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## Diversity of epiphytic lichens in the savannah biome of Namibia

Luciana ZEDDA, Matthias SCHULTZ & Gerhard RAMBOLD

**Abstract:** ZEDDA, L., SCHULTZ, M. & RAMBOLD, G. 2009. Diversity of epiphytic lichens in the savannah biome of Namibia. – *Herzogia* 22: 153–164.

Epiphytic lichens were investigated at different sites in the savannah biome of Namibia (Southern Africa). Altogether, 37 taxa were recorded, 24 of which are new to Namibia. Six of these are even new to Southern Africa and two to Africa. The lichen mycota is dominated by cosmopolitan species, mainly belonging to the Physciaceae. Large foliose lichens are rare and fruticose ones absent.

**Zusammenfassung:** ZEDDA, L., SCHULTZ, M. & RAMBOLD, G. 2009. Diversität von epiphytischen Flechten in den Savannen von Namibia. – *Herzogia* 22: 153–164.

Epiphytische Flechten wurden in verschiedenen Gebieten des Savannen-Bioms von Namibia im südlichen Afrika untersucht. Insgesamt wurden 37 Taxa nachgewiesen, von welchen 24 Neunachweise für Namibia, sechs für das südliche Afrika und zwei für Afrika darstellen. Die Flechtenflora wird von kosmopolitischen Arten überwiegend aus den Physciaceae dominiert. Große Blattflechten kommen nur selten vor und Strauchflechten fehlen völlig.

**Key words:** Lichenized Ascomycetes, Africa, biodiversity.

### Introduction

Lichens have so far received only little attention in studies of the savannah ecosystems of Southern Africa, especially of Namibia. This contrasts with East Africa, where at least the macrolichen flora is comparably well known (SWINSCOW & KROG 1988, BIEDINGER & FISCHER 1996, KILLMANN & FISCHER 2005). APTROOT (2001) published records of lichen species from savannahs of Gambia, West Africa. Lichenological exploration in Namibia started at the beginning of the 20<sup>th</sup> century. VAINIO (1900) was the first who reported three lichen species from Namibia (Hereroland) collected by Dinter. ZAHLBRUCKNER (1926) and DOIDGE (1950) reported a smaller number of lichen species from Namibia (former “South West Africa”), collected by different scientists mainly in the Namib Desert. First, still incomplete checklists from Namibia were provided by FEUERER & ZEDDA (2001) and FEUERER (2008). Numerous floristic and vegetation studies were dedicated to the peculiar lichen fields of the Namib Desert (SCHINZ 1900, ZAHLBRUCKNER 1926, MATTICK 1970, DODGE 1971, JOUBERT et al. 1982, BRUSSE 1986, 1987a, WALTER 1986, ALMBORN 1988, GIESS 1989, SCHIEFERSTEIN 1989, WESSELS 1989, SCHIEFERSTEIN & LORIS 1992, MÜLLER 2003, ZEDDA & RAMBOLD 2004, LALLEY & VILES 2005, WIRTH & HEKLAU 2006, WIRTH et al. 2007). In these studies, however, mostly saxicolous and terricolous lichens were investigated, while records

of epiphytic lichens are scarce. In addition, a considerable number of ecophysiological investigations and taxonomic revisions exist, including the description of many new species from that region. The lichen diversity in other areas of Namibia has remained rather unexplored so far. Only a few species were described by BRUSSE (1987b, 1987c) from the Etosha Pan and the Damara System. Some saxicolous species were reported from the Windhoek area, the Waterberg Plateau and Otjiwarongo (north-eastern Namibia) by ZAHLBRUCKNER (1926) and BRUSSE (1987d, 1989). Only two epiphytic lichen species were hitherto reported from Otavi (north-eastern Namibia) (*Phaeophyscia confusa* Moberg on *Acacia*) (BRUSSE 1993) and from Windhoek (*Flavopunctelia soledica* Nyl. on *Jacaranda*) (BRUSSE 1988). ALMBORN (1966) recorded *Candelaria concolor* on bark at the Waterberg. Few species were recently reported by SCHULTZ et al. (2009). The present work aims to provide a first account of the diversity of epiphytic lichens in the savannahs of Namibia.

### Study area

Namibia is the most arid African country south of the Sahara with extremely variable rainfall, and an annual average ranging from less than 20 mm along the coast to 600 mm in the extreme northeast (Fig. 1). Most precipitation is received between September and May. Annual mean temperature amounts to 16 °C along the Atlantic coast and >22 °C in northern and south-eastern Namibia. Savannahs are primarily restricted to the Central Plateau of Namibia, a mountainous area at 1000 to 2600 m a.s.l., located between the Great Escarpment in the west and the Kalahari in the east. Precipitation in the Central Plateau varies between 200 mm in the south and 600 mm in the north (WERGER 1986, MENDELSON et al. 2002, MENDELSON 2006).

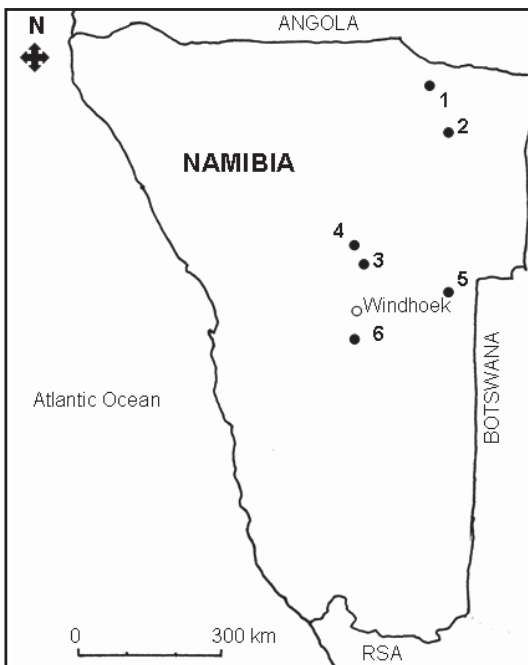


Fig. 1: Map of Namibia with location of investigation sites.

The savannah vegetation of Namibia can be differentiated in thorn bush savannah and dry woodland savannah (GIESS 1971, 1998). The thorn bush savannah is widespread on different soil types and covers about 65 % of the country. Mopane woodlands, which are primarily found in north-eastern Namibia, account for c. 20% of the Namibian territory. Dry woodlands are supported by coarse Aeolian sands with poor water holding and nutrient status. Frequent fires and wood logging strongly affect the environment. During the last few decades, Namibian woodlands have declined rapidly, especially in the northern part of the country (GRAZ 2006). In southern and south-eastern Namibia, transition forms to the Nama Karoo prevail where the savannah is characterized by deciduous low shrubs, scattered wood and herbaceous plants (OKITSU 2005).

## Material and methods

The following sites, all located in the Central Plateau of Namibia, have been investigated and correspond to so called “BIOTA observatories” as defined by SCHMIEDEL & JÜRGENS (2005):

- 1) Okavango Province: Mile 46 Research Station & Mutompo, NW of road B1, c. 65 km south of Rundu, 18°18'S/19°15'E, 1179 m a.s.l. Annual precipitation: 550 mm. Vegetation type: northern Kalahari dry woodlands. This site is a communal farm with rotational grazing located in a subtly undulating Kalahari sand dune landscape, covered by open tree savannah vegetation. Much of the bush vegetation is logged and converted into agricultural fields; occasional fires occur.
- 2) Otjozondjupa Province: Sonop 903, Research Station, c. 80 km NE of Grootfontein, 19°04'S/18°54'E, 1236 m a.s.l. Annual precipitation: 450 mm. Vegetation type: northern Kalahari tree vegetation with open tree savannah. This is a research station with experimental cattle farming and rotational grazing, located in a Kalahari sand dune landscape.
- 3) Otjozondjupa Province: Otjiamongombe West 44 (Erichsfelde), 37 km N of Okahandja, 21°35'S/16°56'E, 1495 m a.s.l. Annual precipitation: 350 mm. Vegetation type: thorn bush savannah with *Acacia* and *Boscia* trees and grasses. Cattle and hunting farm located in a transition zone between the western Kalahari margins and the escarpment in the west.
- 4) Otjozondjupa Province: Toggekry 205 (Omatoko Ranch), W of the junction of the road B1 to district road D2404, 21°30'S/16°43'E, c. 1500 m a.s.l. Annual precipitation: 300 mm. Vegetation type: thorn bush savannah with *Acacia* and *Boscia* trees and grasses. Cattle and hunting farm.
- 5) Omaheke Province: Sandveld Research Farm, NE of Drimiopsis, 22°02'S/19°08'E, c. 1525 m a.s.l. Annual precipitation: 350 mm. Vegetation type: central Kalahari camelthorn savannah, with *Acacia erioloba*, *A. mellifera* and *Terminalia sericea* representing a transition zone from the central Namibian thorn bush savannah to broad-leaved Sandveld vegetation.
- 6) Hardap Province: Farms Narais and Duruchaus, near district road D1237, NE of Rehoboth, 23°07'S/16°53'E, c. 1800 m a.s.l. Annual precipitation: c. 200–300 mm. Vegetation type: shrub savannah, with elements of the Nama Karoo biome.

Biodiversity surveys of the area were conducted between 2001 and 2008 by M. Schultz at Sandveld and Narais/Duruchaus as well as by L. Zedda at Mile 46/Mutompo, Sonop, Otjiamongombe and Toggekry. Lichens were identified using the following keys: *Caloplaca* (GIRALT et al. 1992, WETMORE 1994), *Chaenothecopsis* (TIBELL 1987), *Collema* (DEGELIUS 1974, SCHULTZ et al. 2004), Parmeliaceae (HALE 1976a, 1976b, ELIX et al. 1986), Physciaceae (GIRALT 1994, MARBACH 2000, MOBERG 2004), other taxa (PURVIS et al. 1992, SWINSCOW & KROG 1988, WIRTH 1995). Taxonomical nomenclature follows “LIASnames” ([www.lias.net](http://www.lias.net)) and “Index Fungorum” ([www.indexfungorum.org/](http://www.indexfungorum.org/)). The classification of families is according to the “Myconet Project” ([www.fieldmuseum.org/myconet/outline.asp](http://www.fieldmuseum.org/myconet/outline.asp)). Voucher specimens will be deposited at the end of the BIOTA project (2009) in WIND and M. Duplicates of the lichens collected in Namibia by M. Schultz will additionally be deposited in HBG. Species new to Namibia are indicated by the mark \*, species new to Southern Africa by \*\*. Species new to Africa are marked with \*\*\*. Previous lichenological records from Namibia have been checked in detail because Namibia is a relatively young country (it gained independence from South Africa in 1990). When a given taxon was reported from “South Africa”, the exact collecting localities where checked, in order to proof whether the same taxon had been found in South-West Africa (former name for Namibia) and/or from localities which are at present part of Namibia. In the case that only “Southern Africa” was indicated, without specification of any site, the taxon was not considered as new to Namibia.

## List of species

*Amandinea extenuata* (Müll.Arg.) Marbach – Sonop 903, 25.10.2001, on *Acacia*, L. Zedda 5571, 5608 (M-0038809, M-0038814).

This is a very common species in tropical and subtropical regions where it grows on wood and bark, from sea level to 2860 m. It is known from Central and South America, Africa and Australia and has been reported from Namibia and South Africa by MARBACH (2000).

\**Arthonia* sp. – Sonop 903, 25.10.2001, on *Acacia*, L. Zedda 5592 (M-0038773).

The specimen could not be identified on the species level due to the lack of well-developed ascospores. Nevertheless, the record is published because the genus has not been previously reported from Namibia.

\**Bulbothrix hypocraea* (Vain.) Hale – Sonop 903, 25.10.2001, on *Acacia*, L. Zedda 5612 (M-0038792).

This species is known from Angola, South Africa (DOIDGE 1950, HALE 1976a), western and eastern Africa, South America (SWINSCOW & KROG 1988, KILLMANN & FISCHER 2005) and Thailand (POOPRANG et al. 1999). It is mainly corticolous, rarely saxicolous, and grows in semi-arid woodlands under open conditions at mid-elevations (900–1750 m) (HALE 1976a, SWINSCOW & KROG 1988).

\*\**Caloplaca alnetorum* Giralt, Nimis & Poelt – Sonop 903, 4.3.2001, 25.10.2001, on *Acacia* tree, L. Zedda 5539, 5566, 5567, 5561, 5558 (M-0038780, M-0038777, M-0038781, M-0038784, M-0038810).

*Caloplaca alnetorum* is related to *C. flavorubescens* (Huds.) J.R. Laundon which has been previously reported from South Africa by DOIDGE (1950) under the names *C. aurantiaca* Th.Fr. and *C. flavovirescens* (Wulfen) Dalla Torre & Sarnth. *Caloplaca alnetorum* differs from *C. flavorubescens* by the smaller ascospores [ $9-13(-15) \times 6-9 \mu\text{m}$ ] and rare occurrence of oil droplets in the hymenium. The species was so far known from the bark of broad-leaved trees from Mediterranean mountains and the Alps (GIRALT et al. 1992). It has been reported from Tunisia by SEAWARD (1996).

\*\**Caloplaca citrina* (Hoffm.) Th.Fr. – Sonop 903, 25.10.2001, on *Acacia* and *Burkia*, L. Zedda 5603, 5564, 5598 (M-0038774, M-0038782, M-0038807). Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5831, 5845, 5704 (M-0038962, M-0038977, M-0039382). Toggekry 205 (Omatako Ranch), 3.11.2001, on *Acacia*, L. Zedda 6223 (M-0039517). Sandveld Research Farm, 3.3.2006, on *Acacia erioloba*, M. Schultz 19105, 19109 (HBG-019511).

This is a cosmopolitan species found on calcareous and occasionally acid rocks as well as on nutrient rich bark and wood (PURVIS et al. 1992). On the African continent, it has been reported, so far, only from Morocco (EGEA 1996).

\**Caloplaca holocarpa* (Hoffm.) A.E.Wade s. lat. – Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5699 (M-0039387).

The *Caloplaca holocarpa* group has been recently revised by ARUP (2009) in the Nordic countries. The small specimen collected in Namibia results to be more similar to the true *C. holocarpa* than to other species of the group, having a discontinuous thallus formed by greyish yellow areoles, small orange-yellow apothecia (0.3–0.5 mm) without thalline margin, and wide spore septum. Since a revision of this group is missing from Southern Africa, our specimen is preferably kept as *C. holocarpa* s. lat. Former records of *C. holocarpa* in Africa are known from Morocco (EGEA 1996) and Tunisia (SEAWARD 1996). Another species of this group, *C. pyracea* (Ach.) Th.Fr. has been reported by DOIDGE (1950) from South Africa.

\**Caloplaca* sp. – Sonop 903, 25.10.2001, on old *Acacia* tree, L. Zedda 5563 (M-0038812).

This specimen is closely related to *C. cupreorufa* Zahlbr., hitherto known from China (WETMORE 1994). It is characterized by a brown,  $\pm$  areolate thallus and dark brown, pruinose apothecia (0.5–1 mm diam.); hymenium not interspersed, 70–80  $\mu\text{m}$ ; ascospores 4–8 per ascus, of  $12-15 \times 7-10 \mu\text{m}$  size, with an isthmus of 5  $\mu\text{m}$  thickness; hypothecium hyaline. Probably, a new species.

***Candelaria concolor*** (Dicks.) Stein – Sonop 903, 25.10.2001, on *Acacia* and *Burkia*, L. Zedda 5603, 5611, 5555, 5560 (M-0038774, M-0038775, M-0038778, M-0038813). Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5831, 5836, 5830 (M-0038962, M-0038963, M-0038969). Sandveld Research Farm, 3.3.2006, on bark of *Acacia erioloba*, M. Schultz 19114 (HBG-019516, M-0039727). Farms Narais/Duruchaus, 13.3.2006, M. Schultz 19186 HBG-019577, M-0138908).

*Candelaria concolor* is a cosmopolitan species growing on nutrient-rich bark of sun-exposed trees, and occasionally on rocks and walls (PURVIS et al. 1992). It is widespread in East Africa (KILLMANN & FISCHER 2005) and has been reported from Namibia (Waterberg) by ALMBORN (1966). It is very frequent in Namibian savannahs and found on the bark of different tree species.

\*\****Canoparmelia epileuca*** (Hale) Elix & Hale – Sonop 903, 24.10.2001, on old *Acacia* trees, L. Zedda 5570 (M-0038793).

This corticolous species is known from East Africa and Madagascar (APROOT 1991, SWINSCOW & KROG 1988) where it occurs in dry, sun-exposed habitats on lowlands and coastal hills up to 1000 m alt.

\*\*\****Chaenothecopsis nana*** Tibell – Sonop 903, 24.10.2001, on old *Acacia* trees, L. Zedda 5564, 5565 (M-0038782, M-0038783).

*Chaenothecopsis nana* is widely distributed in the northern hemisphere. Reports from the southern hemisphere are rarer and include Australasia (TIBELL 1987).

\*\****Collema occultatum*** Bagl. – Sonop 903, 25.10.2001, on *Acacia*, L. Zedda 5561 (M-0038784).

This species is characterized by a minute (up to 3 mm diam.), subcrustose to small foliose, ± dark olive-brown thallus, and muriform, cuboid-oblong ascospores (13–16 × 10–13 µm). The specimen examined has isidia-like lobules. *Collema occultatum* is widespread in Europe, the Mediterranean region, North Africa and North America (PURVIS et al. 1992, SCHULTZ et al. 2004).

***Flavoparmelia soredians*** (Nyl.) Hale – Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5834, 5696 (M-0038967; M-0039386).

*Flavoparmelia soredians* occurs widespread in eastern Africa on trees and rarely rock in open, sun-exposed forests. It has been reported from Morocco (EGEA 1996) and from Southern Africa by DOIDGE (1950) (as *Parmelia conspersa* var. *polyphylla* Müll.Arg.), HALE (1976b) (as *Pseudoparmelia soredians* (Nyl.) Hale), THOMAS & BHAT (1996) and SWINSCOW & KROG (1988).

***Flavopunctelia flaventior*** (Stirt.) Hale – Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia* tree, L. Zedda 5699 (M-0039387). Sandveld Research Farm, 3.3.2006, on *Acacia erioloba*, M. Schultz 19103 (HBG-019506, M-0039709). Farms Narais and Duruchaus, M. Schultz.

This is a corticolous or rarely saxicolous species rather common in East Africa (SWINSCOW & KROG 1988, KILLMANN & FISCHER 2005). Reported as new to Namibia by SCHULTZ et al. (2009).

***Flavopunctelia soredica*** (Nyl.) Hale – Sandveld Research Farm, 2.3.2006, on *Acacia erioloba*, M. Schultz 19106 (HBG-019508, M-0039714).

This species is widespread in Asia as well as North and South America. It has been previously reported from *Jacaranda* in Windhoek (BRUSSE 1988, as *Parmelia soredica* Nyl).

***Hyperphyscia adglutinata*** (Flörke) H.Mayrhofer & Poelt – Mutompo, Mile 46 Research Station, 26.02.2001, on trees, L. Zedda 6228 (M-0039973). – Sonop 903, 24.10.2001, 25.10.2001, on *Acacia*, L. Zedda 5603, 5664, 5604 (M-0038774, M-0038782, M-0038798). Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5831, 5700, 5695 (M-0038962, M-0039388, M-0039390). Sandveld Research Farm, 3.3.2006, on *Acacia erioloba*, M. Schultz 19102 (HBG-019505, M-0039706).

This is a widely distributed common species, which grows on trees and rocks in open or partly shaded habitats (SWINSCOW & KROG 1988). It is widespread in East Africa (SWINSCOW & KROG 1988) and has



been previously reported from South Africa (DOIDGE 1950, MOBERG 2004) and Namibia (SCHULTZ et al. 2009).

***Hyperphyscia granulata*** (Poelt) Moberg – Sonop 903, 25.10.2001, on *Acacia*, L. Zedda 5602, 5557 (M-0038787, M-0038800). Sandveld Research Farm, 3.3.2006, on *Acacia erioloba*, M. Schultz 19111 HBG-019513, M-0039723).

This corticolous species from open to partly shady situations (MOBERG 2004) has been reported from tropical East Africa, Madagascar, Zambia, Zimbabwe (SWINSCOW & KROG 1988, APTROOT 1990, BECKER 2002), South Africa (MOBERG 2004) and Namibia (SCHULTZ et al. 2009).

**\**Hyperphyscia pruinosa*** Moberg – Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5701 (M-0039392).

*Hyperphyscia pruinosa* grows on old wood and old bark in open situations (MOBERG 2004). It is known from South Africa (MOBERG 2004) and East Africa (SWINSCOW & KROG 1988).

**\**Hyperphyscia syncolla*** (Tuck. ex Nyl.) Kalb – Sonop 903, 24.10.2001, 25.10.2001, on *Acacia*, L. Zedda 5564, 5554, 5643 (M-0038782, M-0038799, M-0039537). Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5837, 5846, 5695 (M-0038964, M-0038976, M-0039390).

This is a pantropical species and one of the most common species of *Hyperphyscia* in southern Africa growing on trunks, branches and twigs under open conditions, and often being associated with other *Hyperphyscia* species (MOBERG 2004). It has been found in the savannahs of Gambia by APTROOT (2001) and is widespread in East Africa (SWINSCOW & KROG 1988) and South Africa (MOBERG 2004).

**\*\*\**Hypocenomyce anthracophila*** (Nyl.) P. James & Gotth. Schneid. – Sonop 903, 25.10.2001, on old *Acacia* trees, L. Zedda 5556 (M-0038789).

This species is widespread in Europe, North America, Japan and Australia, especially in relict woodlands (SCHNEIDER 1979, PURVIS et al. 1992, THOR & TIMDAL 1995). It is characterized by the brown to dark brown squamules, with a negative C-reaction of the upper cortex.

**\*\**Opegrapha varia*** Pers. – Otjiamongombe West 44 (Erichsfelde), 5.4.2001, on *Acacia*, L. Zedda 5449 (M-0038655).

This is a cosmopolitan species having wide ecological amplitude and occurring on bark and calcareous rock. It is rather resistant also to arid conditions (TORRENTE & EGEA 1989).

***Parmotrema austrosinense*** (Zahlbr.) Hale – Sonop 903, 25.10.2001, on *Acacia* and *Burkea* trees, L. Zedda 5602, 6228, 6243 (M-0038795, M-0039522, M-0039969). Sandveld Research Farm, 3.3.2006, on *Acacia erioloba*, M. Schultz 19107 (HBG-019509, M-0039715).

*Parmotrema austrosinense* is widespread in temperate and tropical regions of the world. On the African continent, it is known from East Africa (SWINSCOW & KROG 1988, KILLMANN & FISCHER 2005) and South Africa (ALMBORN 1988). It has been recently recorded from Namibia by SCHULTZ et al. (2009) where it appears to be rather common.

**\**Parmotrema eciliatum*** (Nyl.) Hale – Sonop 903, 25.10.2001, on *Acacia* trees in savannah sand dune vegetation, L. Zedda 5610 (M-0038794).

This is a widespread species in tropical and subtropical regions of Africa, Asia, Central and South America, the West Indies and Australia. It is known from East and South Africa, where it occurs in low montane forests at 800–1200 m (SWINSCOW & KROG 1988, DOIDGE 1950).

**\*\**Peltula corticola*** Büdel & R. Sant. – Farms Narais and Duruchaus, Oanob Rivier, 13.3.2006, on base of old *Acacia erioloba* tree, M. Schultz 19189 (HBG-019580, M-0138911).

This species has been described from Kenya (BÜDEL 1987) and was later reported from Santa Cruz Island, California by BÜDEL et al. (2007) who did not adopt the new combination, *Phyllopettula corticola* (Büdel & R. Sant.) Kalb, which was based on unpublished molecular results. *Peltula corticola* is also present in southern Yemen and Socotra (Schultz unpublished).

\**Pertusaria coccodes* (Ach.) Nyl. – Sonop 903, 25.10.2001, on *Acacia*, L. Zedda 5562, 5605 (M-0038797, M-0038796).

*Pertusaria coccodes* is a frequent species in Europe where it grows on nutrient-rich bark of deciduous trees and rarely on wood and rock. It has been reported from South Africa by DOIDGE (1950).

\**Phaeographis* sp. – Sonop 903, 25.10.2001, on *Acacia*, L. Zedda 5573 (M-0038785).

The specimen is characterized by black, lirellate apothecia (0.5–0.8 × 0.2 mm), and dark brown, muriform ascospores (35–45 × 10–15 µm), with 0–2 longitudinal septa and 5–7 transversal septa; apothecia black.

*Phaeophyscia confusa* Moberg – Sonop 903, 25.10.2001, on *Acacia* trees, L. Zedda 5597, 5601 (M-0038804, M-0038806).

This species is known from East and southern Africa and Asia. It has been recorded by BRUSSE (1993) from Namibia (surroundings of Otavi, on *Acacia mellifera*) and MOBERG (2004) from South Africa. *Phaeophyscia confusa* appears to be a rather common inhabitant of *Acacia* in Namibia.

\**Phaeophyscia hispidula* (Ach.) Moberg – Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5710 (M-0039391).

*Phaeophyscia hispidula* is widespread throughout the tropical and subtropical parts of the world as well as in warm-temperate regions (MOBERG 2004). It is frequent in East Africa (KILLMANN & FISCHER 2005) and South Africa (DOIDGE 1950, MOBERG 2004). It occurs on tree trunks and rock, especially under somewhat shaded conditions.

\**Phaeophyscia orbicularis* (Neck.) Moberg – Sonop 903, 25.10.2001, on *Acacia*, L. Zedda 5606, 5601 (M-0038803, M-0038806).

This is a cosmopolitan species, known from Lesotho and South Africa where it grows on tree trunks in open situations and on nutrient-rich substrata (PURVIS et al. 1992, MOBERG 2004).

\**Physcia biziana* Poelt & Vězda – Sonop 903, 25.10.2001, on *Burkea* trees in savannah sand dune vegetation, L. Zedda 6242 (M-0039536).

This species, known from East Africa, North and South America, Australia and Europe, has been reported by MOBERG (2004) for South Africa. It occurs on trees in open situations.

\**Physcia poncinsii* Hue – Otjiamongombe West 44 (Erichsfelde), 8.3.2008, on *Acacia*, L. Zedda 6900 (M-0138848).

It is common in warm-temperate to subtropical regions of the world and has been reported by MOBERG (2004) from bark, wood and rocks in open situations in South Africa.

\**Physcia undulata* Moberg – Mile 46-Mutombo, 26.2.2001, on trees, L. Zedda 6228 (M-0039972).

*Physcia undulata* grows on trees and rocks under open conditions at a wide altitudinal range. It is known from East Africa, South and Central America, Australia and southern Africa (South Africa, Lesotho) (SWINSCOW & KROG 1988, MOBERG 2004).

*Physciella chloantha* (Ach.) Essl. – Sandveld Research Farm, 3.3.2006, on *Acacia mellifera*, M. Schultz 19112 (HBG-019514, M).

A widespread species from temperate to subtropical regions. Known from Kenya, it has been recently reported by SCHULTZ et al. (2009) from Namibia growing on *Acacia* trees in the Namib Desert (Gobabeb, Kuiseb Rivier).

\**Pyxine cocoës* (Sw.) Nyl. – Sonop 903, 25.10.2001, on *Acacia* trees, L. Zedda 5539, 5593, 5599 (M-0038781, M-0038801, M-0038805). – Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5844, 5697 (M-0038978, M-0039393, M-0039542). – Sandveld Research Farm, 3.3.2006, on *Acacia erioloba* and *A. mellifera*, M. Schultz 19101, 19113 (HBG-019504, HBG-019515, M-0039704, M-0039726). – Farms Narais and Duruchaus, M. Schultz.



Already known from South Africa (DOIDGE 1950, MOBERG 2004) and Namibia (SCHULTZ et al. 2009), it is a very common and widespread pantropical species occurring in Africa from sea level to mountains of up to 2500 m. It is especially frequent in East Africa (SWINSCOW & KROG 1988) and southern Africa (MOBERG 2004). In Namibia, it seems to be widespread in the savannah biome and rather common on *Acacia*.

***Pyxine nubila*** Moberg – Sonop 903, 25.10.2001, on *Acacia* trees, L. Zedda 5600, 5606, 5558 (M-0038802, M-0038803, M-0038810). Sandveld Research Farm, 2.3.2006, on *Acacia erioloba*, M. Schultz 19104 (HBG-019507, M-0039711). – Farms Narais/Duruchaus, 13.3.2006, M. Schultz 19187 (HBG-019587, M-0138909).

It is a subtropical species already known from Lesotho and South Africa where it grows on both trees and rocks (MOBERG 2004). It has been recently reported from Namibia (SCHULTZ et al. 2009), where it is rather frequent on *Acacia*.

***Pyxine petricola*** Nyl. – Sonop 903, 25.10.2001, on *Acacia* and *Burkea* trees, L. Zedda 5557, 5609, 5571, 6242 (M-0038800, M-0038808, M-0038809, M-0039536). Sandveld Research Farm, 2.3.2006, on bark of *Acacia erioloba*, M. Schultz 19108 (HBG-019510, M-0039717).

A pantropical to nearly cosmopolitan species reported from tropical East Africa (SWINSCOW & KROG 1988), Gambia (APTROOT 2001), Zimbabwe (BECKER 2002) and South Africa (DOIDGE 1950, MOBERG 2004). It is mainly corticolous, but occasionally occurs on rock. It has been recently recorded from Namibia by SCHULTZ et al. (2009) where it is rather common on bark of *Acacia* and *Burkea* in savannah areas.

**\**Rinodina* aff. *boleana*** Giralt & Mayrhofer – Sonop 903, 25.10.2001, on *Acacia* trees, L. Zedda 5569, 5560, 6243 (M-0038811, M-0038813, M-0039537).

Thallus olive-green to greenish-grey, discontinuous to evanescent; apothecia lecanorine with margin excluded at maturity, up to 0.5 mm diam.; hymenium 60–70 µm; hypothecium colourless; ascospores of *Pachysporaria*-type, with ontogenesis of type B, 13–16(–20) × 6–8 µm; thallus K–, C–, P–. *Rinodina boleana* s. str. is a Mediterranean species growing on eutrophic bark of exposed shrubs and trees from low to middle altitudes (GIRALT & MAYRHOFFER 1991, 1995). Our specimens differ from the typical *R. boleana* in having somewhat larger spores (GIRALT & MAYRHOFFER 1991, 1995).

**\**Xanthoria candelaria*** (L.) Th.Fr. – Otjiamongombe West 44 (Erichsfelde), 30.10.2001, on *Acacia*, L. Zedda 5844 (M-0038978).

This is a cosmopolitan and common species from nutrient-rich and -enriched bark, wood and rocks (PURVIS et al. 2002). It has been reported from East Africa (SWINSCOW & KROG 1988) and South Africa by ZAHLBRUCKNER (1926) and DOIDGE (1950).

## Discussion

Hitherto, only 190 lichen taxa growing on different substrata were known from Namibia (FEUERER & ZEDDA 2001, FEUERER 2008, SCHULTZ et al. 2009). Altogether, 37 taxa of epiphytic lichens are recorded from the Namibian savannahs. Most of them (24) are reported from Namibia for the first time, six are also new to Southern Africa and two to Africa (*Chaenothecopsis nana* and *Hypocenomyce anthracophila*). A total of 23 species were found in Sonop, 14 in Erichsfelde, 12 in Sandveld and 3 in Mile 46 as well as in Narais and Duruchaus. In Mile 46, land use is particularly intense. The sites Narais and Duruchaus are characterized by particularly low precipitation (200–300 mm). The greater diversity of species in Sonop could be related to higher average precipitation (c. 450 mm) compared with Erichsfelde and Sandveld (300 and 350 mm, respectively) as well as to lower man-made disturbance, since Sonop is a research station hosting an experimental cattle farm with rotational grazing.

The most frequent species are *Caloplaca citrina*, *Candelaria concolor* and *Hyperphyscia adglutinata* all occurring in almost all examined localities. These lichens are cosmopolitan, very common pioneer taxa which prefer nutrient-rich, sun-exposed bark. All other species were found at only one or two study sites. Most recorded species (49%) are cosmopolitan, whereas 31% of species have a tropical to subtropical distribution. In the remaining species, the geographical distribution is poorly known. Most species found belong to the Physciaceae (40% of taxa), Parmeliaceae (20%) or Teloschistaceae (14%). Species of other families occurred much more rarely, including the Arthoniaceae, Candelariaceae, Collemataceae, Graphidaceae, Mycocaliciaceae, Ophioparmaceae, Pertusariaceae, Peltulaceae, and Roccellaceae.

In comparison to the lichen mycota of two dry forests with *Acacia* trees of Rwanda, where 20 and 30 lichen taxa, respectively, were recorded by BIEDINGER & FISCHER (1996) and KILLMANN & FISCHER (2005), and with 27 epiphytic lichen species reported by APTROOT (2001) from Gambia, lichen richness on trees in Namibia results to be relatively high. However, several families and genera are likely to be lacking or are underrepresented due to climatic reasons. For instance, genera of fruticose lichens such as *Ramalina* and *Usnea* are probably completely absent from the Namibian savannahs. Large foliose to subfruticose lichens belonging to *Hypotrachyna* – a rather common genus in tropical to subtropical forests –, and *Heterodermia* do not occur either. Among crustose lichens, *Lecanora* species and leprose lichen taxa (*Lepraria*) are lacking, and cyanolichens are represented by few species with small thalli (*Collema occultatum* and *Peltula corticola*). The absence or rareness of these groups of lichens, and the dominance of small foliose and crustose lichens can be explained by the dry and hot climate in Namibian savannahs. Large foliose lichens such as *Parmotrema* are limited to less disturbed sites such as the patches of older *Acacia* and *Burkea* tree vegetation in Sonop. Bush removal and fire are important factors decreasing lichen diversity on trees. Under open conditions where shrubs are lacking, mostly no lichens at all grow on trees, except for the occasional occurrence of only few nitrophytic and xerophytic species (*Candelaria concolor*, *Caloplaca citrina*, *Hyperphyscia*). The same pioneer species are found on young *Acacia* trees. During our field work, it was also noticed that more lichens are found on trees close to river beds or dams, probably due to the increased humidity.

It can be concluded that the epiphytic lichen mycota of Namibian savannahs is relatively rich in species, and a number of specimens has not been identified to species level so far. Taxon composition at species and family level reflects the semiarid climatic conditions and the intensity of man-made disturbance.

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