pollinators can be assumed should be especially monitored during the flowering period. It is now clear that the coffee flower is a typical moth flower. But night-time investigations of coffee blossoms still need to be made. The flowers of Cucurbitaceae species are very unique, suggesting they might be visited by highly specialised insects. In addition, many specialised flowers were found on a number of tree species in the Afromontane rainforest. These should be investigated in future, which will require special methods and equipment.

However, a variety of flowering plants, especially in cleared areas, also provides food sources for several non-specialised flower-visiting insects. As a result, monitoring activities cannot be restricted to studies on individual plant species, but should complement the investigation of flower-insect relationships to improve understanding of pollination of wild plants and crops. In addition to using sweeping nets on selected herbaceous plant species, flight intercepting traps, light traps, pheromones and photo traps can improve

the quality of results, especially in higher woody and climbing flowering plant species.

According to the preliminary results presented in this report, many highly specialised species and most of the species new to science occur in the Afromontane forests, which are home to diverse and fragile relationships between different flower-visiting species. We therefore recommend protecting the montane rainforests from disturbance as far as possible. Furthermore, to identify the original pollinators of the coffee tree (*Coffea arabica*), pollinators in both plantations and the natural habitats of *Coffea arabica* require extensive investigation and monitoring during both day and night.

Due to the current lack of ecological background information on the flower-visiting insects we found, we cannot propose any indicator species. Potential indicator species should be easy to identify, however, which makes butterflies or carpenter bees (e.g., *Xylocopa* species) good candidates. These species belong to flower-visiting insect groups that are closely connected to a particular habitat and/or plant species. Indicator species should only be chosen after thorough observations.

## 5. References

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## 6. Appendix

### 6.1 Tables

**Table 2:** Overview of observation sites at the Kafa BR

Code	Alt. (m a.s.l.)	Lat.	Long.	Biotope	Date
AG	1,724	07°21'47" N	036°13'11" E	Wetland	10-Dec-14
AG	1,737	07°21'48" N	036°13'19" E	Wetland	10-Dec-14
AG	1,727	07°21'48" N	036°13'08" E	Wetland	10-Dec-14
AG	1,716	07°21'40" N	036°13'19" E	Wetland	10-Dec-14
AG	1,722	07°21'44" N	036°13'13" E	Wetland	10-Dec-14
AW	1,630	07°05'67" N	036°13'57" E	Rainforest	05-Dec-14
AW	1,314	07°05'56" N	036°13'91" E	Rainforest	05-Dec-14
BA	2,621	07°14'28" N	036°27'08" E	Stream valley	07-Dec-14
BA	2,673	07°14'40" N	036°27'22" E	Bamboo forest	07-Dec-14
BG	1,756	07°15'04" N	036°15'24" E	Fallow	03-Dec-14
BG	1,739	07°14'57" N	036°15'11" E	Fallow	06-Dec-14
BG	1,624	07°36'10" N	035°59'59" E	Garden	09-Dec-14
BG	1,765	07°15'03" N	036°15'17" E	Guesthouse	02-Dec-14
BG	1,755	07°15'02" N	036°15'14" E	Edge of woods	12-Dec-14
BG	1,765	07°15'03" N	036°15'17" E	Outdoor, lamps	04-Dec-14
BG	1,765	07°15'03" N	036°15'17" E	Outdoor, lamps	08-Dec-14
BG	1,765	07°15'03" N	036°15'17" E	Outdoor, lamps	09-Dec-14
BG	1,765	07°15'03" N	036°15'17" E	Outdoor, lamps	11-Dec-14
BG	1,762	07°15'02" N	036°15'17" E	Meadow	03-Dec-14
BG	1,759	07°15'02" N	036°15'16" E	Meadow	06-Dec-14
BG	1,761	07°15'02" N	036°15'16" E	Meadow	12-Dec-14
BK	2,439	07°18'05" N	036°22'29" E	Boka Forest	11-Dec-14
BK	2,418	07°17'43" N	036°22'32" E	Wetland	07-Dec-14
BK	2,426	07°17'43" N	036°22'35" E	Wetland	07-Dec-14
BK	2,428	07°17'57" N	036°22'21" E	Wetland	11-Dec-14
BK	2,436	07°17'49" N	036°22'22" E	Wetland	11-Dec-14
BK	1,955	07°14'09" N	036°16'36" E	Roadside	11-Dec-14
BO	2,116	07°30'24" N	036°06'18" E	Edge of woods	11-Dec-14
BO	2,001	07°30'30" N	036°06'42" E	Edge of woods	09-Dec-14
GO-R	1,403	07°26'11" N	036°22'04" E	Disturbed habitats	08-Dec-14
GO-R	1,330	07°24'41" N	036°22'09" E	Disturbed habitats	08-Dec-14
GO-R	1,329	07°24'42" N	036°22'08" E	Disturbed habitats	08-Dec-14
GO-W	1,577	07°34'48" N	036°02'24" E	Wetland	09-Dec-14
GO-W	1,577	07°34'38" N	036°01'34" E	Wetland	09-Dec-14
KO	1,988	07°18'59" N	036°05'17" E	Rainforest	06-Dec-14
KO	1,766	07°16'84" N	036°11'43" E	Edge of woods	03-Dec-14
KO	1,988	07°18'59" N	036°05'17" E	Edge of woods	06-Dec-14
KO	1,988	07°18'59" N	036°05'17" E	Edge of woods	06-Dec-14
KO	1,988	07°18'59" N	036°05'17" E	Edge of woods	06-Dec-14
KO	1,921	07°18'90" N	036°03'52" E	Edge of woods	06-Dec-14
KO	1,921	07°18'90" N	036°03'52" E	Edge of woods	06-Dec-14
KO	1,921	07°18'90" N	036°03'52" E	Edge of woods	06-Dec-14
KO	1,921	07°18'90" N	036°03'52" E	Edge of woods	06-Dec-14
MA	1,601	07°12'00" N	036°16'20" E	Stream valley	04-Dec-14

Code	Alt. (m a.s.l.)	Lat.	Long.	Biotope	Date
MA	1,628	07°11'87" N	036°15'13" E	Edge of woods	04-Dec-14
MA	1,628	07°11'87" N	036°15'13" E	Edge of woods	04-Dec-14
MA	1,620	07°12'00" N	036°16'63" E	Edge of woods	04-Dec-14
MA	1,628	07°11'87" N	036°15'13" E	Edge of woods	12-Dec-14
SHO	1,745	07°20'65" N	036°12'71" E	Field edge	10-Dec-14
SHO	1,753	07°20'41" N	036°12'44" E	Edge of groves	10-Dec-14
SHO	1,607	07°20'51" N	036°12'28" E	Shoriri Wetlands	10-Dec-14
SHO	1,753	07°20'41" N	036°12'44" E	Edge of woods	12-Dec-14

**Table 3:** Plants on which floral-ecological observations were carried out at the Kafa BR

Code	Family	Observed plant species with flower visits
GO	Acanthaceae	<i>Hygrophila schulli</i> (Hamilt.) MR. & S.M Almeida
KO	Acanthaceae	<i>Hypoestes forskalii</i> (Vahl) R. Br.
GO	Acanthaceae	<i>Justicia bizuneshiae</i> Ensermu
GO	Amaranthaceae	<i>Cyathula uncinulata</i> (Schrad.) Schinz
KO, MA	Asteraceae	<i>Bothriocline schimperii</i> Olivo & Hiern ex Benth.
BK	Asteraceae	<i>Cineraria deltoidea</i> Sond.
AG, MA	Asteraceae	<i>Crassocephalum macropappum</i> (Sch. Bip. ex A. Rich.) S. Moore
BG, BK, BO, KO	Asteraceae	<i>Guizotia scabra</i> (Vis.) Chiov.
GO	Asteraceae	<i>Vernonia leopoldi</i> (Sch. Bip. ex Walp.) Vatke
AG, GO, KO, MA, SHO	Fabaceae	<i>Caesalpinia decapetala</i> (Roth) Alston
	Fabaceae	<i>Crotalaria fascicularis</i> Polhill
GO	Fabaceae	<i>Desmodium uncinatum</i> (Jacq.) DC
BA	Fabaceae	<i>Lotus cf. discolor</i> E. Mey.
BK	Fabaceae	<i>Senna septemtrionalis</i> (Viv.) Irwin & Barneby
BK	Hypericaceae	<i>Hypericum revolutum</i> Vahl
MA	Lamiaceae	<i>Ocimum gratissimum</i> L.
MA, SHO	Lamiaceae	<i>Plectranthus longipes</i> Baker

**Table 4:** Insect groups sampled during the floral-ecological investigation of the study areas at the Kafa BR and their determination probabilities

Order	Family/genus	Species estimated	Species determined	Identification support by	Determination probability (%)
Diptera	Asilidae	5		Unknown	?
Diptera	Bombyliidae	1		Unknown	?
Diptera	Conopidae	5	4	J.-H. Stuke	100
Diptera	Diopsidae	6		H. R. Feijen	100
Diptera	Pipunculidae	4		Dr C. Kehlmaier	90
Diptera	Psychodidae	8		Dr R. Wagner	100
Diptera	Sepsidae	12		Unknown	?
Diptera	Syrphidae	40		Dr A. Ssymank	50
Diptera	Sarcophagidae	4		J. Velterop	70
Diptera	Tabanidae	2		Unknown	?

Order	Family/genus	Species estimated	Species determined	Identification support by	Determination probability (%)
Diptera	Tachinidae	15		Unknown	?
Diptera	Tephritidae	10		Dr A. Friedberg	100
Diptera	All other families	50		Unknown	?
Heteroptera	Bugs	50		Dr J. Deckert	40
Auchenorrhyncha	Cicadinae	20		Unknown	?
Coleoptera	Staphylinidae	10		M. Schülke	100
Coleoptera	All other families	80		Different persons	70
Lepidoptera	Night active butterflies	20		Dr A. Hausmann	90
Lepidoptera	Day active butterflies	70		Unknown	?
Hymenoptera	Chalcid wasp	10		Dr L. Krogmann	80
Hymenoptera	Gasteruptiidae	2		Unknown	?
Hymenoptera	Symphyta	3		Dr F. Koch	70
Hymenoptera	Vespidae	10	9	J. Gusenleitner	90
Hymenoptera	Sphecidae	15		Unknown	?
Hymenoptera	Pompilidae	6		Unknown	?
Hymenoptera	Chrysididae	3		Unknown	?
Hymenoptera	Xylocopa	7		G. Hölzler	100
Hymenoptera	Andrena	1		E. Scheuchl	100
Hymenoptera	Colletes	2		Dr M. Kuhlmann	100
Hymenoptera	Other Apidae	22		Alain Pauly	50

**Table 5:** Insects caught during the flower ecological studies and other observations at the Kafa BR (Sex: f = female, m = male) which were identified before the 25/02/2015

Conopidae species	Sex	Date	Biotope	Flower type or catching method	Code
<i>Dacops kaplanae</i> (Camras 2001)	f	11.12.2014	Roadside	<i>Guizotia scabra</i>	BK
<i>Physocephala bimarginipennis</i> (Karsch 1887)	f	04.12.2014	Edge of woods	<i>Bothriocline schimperi</i>	MA
<i>Physocephala halterata</i> (Brunetti 1925)	f	04.12.2014	Edge of woods	<i>Bothriocline schimperi</i>	MA
<i>Thecophora pilosa</i> (Kröber 1916)	m	10.12.2014	Edge of woods	Sweeping net	AG
<i>Thecophora pilosa</i> (Kröber 1916)	f	04.12.2014	Edge of woods	Sweeping net	MA
Vespidae species					
<i>Afreumenes melanosoma</i> (Sauss.)	1f,1m				
<i>Ancistrocerus andreinii</i> G.S.	2m				
<i>Antepipona mucronata</i> (Sauss.)	2f,6m				
<i>Belonogaster j. juncea</i> (F.)	4f,2m				
<i>Belonogaster meneliki</i> Grib.	3f,1m				
<i>Delta e. emarginatum</i> (L.)	1f				
<i>Micreumenes kelneria</i> G.S.	2f				
<i>Polistes marginalis</i> F.	4f,1m				
<i>Pseudonortonia rufoquadripustulata</i> (Cam.)	1f				

## 6.2 Photos



**Figure 1:** Many insects occur in the wetlands like the Shoriri Wetland (photo: Hans-Joachim Flügel)



**Figure 2:** Asteraceae *Guizotia scabra*, on which honeybees and other flower-visiting insects could always be found, was numerous in many fallow fields and along the roads in December (photo: Hans-Joachim Flügel)



**Figure 3:** Lush, but species-poor herbaceous vegetation can be found between the bamboo rods, it was primarily inhabited by flies and gnats (photo: Hans-Joachim Flügel)



**Figure 4:** A species-rich flora, inhabited by many different insect species, can be found along the edges of the bamboo forest (photo: Hans-Joachim Flügel)



**Figure 5:** Many different microhabitats and flowering plants exist in cleared wasteland (photo: Hans-Joachim Flügel)



**Figure 6:** Numerous herbaceous and shrubby flowering plants grow in the woodland clearings and at the forest edges, these are particularly good places for floral-ecological observations (photo: Hans-Joachim Flügel)



**Figure 7:** Representatives of the syrphid genus *Phytomia* can often be found on the inflorescences of the frequent Asteraceae *Guizotia scabra* near rainforest (photo: Hans-Joachim Flügel)



**Figure 8:** Stingless bees of the genus *Meliponula*, possibly the species *M. beccarii* (Gribodo), were occasionally found, although one fifth of the honey harvested by the local beekeepers is supposed to come from stingless bees (photo: Hans-Joachim Flügel)



**Figure 9:** Most honeybees are still traditionally kept in tubes suspended from tall *Euphorbia* trees (photo: Hans-Joachim Flügel)