Coffee leaf rust (*Hemileia vastatrix*) in the wild coffee population (*Coffea arabica*) of Ethiopia.

H. Hindorf* and A. Ritschel**

* Institut für Pflanzenkrankheiten, Universität Bonn
** Botanisches Institut, Universität Tübingen

Abstract: Coffee (*Coffea arabica*) as a qualified beverage with a great demand in many countries and coffee leaf rust (*Hemileia vastatrix*) as a quarantine pathogen causing high losses have attracted world-wide high attention. Ethiopia as the source of origin for perhaps both, the host and pathogen, plays an important role in science either for breeders or pathologists. Coffee leaf rust occurs in Ethiopia in nearly all areas and under all growing systems like wild, forest, garden and plantation coffee not following a certain altitude preference like in Kenya. Disease assessments could be carried out during 2003 and 2006 in the four different rainforest areas Harenna (Bale Mountains), Bonga, Berhane-Kontir and Yayu of Ethiopia. The disease occurred in all forest sites with varying intensities during the season. After collecting uredinospores in the field morphological characteristics were studied and all samples could be identified as *H. vastatrix* (Ritschel 2005). Finally race specification could be carried out with the necessary differentials in the Center of Coffee Leaf Rust (CIFC) at Oeiras/Portugal. The proof of races II (v5), III (v1,5) and X (v1,4,5) was stated by Varzea (pers. comm.) for wild coffee in the rainforests at Bonga and Berhane-Kontir.
But so far the disease did not influence the production seriously. Several reasons could be responsible for that situation: First of all, since fungicides were never used, the hyperparasite *Verticillium hemileiae* occurs quite frequently and is able to reduce the inoculum under a certain threshold. Secondly the race spectrum might exist of less aggressive races. Since the work of Wondimu et al. (1987, 1993) on race specification, not much has been done in the Ethiopian rust population, but will be investigated during a second phase of the project CoCE supported by BMBF and co-ordinated by the Center for Development Research (ZEF), Bonn Univeriity.
For further genetical, morphological and phytopathological investigations on the host and pathogen the last ecosystems of rainforest/wild coffee in Ethiopia urgently need to be protected. With international help there exists a strong effort to develop an agrosystem which preserves the natural rainforest including the wild coffee, but allows people to share the benefits of products in that habitat like coffee, spices and fruits.

Key words: coffee, leaf rust, *Hemileia vastatrix*, Ethiopia

Introduction: World-wide Ethiopia is known as a country of great diversity for wild plants and agricultural crops due to favoured climatic, soil, topographic and water conditions. Of course the best known and most important cash crop coffee (*Coffea arabica*) achieved an outstanding influence in international agriculture and has its roots in the former Province of Kaffa in the south-west of the country. Ethiopia is not only the centre of origin for Arabica coffee, but the country also provides a great diversity in the last remaining rainforests, which could serve as a gene-pool for further breeding improvements. Coffee played for centuries an important role in the society of the Ethiopian people and represented a crop for social, economical, political and ecological sustainability. Therefore coffee achieves high attention in the country and will be always protected even under difficult economic conditions concerning prices on the world market at presence. The Ethiopian highlands favour with its congenial climatic conditions, fertile soils, sufficient and cheap labour capacities and good management better yields and high quality with best aromas and natural flavours. More than 50 % of the

coffee production Ethiopians consume on their own, preparing and honouring the crop in a ceremony unique in the world.
For centuries Ethiopian coffee selections proved to be resistant or tolerant against many diseases and pests. Grown under indigenous shade trees coffee selections adopted to stand drought conditions and developed a certain tolerance. The few occurring pathogenic organisms and parasites facilitated best hosts for antagonists, hyperparasites and natural enemies. Due to human influences during the 1970s two major diseases were introduced to the country: coffee berry disease (CBD) and coffee wilt disease (CWD) causing tremendous losses (Hindorf 1998). In Kenya breeding the resistant variety Ruiru 11 has solved that problem locally (Omondi et al. 2001). In Ethiopia tolerant selections distributed regionally to farmers proved to control CBD at time. Coffee leaf rust (CLR) seems to be present in Ethiopia since coffee has been grown, but that quarantine disease in the country never achieved such an importance like in Asia in the 19^{th} century (Hindorf et al. 2004).

Material and Methods: Disease assessments were carried out during 2003 and 2006 in four regions with larger areas of the last remaining rainforest in the south and south-west of Ethiopia in an altitude range of 1200 to 1800 m: I Bale Mountains (Province Bale), II Bonga (Province Kaffa), III Berhane-Kontir (Province Banj Maji) and IV Yayu (Province Illubabor). Per region two field sites were selected not at all being cultivated by men and grown naturally. People only used these sites for picking coffee during harvesting time end of the year.
The disease frequency (DF in %) was scored by counting diseased and healthy trees (100 trees per experimental field site). The disease intensity (DI in a scale ranging from 1 – 4) was scored on 100 infected branches in the experimental field site using the following scale: class 1 = no disease; class 2 = one rust pustule/leaf; class 3 = two rust pustules/leaf and class 4 = three and more rust pustules/leaf. The DI was calculated using the formula:

$$\mathbf{n_1 + n_2 \times 2 + n_3 \times 3 + n_4 \times 4 / n_1 + n_2 + n_3 + n_4}$$

n_1 = number of leaves in class 1, n_2 = number of diseased leaves in class 2, etc.
During 2004 rust samples were brought to Germany for further diagnostic investigations on the morphology of uredinospores. Spore sizes could be measured and scanning electron microscopic (SEM) photos were taken by Ritschel, Institute of Botany, University of Tübingen/Germany. In May 2005 leaf samples with active sporulating rust pustules were collected and sent to CIFC, Oeiras/Portugal for further investigations on races of *H. vastatrix*.

Results: In all field sites of the four regions CLR could be detected more or less frequent depending on seasonable variations (Table 1). No significant differences of the disease frequency in lower stands (1200 m) or higher altitudes (1800 m) could be observed. The infection concentrated on younger leaves of tips of secondary branches. Leaves scored in class 4 showing al least 3 pustules and up to 30 had no chance to survive, they dropped lateron. The majority of leaves in the wild coffee produced only very few pustules, so that a loss in leaf area could be ignored. The actual loss in leaves was caused partly only by CLR and more often by a drought stress or insect damage like common leaf miner, serpentine leaf miner and skeletonizers.
Spore measurements resulted in typical length and width of the uredinopores of *H. vastatrix* with average sizes of 31.61 x 21.19 mµ (Table 2). Comparing these results with defined samples from known selections like Arba Gugu or Harrar from Jimma/Ethiopia or from other countries like Indonesia and Colombia the spores showed an identical morphology (Table 2).

Tab. 1: CLR occurrence in wild coffee populations of Ethiopia

locality	disease frequency (%)							disease intensity** (DI)					
	date	9.2003	1.2004	4.2004	8.2004	4.2005	1.2006	9.2003	1.2004	4.2004	8.2004	4.2005	1.2006
I Harenna 2					32.0	92.0	95.0				1.54	2.00	3.49
I Harenna 3					38.0	100	96.0				1.76	2.75	3.65
II Bonga 1		74.0			32.0	60.0	69.0	2.17			1.81	1.79	1.96
II Bonga 3		24.0	52.0		88.0	20.0	80.0	1.02	3.04		2.42	1.88	2.53
III Berh.-K. 2		54.0	70.4	20.0	24.0	48.0	98.0	1.90	3.13	1.92	2.06	2.26	3.33
III Berh.-K. 3		68.0	70.8	18.9	2.0	16.3	53.0	1.79	2.95	1.94	1.11	1.93	1.56
IV Yayu 1		69.8		74.3	96.0	70.0	99.0	2.15		2.32	3.00	2.95	2.90
IV Yayu 2		53.3				82.0	100	1.76				3.15	3.22

- 100 trees per site, ** 100 secondary branches of 30-50 infected trees with 4 leaves each (classes: 1 = no rust pustule, 2 = one rust pustule, 3 = two rust pustules, 4 = three and more rust pustules)

Tab. 2: Uredinospore sizes of *Hemileia vastatrix* (µm)

locality and site	coll. date	length	width	variations
I Harenna 1	8. 2004	33.7	22.1	31-36 x 21-23
II Bonga 3	1. 2004	30.3	18.9	29-33 x 18-20
II Bonga 3	5. 2004	31.8	23.3	27-37 x 20-26
II Bonga 2 (1-BA2)	11.2003	30.5	21.2	29-32 x 20-23
II Bonga 2 (3-6)	11.2003	30.1	19.8	28-31 x 18-21
II Bonga 2 (2-9)	11.2003	30.0	20.5	28-32 x 20-22
II Bonga 2 (1-BA5)	11.2003	30.9	20.4	30-33 x 20-22
II Bonga 1	5.2004	32.7	23.7	29-36 x 21-26
III Berhane-Kontir 3	1.2004	32.1	19.9	30-34 x 19-21
III Berhane-Kontir 3	5.2004	34.5	23.6	32-40 x 21-26
III Berhane-Kontir 2	1.2004	33.2	19.5	30-36 x 18-21
III Berhane-Kontir 2	5.2004	29.7	21.9	26-33 x 17-25
IV Yayu 1	5.2004	30.3	22.7	27-34 x 20-25
IV Yayu 1	11.2003	30.4	20.4	29-32 x 20-22
IV Yayu 2 (8)	11.2003	31.2	19.8	30-33 x 19-20
IV Yayu 2	5.2004	34.4	21.3	31-38 x 19-23
mean	2003/04	31.61	21.19	26-40 x 17-26
Selection Arba Gugu	9.2003	30.7	20.5	30-32 x 19-22
Selection Harrar	9.2003	31.1	20.3	30-33 x 20-21
Blawan/Indonesia	4.2003	32.4	20.0	30-35 x 18-22
Calarcá/Colombia	1998	30.8	21.0	29-33 x 20-22

References:

Hindorf, H.: Current diseases of *Coffea arabica* and *C. canephora* in East Africa causing crop losses. Med. Fac. Landbouww. Univ. Gent **63**,861-865,1998.

Hindorf, H.; Kassahun, Y. und A. Ritschel: Krankheitssituation in der Wildpopulation von Kaffee (*Coffea arabica*) in Äthiopien unter besonderer Berücksichtigung des Kaffeerostes (*Hemileia vastatrix*). Mitt. BBA **396**,388,2004.

Omondi, C.O.; Ayiecho, P.O.; Mwang'ombe, A.W. and H. Hindorf: Resistance of *Coffea arabica* cv. Ruiru 11 tested with different isolates of *Colletotrichum kahawae*, the causal agent of coffee berry disease. Euphytica **121**,19-24,2001.

Ritschel, A.: Monograph of the genus *Hemileia* (Uredinales). Bibliotheca Mycologica Vol. **200**. E. Schweizerbart, Borntraeger and Cramer Science Publishers, Stuttgart, Germany, pp. 132, 2005.

Wondimu, M.; Mengistu, H. and C. Rodrigues jun.: Distribution of *Hemileia vastatrix* races and physiologic resistance groups of *C. arabica* in Ethiopia. Eth. J. Agr. Sci. **9**,25-39,1987.

Wondimu, M.: Grouping of coffee sub-districts surveyed for CLR in Ethiopia using numerical taxonomy. SINET Eth. Sci. **16**,35-42,1993