South African Journal of Botany 124 (2019) 402–413

Contents lists available at ScienceDirect

South African Journal of Botany

journal homepage: www.elsevier.com/locate/sajb

Myxomycete biodiversity revealed in the Namib desert

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ARTICLE INFO

Article history:
Received 5 February 2019
Received in revised form 8 May 2019
Accepted 2 June 2019
Available online 18 June 2019

Edited by GV Goodman-Cron

Keywords:
Amoebozoa
Arid ecoregion
Eumycetozoa
Desert microbiota
Distribution
Free-living protists

ABSTRACT

This paper describes the results from a survey for myxomycetes (plasmodial slime molds or myxogastrids) in the Namib Desert. There are no previous records of this group of organisms from Namibia, so the results are all first records for the country and demonstrate that even the world's oldest desert has a surprising number of these visible and important microorganisms, which form an integral part of the desert microbiota. The survey recovered eight species that have never previously been reported from any country in Africa, and reveals the presence of two species *Physarum atacamense* and *Licea eremophila*, recently described from arid areas in South America. Three of the species collected are possibly new to science, but there was insufficient material to develop formal descriptions. Comments on the most interesting collections are included, and the results are compared with surveys for myxomycetes in other arid environments. These results show similarities with the coastal desert of Peru, as well as a disjunct distribution and evidence of area specificity. The fact that deserts harbor a notable diversity of myxomycetes is confirmed.

1. Introduction

Myxomycetes (plasmodial slime molds or myxogastrids) are a group of fungus-like organisms associated with dead plant material in virtually every type of terrestrial ecosystem. Approximately 1000 species are known worldwide (Lado, 2014–2018). Since myxomycetes are almost invariably associated with relatively moist conditions, one might not expect these organisms to be particularly abundant in deserts. However, the number of species reported from those desert regions investigated to date is surprisingly high. Although the lack of moisture in desert environments undoubtedly places severe constraints on the growth and development of myxomycetes, there are several types of special microhabitats that retain moisture long enough to support these organisms. Among these are the bark surface of desert shrubs, the decaying portions of succulent plants, ground litter, herbivore dung and soil. Moreover, myxomycetes appear to have evolved several different ecological strategies to reproduce successfully under what are often exceedingly dry conditions.

During the past 15 years, a number of studies have been carried out in the deserts of Asia, North America, South America and Australia. These studies have yielded a considerable body of information on the myxomycetes found in many of the major desert regions of the world (Blackwell and Gilbertson, 1980b; Estrada-Torres et al., 2009; Lado et al., 2009; Lado et al., 2011; Lado et al., 2016; Wrigley de Basanta et al., 2010; Wrigley de Basanta et al., 2015), but there has been no previous study in southern Africa, and there were (until this study) no myxomycete records from Namibia (Ndiritu et al., 2009). Although the study reported herein represented the first investigation of myxomycetes in the Namib Desert, there have been several previous studies of the fungi. For example, Jacobson et al. (1993, 1999) examined the ecological distribution of one species of stalked puffball and determined the mycorrhizal status of the well-known indigenous plant *Welwitschia mirabilis*. More recently, Ramond et al. (2014) and Johnson et al. (2017) used metagenomics DNA extraction, PCR amplication and T-RFLP fingerprinting to characterize the communities of soil microbes (including microfungi) in soils of the four types of major desert habitats considered in the present study. Although myxomycetes are known to occur in soil (Stephenson et al., 2011), they were not considered in either of these studies.

The Namib Desert, located along the coast of Namibia in Southern Africa, is one of the most arid sites in the world. This desert is thought to be the oldest desert in the world, with geological evidence suggesting that the onset of arid conditions may have occurred as long ago as the late Cretaceous or early Tertiary (Seely, 1978, 1984). The Namib extends a distance of approximately 2000 km from north to south between latitudes 17° and 29° S and inland about 140 km at its widest point (Lancaster et al., 1984). It is dissected by a series of ephemeral rivers,

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https://doi.org/10.1016/j.sajb.2019.06.002
0254-6299/

including the Kuiseb River, which passes through the Central Namib (Fig. 1). There is a strong rainfall gradient with rain increasing from the coast to more inland areas (Lancaster et al., 1984). The presence of the cold Benguela Current off the coast produces coastal fog that extends up to 60 km inland. This fog, in addition to the <100 mm of mean annual rainfall, provides moisture for the flora and fauna in this portion of the Namib (Jacobson et al., 2015).

2. Materials and methods

The research carried out in the Namib Desert had both a field component, with surveys for specimens of myxomycetes that had fruited in the field under natural conditions, and a laboratory component involving isolation of specimens in moist chamber cultures. Myxomycete fruiting bodies can achieve macroscopic dimensions (usually no more than 1–2 mm tall in most species) and be collected and preserved for study in much the same way as the sporocarps of fungi (Wrigley de Basanta and Estrada-Torres, 2017). However, most species of myxomycetes tend to be rather inconspicuous or sporadic in their occurrence, especially in arid environments. As such, the moist chamber culture technique as it applies to myxomycetes (Stephenson and Stempen, 1994) provides a convenient and often very productive method of supplementing field collections and was used extensively in the research described herein. In brief, this technique involves collecting small (5–10 g) samples of dead plant material and placing these in Petri dishes lined with filter paper, adding distilled water and then maintaining the dishes (as moist chamber cultures) under laboratory conditions. Specimens of myxomycetes appearing in these cultures were removed and preserved in much the same way as those obtained in the field (Stephenson, 1988; Stephenson and Stempen, 1994; Wrigley de Basanta and Estrada-Torres, 2017). In each instance, specimens were placed in small pasteboard boxes for permanent storage and then deposited in the herbaria of the University of Arkansas (UARK) for Stephenson collections, the Real Jardín Botánico, Madrid (MA-Fungi) for Lado or the Universidad Autónoma de Tlaxcala (TLXM) for Estrada-Torres, and the private collection of D. Wrigley de Basanta (dwb).

The collecting activities described herein were based at the Gobabeb Research and Training Centre (23°33′42″ S, 15°02′27″ E) in western Namibia, with fieldwork carried out during a two-week period in March 2015. The Centre, located in Namib-Naukluft National Park approximately 120 km southeast of Walvis Bay and about 350 km southwest of Windhoek, is an internationally recognized centre for dry land training and research in Namibia where more than 50 years of Namib desert research has been based (Henschel and Lancaster, 2013). It is an especially appropriate place because the Centre is located at the intersection of the three key Namib ecosystems – the dune sea (Fig. 2 A–C, F), the rocky gravel plains (Fig. 2 D–E, G–H), and the dry Kuiseb River (Fig. 2 C, K).

During the fieldwork, localities were visited where representative examples of each of the different types of ecosystems are located, and all of the substrates known to support myxomycetes were examined for the presence of fruiting bodies. In addition, samples of various types of dead plant material such as the bark of desert trees and shrubs (Fig. 2 M–N), aerial litter [dead but still attached portions of plants above the ground], along with litter and twigs present on the ground surface, were collected at each locality. These samples were placed in small paper bags for short-term storage.

Later, some additional specimens of myxomycetes were obtained from dead portions of *Euphorbia* spp. on rocky hillsides of Kuiseb Pass (Fig. 2 J–L). and from dead litter from a transition zone to the savanna between Windhoek and Dordabis (Fig. 2 O). All samples were collected by R. Darrah, A. Estrada-Torres, C. Lado, S.L. Stephenson and D. Wrigley de Basanta. To compare our results to those of other studies in arid areas, the Sørensen coefficient of community index (CC) was used. The index considers the presence or absence of a species in each area compared using the formula $CC = 2z/(x + y)$, where z is the number of species in common to both areas, and x and y are the number of species in community A and community B respectively (Sørensen, 1948).

For distribution of species in Africa, unless otherwise stated, the checklist of Ndiritu et al. (2009) was followed as it is the most comprehensive compilation of African myxomycetes.

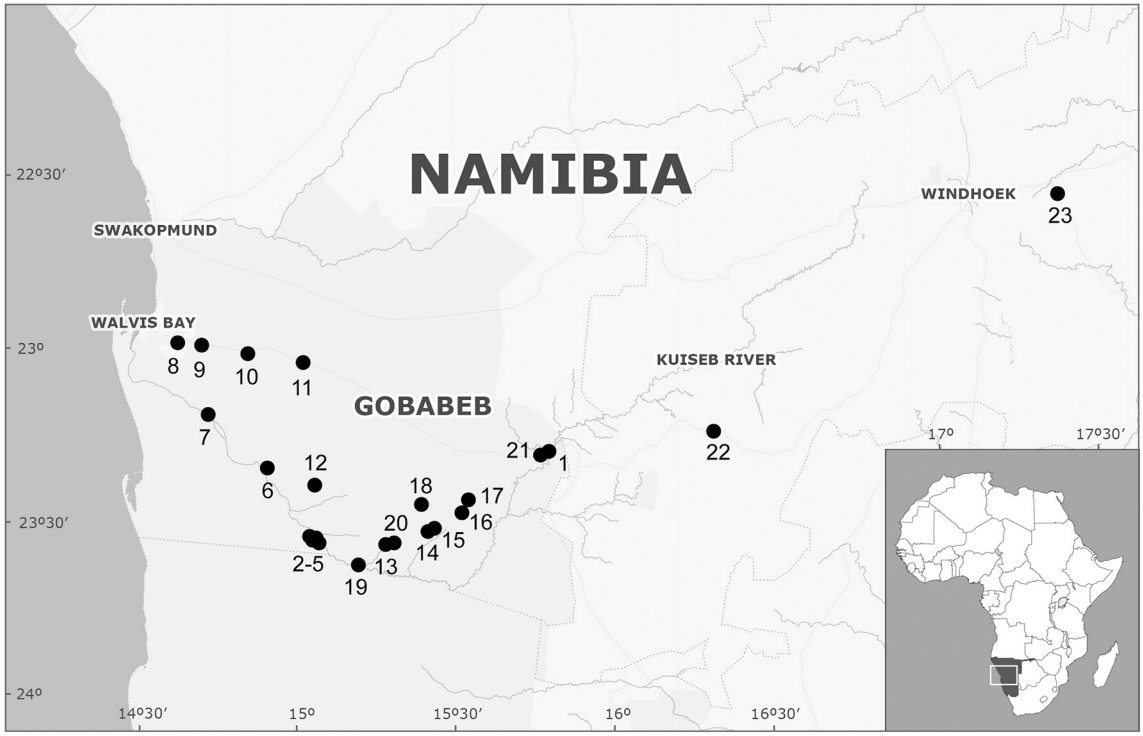

Fig. 1. Map showing collecting localities in Namibia for myxomycetes. See Appendix for list of localities.

Fig. 2. A-O Landscapes and some vegetation types of the Namib desert and bordering areas. A, F. Dunes at Gobabeb. B, C. Dunes with trees such as *Acacia erioloba,* and *Faidherbia albida* marking the course of the dry Kuiseb river-bed. G. gravel plane near Zebra Pan. D, E, H. The rocky gravel planes. I. Grasses on the plateau. J–L. *Euphorbia* spp. among the rocks in the nearby mountains. M. *Vachellia reficiens* and shrubs stabilizing the dunes. N. Detail of *Zygophyllum stapfii* – an endemic shrub to the Namib desert. O. Transition areas toward the savanna vegetation.

3. Results

All identifiable specimens are included in the following list. The locality information is followed by the reference to the list of localities in the appendix and the map Fig. 1, the substrate, the substrate pH, the collector and specimen number. The herbaria are listed above. All specimens are from moist chamber culture unless the substrate is followed by (fc) for field collection. Specimens marked with an asterix (*) are new records for Africa.

Arcyria cinerea (Bull.) Pers.

Namibia. **2315 (Erongo)**: Kuiseb pass, near Kuiseb river, in desert vegetation with *Euphorbia virosa* (-BD), 5 Mar 2015 [NAM-15-01], dung of *Orix gazella* (pH 8.67), *A. Estrada-Torres* 13955, (pH 9.71) *A. Estrada-Torres* 13969. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], *Acacia* bark (pH 4.62), *SL Stephenson* 32125; fruits of *Faidherbia albida* (pH 5.25), *A. Estrada-Torres* 13936, (pH 7.13), *A. Estrada-Torres* 13950, (pH 7.70), *A. Estrada-Torres*

13964. Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-03], aerial twigs of *Acacia erioloba* (pH 6.13), *A. Estrada-Torres* 13963, (pH 7.74) *A. Estrada-Torres* 13976. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], ground litter (pH 4.32), *SL Stephenson* 31740; twigs (pH 4.31), *SL Stephenson* 31737; fruits of *Faidherbia albida* (pH 7.24), *A. Estrada-Torres* 13938, (pH 6.33), *A. Estrada-Torres* 13946, (pH 7.07), *A. Estrada-Torres* 13953. **2314 (Erongo)**: Gobabeb Research and Training Centre, road D1983, 30 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BD), 7 Mar 2015 [NAM-15-06], aerial twigs of *Acacia erioloba* (pH 6.08), *A. Estrada-Torres* 13949, (pH 7.19), *A. Estrada-Torres* 13952, (pH 7.07), *A. Estrada-Torres* 13989; fruits of *Argemone ochroleuca* (pH 7.70), *A. Estrada-Torres* 13945, (pH 7.78), *A. Estrada-Torres* 13959. Gobabeb Research and Training Centre, road D1983, 58 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BA), 7 Mar 2015 [NAM-15-07], fruits of *Argemone ochroleuca* (pH 6.98), *A. Estrada-Torres* 13940, (pH 6.93), *A. Estrada-Torres* 13942. **2214 (Erongo)**: Walvis Bay, road C-14, 19 km east of Walvis Bay, cross to Duna 7, desert vegetation with *Zygophyllum stapfii* (-DC), 7 Mar 2015 [NAM-15-08], aerial litter of *Zygophyllum stapfii* (pH 5.78), *A. Estrada-Torres* 13982. **2314 (Erongo)**: Walvis Bay, road C-14, 42 km east of Walvis Bay, desert vegetation with *Zygophyllum stapfii* (-BB), 7 Mar 2015 [NAM-15-10], aerial litter of *Zygophyllum stapfii* (pH 7.63), *A. Estrada-Torres* 13991. **2315 (Erongo)**: Walvis Bay, road C-14, 60 km east of Walvis Bay, Vogelfederberg, desert vegetation with *Zygophyllum stapfii* (-AA), 7 Mar 2015.[NAM-15-11], ground litter of *Zygophyllum stapfii* (pH 6.99), *A. Estrada-Torres* 13960. Gobabeb Research and Training Centre, road D-2186, 18 km north of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-AC), 7 Mar 2015 [NAM-15-12], aerial litter (pH 6.41), *SL Stephenson* 31739, (pH 6.88), *SL Stephenson* 31997. Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015 [NAM-15-13], aerial litter of unidentified woody plant (pH 6.19), *A. Estrada-Torres* 13984, (pH 6.62), *A. Estrada-Torres* 13995; leaf fibers of unidentified woody plant (pH 6.69), *A. Estrada-Torres* 13974, (pH 6.70), *A. Estrada-Torres* 13997. Gobabeb Research and Training Centre, 40 km east of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-CB), 8 Mar 2015 [NAM-15-15], twigs of *Blepharis grossa* (pH 8.89), *A. Estrada-Torres* 13978, (pH 8.83), *A. Estrada-Torres* 13988. Gobabeb Research and Training Centre, 58 km east of Gobabeb and 4 km North of Zebra Pan, *Acacia* trees (-AD), 8 Mar 2015 [NAM-15-16], dung of *Orix gazella* (pH 7.42), *A. Estrada-Torres* 13948, (pH 8.28), *A. Estrada-Torres* 13951, (pH 8.77), *A. Estrada-Torres* 13968. Gobabeb Research and Training Centre, 65 km east of Gobabeb and 9 km North of Zebra Pan, desert vegetation with *Blepharis grossa* (-BC), 8 Mar 2015 [NAM-15-17], twigs (pH 3.94), *SL. Stephenson* 31712; twigs of *Blepharis grossa* (pH 8.77), *A. Estrada-Torres* 13954, (pH 7.70), *A. Estrada-Torres* 13956, (pH 8.22), *A. Estrada-Torres* 13958. Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], twigs of *Euclea pseudebenus*, (pH 5.38) *A. Estrada-Torres* 13965, (pH 5.32), *A. Estrada-Torres* 13975, (pH 4.85), *A. Estrada-Torres* 13979. Gobabeb Research and Training Centre, 29 km east of Gobabeb, 16 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 9 Mar 2015 [NAM-15-20], bark of unidentified woody plant (pH 6.12), *SL. Stephenson* 31782; aerial litter of unidentified woody plant (pH 6.46), *A. Estrada-Torres* 13962, (pH 6.29), *A. Estrada-Torres* 13966, (pH 7.89), *A. Estrada-Torres* 13970. 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], rotten wood of *Commiphora* sp. (pH 7.26), *A. Estrada-Torres* 13992. **2217 (Khomas)**: road C-23 to Dordabis, 4 km South of junction with B-6, savana vegetation (-CB), 11 Mar 2015 [NAM-15-23], dead wood (fc), *C. Lado* 24100.

Arcyria insignis Kalchbr. & Cooke.

Namibia. **2217 (Khomas)**: road C-23 to Dordabis, 4 km South of junction with B-6, savana vegetation (-CB), 11 Mar 2015 [NAM-15-23], dead wood (fc), *C. Lado* 24,094, *C. Lado* 24095, *C. Lado* 24096, *C. Lado* 24098, *C. Lado* 24101, *C. Lado* 24104, *C. Lado* 24107, *C. Lado* 24110, *C. Lado* 24114.

Arcyria minuta Buchet.

Namibia**. 2315 (Erongo)**: 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], rotten wood of *Commiphora* sp. (pH 7.26), *A. Estrada-Torres* 13927.

Arcyria pomiformis (Leers) Rostaf.

Namibia**. 2315 (Erongo)**: 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], dead portions of *Euphorbia virosa* (fc), *C. Lado* 24089.

Badhamia macrocarpa (Ces.) Rostaf.

Namibia. **2315 (Erongo)**: Kuiseb pass, near Kuiseb river, in desert vegetation with *Euphorbia virosa* (-BD), 5 Mar 2015 [NAM-15-01], aerial litter (pH 8.05), *SL. Stephenson* 31603. Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-03], *Faidherbia albida* bark (pH 6.41), *D. Wrigley de Basanta* 3757. Gobabeb Research and Training Centre, 40 km east of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-CB), 8 Mar 2015 [NAM-15-15], *Blepharis grossa* inflorescence remains (pH 7.62), *D. Wrigley de Basanta* 3790, (pH 7.75), *D. Wrigley de Basanta* 3804. Gobabeb Research and Training Centre, 58 km east of Gobabeb and 4 km North of Zebra Pan, *Acacia* trees (-AD), 8 Mar 2015 [NAM-15-16], *Vachellia reficiens* bark (pH 5.14), *D. Wrigley de Basanta* 3786. Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], *Euclea pseudebenus* bark (pH 7.54), *D. Wrigley de Basanta* 3806, (pH 7.52), *D. Wrigley de Basanta* 3796, (pH 7.01), *D. Wrigley de Basanta* 3800. 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], *Euphorbia virosa* litter (pH 8.04), *D. Wrigley de Basanta* 3812.

Badhamia melanospora Speg.

Namibia**. 2315 (Erongo)**: 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], dead portions of *Euphorbia virosa* (fc), *C. Lado* 24076, *C. Lado* 24082, *C. Lado* 24087.

Comatricha laxa Rostaf.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], bark of unidentified woody plant (pH 6.39), *SL. Stephenson* 32121. Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015 [NAM-15-13], bark of unidentified woody plant (pH 6.12), *SL. Stephenson* 32102, *SL. Stephenson* 32102. **2217 (Khomas)**: road C-23 to Dordabis, 4 km South of junction with B-6, savana vegetation (-CB), 11 Mar 2015 [NAM-15-23], dead wood (fc), *C. Lado* 24102, *C. Lado* 24103.

Comatricha nigra (Pers. ex J.F. Gmel.) J. Schröt.

Namibia**. 2315 (Erongo)**: Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-03], *Faidherbia albida* bark (pH 4.61), *D. Wrigley de Basanta* 3751.

Collaria sp.

Namibia**. 2315 (Erongo)**: 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], rotten wood of *Commiphora* sp. (pH 7.26), *A. Estrada-Torres* 13928, (pH 7.97).*A. Estrada-Torres* 13929a.

These stipitate sporocarps, 0.5–0.8 mm tall, are dispersed or in small groups and have a subglobose dark brown sporotheca 0.3–0.4 mm in diam. The hypothallus is membranous, concolorous with the base of the fibrous stalk, which is approximately half the total height. The peridium is fugacious except at the base of the sporotheca where it persists as a prominent collar. The dark brown columella, reaching the middle of the sporotheca, splits into various primary branches at the apex. The capillitium arises along the length of the columella and forms a dense internal net thinning toward the periphery and anastomosing in an incomplete surface net with numerous pointed free ends, but not adhering to the collar. The spores are gray-brown in mass brown by transmitted light, 7–8.3 (−9.0) μm diam., faintly warted with some groups of warts.

Collection *A. Estrada-Torres* 13928 has only a few sporocarps but collection *A. Estrada-Torres* 13929a is abundant and consists of hundreds of small sporocarps less than 1 mm tall. The prominent collar, at the base of the sporotheca, visible even under the stereoscope, make it quite distinct from any described species. It differs from *Collaria rubens* since the capillitium does not adhere to the collar. It is different from *C. arcyrionema* and *C. biasperospora* by its smaller size (up to 2.5 and 2.2 mm respectively vs. 0.5–0.8 mm in the Namibian species) and its fugacious peridium. *Collaria nigricapillitia* is nivicolous. *Collaria lurida* can be of similar small size, but its color is dull brown and the capilitium has few anastomoses with long free ends. *Comatricha elegans* has capillitial remains in the form of a reduced collar, but has a short columella with coarse primary capillitium branches rising rigidly from it, while at the base of the sporotheca the capillitium is flexuous forming a net with free ends.

Dictydiaethalium plumbeum (Schumach.) Rostaf.

Namibia. **2217 (Khomas)**: road C-23 to Dordabis, 4 km South of junction with B-6, savana vegetation (-CB), 11 Mar 2015 [NAM-15-23], dead wood (fc), *C. Lado* 24093, *C. Lado* 24097, *C. Lado* 24108, *C. Lado* 24115.

Didymium anellus Morgan.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], *Acacia* bark (pH 6.50), *SL. Stephenson* 32124. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], twigs (pH 5.52), *SL. Stephenson* 31542, (pH 4.96), *SL. Stephenson* 31589.

*__Didymium atrichum__ Henney & Alexop.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], *Acacia* bark (pH 6.50), *SL. Stephenson* 32124; *Salvadora persica* leaf litter (pH 7.3), *D. Wrigley de Basanta* 3736, (pH 7.37), *D. Wrigley de Basanta* 3740, (pH 7.29), *D. Wrigley de Basanta* 3769; dead leaves of *Salvadora persica* (fc), *C. Lado* 24059, *C. Lado* 24063, *C. Lado* 24064, *C. Lado* 24065. Gobabeb Research and Training Centre, 40 km east of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-CB), 8 Mar 2015 [NAM-15-14], aerial litter (pH 6.37), *SL. Stephenson* 31555. Gobabeb Research and Training Centre, 65 km east of Gobabeb and 9 km North of Zebra Pan, desert vegetation with *Blepharis grossa* (-BC), 8 Mar 2015 [NAM-15-17], ground litter (pH 6.69), *SL. Stephenson* 31597, (pH 6.56), *SL. Stephenson* 31596, (pH 6.69), *SL. Stephenson* 31597. 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], *Euphorbia virosa* (pH 7.31), *SL. Stephenson* 31535.

This species was described by Henney et al. (1980) from south-central Texas (USA), and has a very restricted distribution, since it was known previously only from North America. Our collections extend its distribution to Africa and the Paleotropics and confirm the affinities of the species for arid environments. In the Namib desert it appeared abundantly both in the field and in cultures (Fig. 3 A). The most distinctive taxonomic characters of this species are its rather small sessile sporophores 100–300 μm diam., the absent of a capillitium and the spores that are faintly reticulate. This ornamentation is only visible with oil immersion.

*__Didymium comatum__ (Lister) Nann.-Bremek.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-03], *Faidherbia albida* bark (pH 6.41), *D. Wrigley de Basanta* 3756; *Tamarix usneoides* bark (pH 6.86), *D. Wrigley de Basanta* 3735. Gobabeb Research and Training Centre, 58 km east of Gobabeb and 4 km North of Zebra Pan, *Acacia* trees (-AD), 8 Mar 2015 [NAM-15-16], *Vachellia reficiens* bark (pH 6.32), *D. Wrigley de Basanta* 3781, (pH 5.45), *D. Wrigley de Basanta* 3791.

This species is somewhat similar in appearance to *Didymium difforme* but differs in its expanding elastic capillitium and dark brown spore mass. Reported previously from Japan, Europe and North America but not as published records from Africa. There are specimens from Burundi, DR Congo and Rwanda conserved in the BR herbarium but they appear to be unpublished records. *Didymium comatum* (Lister) Nann.-Bremek. in GBIF Secretariat (2017). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2019-05-08.

Didymium difforme (Pers.) Gray.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, road D-2186, 18 km north of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-AC), 7 Mar 2015. [NAM-15-12], aerial litter (pH 6.55), *SL. Stephenson* 31998.

Didymium dubium Rostaf.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], twigs (pH 4.96), *SL. Stephenson* 31589.

This collection somewhat resembles *Didymium orthonemata* H. W. Keller & T. E. Brooks but the spores are smaller (10–12 μm diam.) than those of the latter species and are not spinulose. However, this collection from Namibia appears to fit *D. dubium* better than any other species. The species has been recorded from the Canary Islands but this is the first record from the African continent.

*__Didymium eremophilum__ M.Blackw. & Gilb.

Namibia**. 2315 (Erongo)**: 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], *Euphorbia virosa* litter (pH 6.77), *D. Wrigley de Basanta* 3802, (pH 7.14), *D. Wrigley de Basanta* 3809.

This is another example of a species described originally from arid areas of the United States (desert of Sonora, Arizona) on succulent plants (Blackwell and Gilbertson, 1980a) but which now appears in Africa, in similar environments and habitats. It has also been reported from Mexico (Estrada-Torres et al., 2009). The small size of the sporocarps (0.1–0.75 mm diam.) possibly mean this rare species has been overlooked and is under-reported. The scattered white crystalline lime on a colorless peridium and the absence of capillitium on this tiny species are distinctive characteristics.

Didymium iridis (Ditmar) Fr.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], mixed litter (pH 5.42), *SL. Stephenson* 31682.

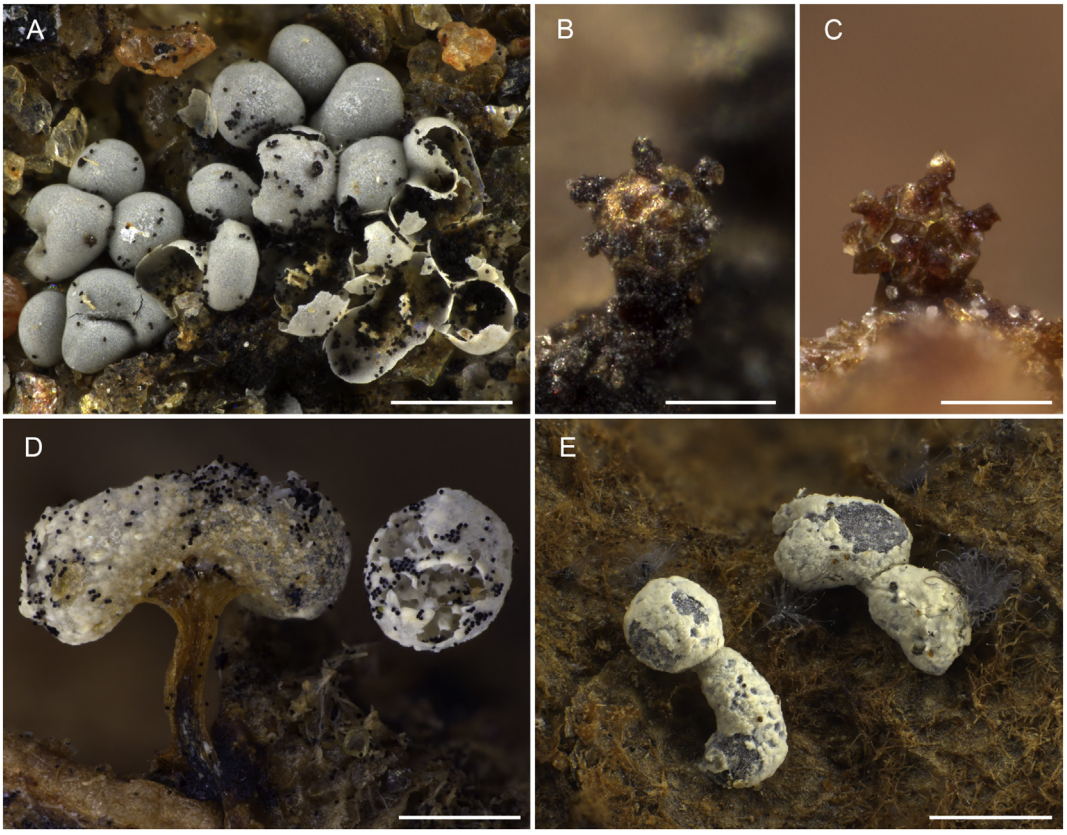

Fig. 3. A–E. 17–21. A. Sporocarps of *Didymium atrichum* (Lado 24065). **B–C**. *Licea eremophila* (dwb 3741), stipitate and subsessile sporocarps. **D.** *Physarum atacamense* (Lado 24061) E. *Physarum clavisporum* (Lado 24057). Bar 17, 20 = 0.5 mm.; 18,19 = 0.1 mm; 21 = 1 mm.

Didymium sp.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], twigs (pH 4.96), *SL. Stephenson* 31589. Gobabeb Research and Training Centre, 40 km east of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-CB), 8 Mar 2015 [NAM-15-14] aerial litter (pH 6.04), *SL. Stephenson* 31538. Gobabeb Research and Training Centre, 65 km east of Gobabeb and 9 km North of Zebra Pan, desert vegetation with *Blepharis grossa* (-BC), 8 Mar 2015 [NAM-15-17], twigs (pH 3.94), *SL. Stephenson* 31539.

These three collections resemble *Didymium comatum* but the spores are too large (15 μm diam. vs.10–13 μm diam. in *D. comatum*) and the capillitium is curly and not expanding. They may represent a species new to science.

Echinostelium arboreum H.W. Keller & T.E. Brooks.

Namibia**. 2315 (Erongo)**: 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], rotten wood of *Commiphora* sp. (pH 7.97), *A. Estrada-Torres* 13929b.

Described from Mexico and also recently reported from various South American countries including the coastal desert of Peru (Lado et al., 2016). In Africa it was recorded from Madagascar (Wrigley de Basanta et al., 2013). This species has pale yellow sporocarps with a persistent shiny peridium.

Echinostelium coelocephalum T.E. Brooks & H.W. Keller.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 58 km east of Gobabeb and 4 km North of Zebra Pan, *Acacia* trees (−AD), 8 Mar 2015 [NAM-15-16], *Vachellia reficiens* bark (pH 5.14), *D. Wrigley de Basanta* 3780, (pH 6.32), *D. Wrigley de Basanta* 3773.

In Africa, recorded previously only from South Africa.

Echinostelium colliculosum K.D. Whitney & H.W. Keller.

Namibia. **2314 (Erongo)**: Gobabeb Research and Training Centre, road D1983, 30 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BD), 7 Mar 2015 [NAM-15-06], *Acacia* bark (pH 6.72), *SL. Stephenson* 32115. **2315 (Erongo)**: Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], *Euclea pseudebenus* bark (pH 7.52), *D. Wrigley de Basanta* 3782, (pH 7.54), *D. Wrigley de Basanta* 3783, (pH 7.01), *D. Wrigley de Basanta* 3784.

In Africa there are records of this species from Tunisia and Tanzania.

Echinostelium minutum de Bary.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], ground litter (pH 4.26), *SL. Stephenson* 31557.

***Licea eremophila** D. Wrigley, Lado & Estrada.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], *Acacia erioloba* bark (pH 6.69), *D. Wrigley de Basanta* 3741. **2314 (Erongo)**: Gobabeb Research and Training Centre, road D1983, 30 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BD), 7 Mar 2015 [NAM-15-06], *Acacia erioloba* bark (pH 6.05), *D. Wrigley de Basanta* 3785.

This distinctive usually stipitate species was described from arid environments in South America (Wrigley de Basanta et al., 2010) and was recently reported from the coastal desert of Peru (Lado et al., 2016). The yellowish sporocarps, angular where the platelets meet, and polyhedral warted spores 10–12 μm diam. Are typical characteristics of the species. The material from Namibia (Fig. 3 B-C) has more thick dark deposits on the surface of the peridium than other specimens examined.

Licea succulenticola Mosquera, Lado, Estrada & Beltrán-Tej.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-03], *Tamarix usneoides* bark (pH 7.25), *D. Wrigley de Basanta* 3733, (pH 6.86), *D. Wrigley de Basanta* 3734.

This is another species associated with succulent plants and reported from arid areas in North and South America. In Africa it was recorded from Madagascar (Wrigley de Basanta et al., 2013). We have been made aware of an unpublished collection from Morocco (M. Meyer pers. comm.)

Perichaena chrysosperma (Curr.) Lister.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], aerial litter (pH 5.72), *SL. Stephenson* 32742.

Perichaena corticalis (Batsch) Rostaf.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015.

[NAM-15-04], aerial litter (pH 6.32), *SL. Stephenson* 31695; ground litter (pH 4.26), *SL. Stephenson* 31734. Gobabeb Research and Training Centre, road D-2186, 18 km north of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-AC), 7 Mar 2015 [NAM-15-12], aerial litter (pH 6.88), *SL. Stephenson* 32103. Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015 [NAM-15-13], bark of unidentified woody plant (pH 6.12), *SL. Stephenson* 32000. Gobabeb Research and Training Centre, 65 km east of Gobabeb and 9 km North of Zebra Pan, desert vegetation with *Blepharis grossa* (-BC), 8 Mar 2015 [NAM-15-17], ground litter (pH 5.87), *SL. Stephenson* 31713. Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], twigs (pH 4.22), *SL. Stephenson* 32004. Gobabeb Research and Training Centre, 29 km east of Gobabeb, 16 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 9 Mar 2015 [NAM-15-20], bark (pH 6.39), *SL. Stephenson* 32120. **2217 (Khomas)**: road C-23 to Dordabis, 4 km South of junction with B-6, savana vegetation (-CB), 11 Mar 2015 [NAM-15-23], dead wood (fc), *C. Lado* 24105, *C. Lado* 24106, *C. Lado* 24109, *C. Lado* 24111, *C. Lado* 24113.

Perichaena depressa Lib.

Namibia. **2315 (Erongo)**: Kuiseb pass, near Kuiseb river, in desert vegetation with *Euphorbia virosa* (-BD), 5 Mar 2015 [NAM-15-01], dung of *Orix gazella* (pH 8.71), *A. Estrada-Torres* 13980. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora pérsica* (-CA), 6 Mar 2015 [NAM-15-05], fruits of *Faidherbia albida* (pH 7.07), *A. Estrada-Torres* 13983. **2314 (Erongo)**: Gobabeb Research and Training Centre, road D1983, 30 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BD), 7 Mar 2015 [NAM-15-06], aerial litter (pH 6.38), *SL. Stephenson* 31659. **2315 (Erongo)**: Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015 [NAM-15-13], aerial litter of unidentified woody plant (pH 6.62), *A. Estrada-Torres* 13994. Gobabeb Research and Training Centre, 58 km east of Gobabeb and 4 km North of Zebra Pan, *Acacia* trees (-AD), 8 Mar 2015 [NAM-15-16], dung of *Orix gazella* (pH 7.42), *A. Estrada-Torres* 13985.

Perichaena quadrata T. Macbr.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 58 km east of Gobabeb and 4 km North of Zebra Pan, *Acacia* trees (-AD), 8 Mar 2015 [NAM-15-16], *Vachellia reficiens* bark (pH 6.32), *D. Wrigley de Basanta* 3808.

In Africa reported previously only from Tanzania.

Perichaena vermicularis (Schwein.) Rostaf.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], aerial litter (pH 6.32), *SL. Stephenson* 31695, (pH 6.72), *SL. Stephenson* 31649. Gobabeb Research and Training Centre, road D-2186, 18 km north of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-AC), 7 Mar 2015 [NAM-15-12], aerial litter (pH 6.71), *SL. Stephenson* 31546, *SL. Stephenson* 31602, (pH 6.41), *SL. Stephenson* 31593, (pH 6.37), *SL. Stephenson* 31655, *SL. Stephenson* 31691. Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], ground litter (pH 5.52), *SL. Stephenson* 31715.

Physarum album (Bull.) Chevall.

Namibia. **2217 (Khomas)**: road C-23 to Dordabis, 4 km South of junction with B-6, savana vegetation (-CB), 11 Mar 2015 [NAM-15-23], dead wood (fc), *C. Lado* 24099.

***Physarum atacamense** D. Wrigley, Lado & Estrada.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], *Acacia* bark (pH 6.50), *SL. Stephenson* 32114, (pH 6.31), *SL. Stephenson* 32113; *Acacia erioloba* bark (pH 6.69), *D. Wrigley de Basanta* 3743, (pH 5.27), *D. Wrigley de Basanta* 3768; *Rogeria longiflora* dry fruit pods (pH 6.11), *D. Wrigley de Basanta* 3749, (pH 7.24), *D. Wrigley de Basanta* 3750; *Salvadora persica* leaf litter (pH 7.3), *D. Wrigley de Basanta* 3746, (pH 7.37), *D. Wrigley de Basanta* 3748; aerial litter (pH 6.53), *SL. Stephenson* 31595; dead leaves of *Salvadora persica* (fc), *C. Lado* 24058, *C. Lado* 24059, *C. Lado* 24060, *C. Lado* 24061; fruits of *Faidherbia albida* (pH 7.13), *A. Estrada-Torres* 13922, (pH 7.70), *A. Estrada-Torres* 13931, (pH 5.25) *A. Estrada-Torres* 13935. Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-03], *Tamarix usneoides* bark (pH 6.32), *D. Wrigley de Basanta* 3738, *D. Wrigley de Basanta* 3739, (pH 7.25), *D. Wrigley de Basanta* 3770, (pH 6.86), *D. Wrigley de Basanta* 3771; aerial twigs of *Acacia erioloba* (pH 7.74), *A. Estrada-Torres* 13924, (pH 6.10), *A. Estrada-Torres* 13925, (pH 6.39) *A. Estrada-Torres* 13930. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], *Moringa ovalifolia* bark (pH 7.23), *D. Wrigley de Basanta* 3760, (pH 7.89), *D. Wrigley de Basanta* 3761, (pH 6.76), *D. Wrigley de Basanta* 3762, (pH 7.91), *D. Wrigley de Basanta* 3764, (pH 7.73), *D. Wrigley de Basanta* 3765, *Moringa ovalifolia* fruit pods (pH 7.77), *D. Wrigley de Basanta* 3759; aerial litter (pH 6.32), *SL. Stephenson* 31609, (pH 5.72), *SL. Stephenson* 31594, (pH 5.59), *SL. Stephenson* 31605; ground litter (pH 6.44), *SL. Stephenson* 31717, (pH 6.12), *SL. Stephenson* 31994, (pH 6.11), *SL. Stephenson* 31650, (pH 7.44), *SL. Stephenson* 31606, (pH 6.44), *SL. Stephenson* 31651, (pH 6.12), *SL. Stephenson* 31654, (pH 6.11), *SL. Stephenson* 31652, (pH 5.92), *SL. Stephenson* 31781, (pH 6.46), *SL. Stephenson* 31591; mixed litter (pH 4.63), *SL. Stephenson* 31687; twigs (pH 5.82), *SL. Stephenson* 31646, (pH 4.96), *SL. Stephenson* 31545, (pH 4.42), *SL. Stephenson* 31982, (pH 5.76), *SL. Stephenson* 31556, (pH 5.76), *SL. Stephenson* 31558, (pH 4.42), *SL. Stephenson* 31582, (pH 4.31), *SL. Stephenson* 31607, (pH 5.66), *SL. Stephenson* 31544. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora pérsica* (-CA), 6 Mar 2015 [NAM-15-05], fruits of *Faidherbia albida* (pH 7.07), *A. Estrada-Torres* 13926, (pH 7.24) *A. Estrada-Torres* 13937. **2314 (Erongo)**: Gobabeb Research and Training Centre, road D1983, 30 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BD), 7 Mar 2015 [NAM-15-06], *Acacia erioloba* bark (pH 5.55), *D. Wrigley de Basanta* 3774, (pH 6.05), *D. Wrigley de Basanta* 3775, (pH 4.93), *D. Wrigley de Basanta* 3776; aerial litter (pH 6.38), *SL. Stephenson* 31741, *SL. Stephenson* 31559, (pH 6.72), *SL. Stephenson* 31599; aerial twigs of *Acacia erioloba* (pH 7.19), *A. Estrada-Torres* 13917, (pH 7.07) *A. Estrada-Torres* 13918, (pH 6.08) *A. Estrada-Torres* 13921; fruits of *Argemone ochroleuca* (pH 6.80), *A. Estrada-Torres* 13943, (pH 7.78), *A. Estrada-Torres* 13944; twigs (pH 4.74), *SL. Stephenson* 31653b, (pH 5.92), *SL. Stephenson* 31584; unidentified desert plant twiglet litter (pH 6.5), *D. Wrigley de Basanta* 3752, (pH 7.83), *D. Wrigley de Basanta*

3754, (pH 7.29), *D. Wrigley de Basanta* 3772. Gobabeb Research and Training Centre,road D1983, 58 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BA), 7 Mar 2015 [NAM-15-07], fruits of *Argemone ochroleuca* (pH 6.98), *A. Estrada-Torres* 13939, (pH 6.93) *A. Estrada-Torres* 13941; ground litter (pH 4.96), *SL. Stephenson* 31783, *SL. Stephenson* 32104, *SL. Stephenson* 32105; twigs (pH 5.92), *SL. Stephenson* 31598. **2214 (Erongo)**: Walvis Bay, road C-14, 19 km east of Walvis Bay, cross to Duna 7, desert vegetation with *Zygophyllum stapfii* (-DC), 7 Mar 2015 [NAM-15-08], aerial litter of *Zygophyllum stapfii* (pH 6.56), *A. Estrada-Torres* 13972, (pH 6.27) *A. Estrada-Torres* 13973; twigs (pH 8.29), *SL. Stephenson* 31683. **2314 (Erongo)**: Walvis Bay, road C-14, 27 km east of Walvis Bay, desert vegetation (-BA), 7 Mar 2015 [NAM-15-09], *Arthraerua* sp. litter (pH 8.24), *D. Wrigley de Basanta* 3777, (pH 8.46), *D. Wrigley de Basanta* 3778, (pH 8.19), *D. Wrigley de Basanta* 3779. Walvis Bay, road C-14, 42 km east of Walvis Bay, desert vegetation with *Zygophyllum stapfii* (-BB), 7 Mar 2015 [NAM-15-10], aerial litter of *Zygophyllum stapfii* (pH 7.63), *A. Estrada-Torres* 13923, (pH 7.49) *A. Estrada-Torres* 13981. **2315 (Erongo)**: Walvis Bay, road C-14, 60 km east of Walvis Bay, Vogelfederberg, desert vegetation with Zygophyllum stapfii (-AA), 7 Mar 2015 [NAM-15-11], ground litter of *Zygophyllum stapfii* (pH 7.01), *A. Estrada-Torres* 13996. **2315 (Erongo)**: Gobabeb Research and Training Centre, road D-2186, 18 km north of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-AC), 7 Mar 2015 [NAM-15-12], ground litter of *Zygophyllum stapfii* (pH 6.52), *A. Estrada-Torres* 13932, (pH 6.02) *A. Estrada-Torres* 13990. Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015 [NAM-15-13], aerial litter of unidentified woody plant (pH 6.62), *A. Estrada-Torres* 13971. Gobabeb Research and Training Centre, 40 km east of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-CB), 8 Mar 2015 [NAM-15-14], aerial litter (pH 6.14), *SL. Stephenson* 31538, (pH 5.8), *SL. Stephenson* 31600, (pH 6.37), *SL. Stephenson* 31608; ground litter of *Zygophyllum stapfii*, *A. Estrada-Torres* 13961 (pH 5.86); twigs (pH 5.39), *SL. Stephenson* 31742. Gobabeb Research and Training Centre, 40 km east of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-CB), 8 Mar 2015 [NAM-15-15], *Blepharis grossa* inflorescence remains (pH 7.75), *D. Wrigley de Basanta* 3787, (pH 7.62), *D. Wrigley de Basanta* 3788, (pH 7.6), *D. Wrigley de Basanta* 3789; twigs of *Blepharis grossa* (pH 8.89), *A. Estrada-Torres* 13947. Gobabeb Research and Training Centre, 65 km east of Gobabeb and 9 km North of Zebra Pan, desert vegetation with *Blepharis grossa* (-BC), 8 Mar 2015 [NAM-15-17], aerial litter (pH 5.97), *SL. Stephenson* 31780; ground litter (pH 6.69), *SL. Stephenson* 31597, (pH 6.56), *SL. Stephenson* 31596; twigs of *Blepharis grossa* (pH 8.22), *A. Estrada-Torres* 13919, (pH 8.77), *A. Estrada-Torres* 13920. Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], *Acacia* bark (pH 4.62), *SL. Stephenson* 32116; *Salvadora persica* leaf litter (pH 7.03), *D. Wrigley de Basanta* 3793, (pH 7.06), *D. Wrigley de Basanta* 3794, (pH 6.95), *D. Wrigley de Basanta* 3795; ground litter (pH 5.14), *SL. Stephenson* 31710. Gobabeb Research and Training Centre, 29 km east of Gobabeb, 16 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 9 Mar 2015 [NAM-15-20], *Acacia* bark (pH 4.96), *SL. Stephenson* 32118. 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], *Euphorbia virosa* litter (pH 6.77), *D. Wrigley de Basanta* 3803, (pH 7.14) *D. Wrigley de Basanta* 3810.

The abundance of this species in the desert area of Namibia is surprising. Described originally from the Atacama desert in Chile (Wrigley de Basanta et al., 2012), occurring on the remains of plants that stabilize the dunes, it has appeared both in the field and in cultures of plant remains in Namibia, in similar environments of dunes and the dry course of the Kuiseb river. It is worth noting that this species was also abundant in the coastal desert of Peru (Lado et al., 2016). The erect, stipitate sporocarps with a non-calcareous fibrous stalk, darker at the base, the large, white, nodes of the capillitium and the dark angular spores of the Namibia collections are absolutely typical of the species (Fig. 3 D).

Physarum bitectum G. Lister.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], *Salvadora persica* leaf litter (pH 7.37), *D. Wrigley de Basanta* 3732, (pH 7.3), *D. Wrigley de Basanta* 3745, (pH 7.29), *D. Wrigley de Basanta* 3747.

Physarum clavisporum G. Moreno, A. Sánchez, A. Castillo & Illana.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], dead leaves of *Salvadora persica* (fc), *C. Lado* 24057, *C. Lado* 24062, *C. Lado* 24063, *C. Lado* 24064, *C. Lado* 24068, *C. Lado* 24069, *C. Lado* 24070, *C. Lado* 24071, *C. Lado* 24072, *C. Lado* 24073.

This species was described by Moreno et al. (2009) from Spain and the Canary Islands. As the latter are geographically African territory, our collections are not the first records for Africa, although they are new for the country of Namibia. Yamni et al. (2015) reported material from Morocco intermediate between *Physarum bitectum* and *P. clavisporum*. The sessile sporocrps with a clear double peridium, the outer layer calcareous and breaking easily are characteristic of the species (Fig. 3 E). The spores have very prominent spines.

Physarum compressum Alb. & Schwein.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, road D-2186, 18 km north of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-AC), 7 Mar 2015 [NAM-15-12], aerial litter (pH 6.55), *SL. Stephenson* 32096. Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], *Euclea pseudebenus* bark (pH 7.52), *D. Wrigley de Basanta* 3797.

*__Physarum daamsii__ Nann.-Bremek.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015 [NAM-15-13], aerial litter of unidentified woody plant, *A. Estrada-Torres* 13934 (pH 6.35).

Described from the Netherlands and collected elsewhere in Europe but this is the first record of the species in Africa. The Namibian collection has dispersed sessile subglobose sporocarps that are grayish white, calcareous with peridial lime in a pattern of veins on the surface. The capillitium has rounded white nodes and the spores are warted and rather dark, 10–11.2 μm diam. It is similar to *Physarum cinereum*, but with darker spores.

Physarum licheniforme (Schwein.) Lado.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015.

[NAM-15-02], ground litter (pH 6.34), *SL. Stephenson* 32097. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], aerial litter (pH 6.94), *SL. Stephenson* 31681, (pH 6.82), *SL. Stephenson* 31680. Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015 [NAM-15-13], ground litter (pH 6.04), *SL. Stephenson* 31716. Gobabeb Research and Training Centre, 40 km east of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-CB), 8 Mar 2015 [NAM-15-14], twigs (pH 5.85), *SL. Stephenson* 31583. Gobabeb Research and Training Centre, 65 km east of Gobabeb and 9 km North of Zebra Pan, desert vegetation with *Blepharis grossa* (-BC), 8 Mar 2015 [NAM-15-17], twigs (pH 3.94), *SL. Stephenson* 31601.

Physarum pusillum (Berk. & M.A. Curtis) G. Lister

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-03], *Faidherbia albida*

bark (pH 6.41), *D. Wrigley de Basanta* 3755. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-04], *Moringa ovalifolia* bark (pH 6.76), *D. Wrigley de Basanta* 3763; aerial litter (pH 6.34), *SL. Stephenson* 31592; twigs (pH 5.52), *SL. Stephenson* 31541. Gobabeb Research and Training Centre, 58 km east of Gobabeb and 4 km North of Zebra Pan, *Acacia* trees (-AD), 8 Mar 2015 [NAM-15-16], *Vachellia reficiens* bark (pH 5.45), *D. Wrigley de Basanta* 3792. 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015 [NAM-15-21], dead portions of *Euphorbia virosa* (fc), *C. Lado* 24077, *C. Lado* 24078, *C. Lado* 24079, *C. Lado* 24081, *C. Lado* 24084, *C. Lado* 24085, *C. Lado* 24087, *C. Lado* 24092.

Physarum sp.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015 [NAM-15-19], twigs (pH 4.09), *SL. Stephenson* 31581.

This collection was represented by very limited material and could not be determined to the level of species. However, the slightly yellowish capillitium and warted spores 11–13 μm diam. are characteristics not shared with any other species of *Physarum* recorded in the present study.

Protophysarum phloiogenum M.Blackw. & Alexop.

Namibia. **2315 (Erongo)**: Kuiseb pass, near Kuiseb river, in desert vegetation with *Euphorbia virosa* (-BD), 5 Mar 2015 [NAM-15-01], aerial litter (pH 8.05), *SL. Stephenson* 31540. Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-02], *Acacia* bark (pH 6.50), *SL. Stephenson* 32123. Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015 [NAM-15-03], *Tamarix usneoides* bark (pH 6.32), *D. Wrigley de Basanta* 3731. **2314 (Erongo)**: Gobabeb Research and Training Centre, road D1983, 30 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BD), 7 Mar 2015 [NAM-15-06], unidentified desert plant twiglet litter (pH 6.5), *D. Wrigley de Basanta* 3753. **2315 (Erongo)**: Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015 [NAM-15-13], aerial litter (pH 7.37), *SL. Stephenson* 31536, (pH 7.28), *SL. Stephenson* 31537.

Described originally from Colorado (USA) by Blackwell and Alexopoulos (1975) but known from other parts of the world such as other states of the United States (Blackwell and Gilbertson, 1984), Tunisia (Neubert et al., 1995), Greece and European Russia (Novozhilov, 1993) and Kazakhstan (Schnittler, 1996) also unpublished records from Mongolia (J. K. Novozhilov, pers.comm.) and California (M. Blackwell, pers. comm. see Castillo et al., 1998). This species of small size (0.1–0.75 mm in total height, 75–200 μm in diam.), is characterized by its scattered, stipitate, limeless sporcarps, with scanty capillitium, the threads without lime, branching and anastomosing, and the spores ornamented with small warts, densely distributed, but under SEM shows a full network of small meshes (Castillo et al., 1998).

Stemonitis flavogenita E. Jahn.

Namibia**. 2315 (Erongo)**: Gobabeb Research and Training Centre, 29 km east of Gobabeb, 16 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 9 Mar 2015. [NAM-15-20], *Acacia* bark (pH 6.72), *SL. Stephenson* 32119.

This specimen consists of only four sporocarps and was referred to this species on the basis of the occasional expansions in the internal net of the capillitium.

***Stemonaria fuscoides** var. **longipes** Y. Yamam. & Nann.-Bremek.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015. [NAM-15-13], ground litter (pH 3.32), *SL. Stephenson* 31588.

This is a rare species reported previously from only a few localities in Europe (France, Germany and Austria) and Japan in temperate regions of the world and one locality in the tropics of South America (Brazil), reported recently by Damasceno et al. (2009). The record reported herein apparently represents the first for Africa. The sporocarps are in tufts on a common hypothallus, with long, opaque stalks, reaching over half the total height of the sporocarp. The pale brown capillitium, forming a three-dimensional internal net but not forming a peripheral net and the spiny-reticulate spores, 8.5–9.5 μm diam., are the main characters of this variety.

Stemonitis herbatica Peck.

Namibia. **2314 (Erongo)**: Gobabeb Research and Training Centre, road D1983, 30 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BD), 7 Mar 2015 [NAM-15-06], twigs (pH 4.74), *SL. Stephenson* 31653.

***Stemonitopsis gracilis** (G. Lister) Nann.-Bremek.

Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015. [NAM-15-19], *Euclea pseudebenus* bark (pH 7.52), *D. Wrigley de Basanta* 3798.

This species has a short fibrous stalk and a brown sporotheca with a dense internal net. Known from Europe and the USA but unknown until now from Africa. Some records from Cameroon, DR Congo and Nigeria appear to be unpublished records or "human observations" (*Stemonitopsis gracilis* (Wingate ex G.Lister) Nann.-Bremek. in GBIF Secretariat (2017). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2019-05-08.

4. Discussion

Among the 298 identifiable specimens collected as part of this survey there were 43 different species from 14 genera, representative of the five orders recognized for the Myxomycetes. All of these are new records for Namibia and 8 of them have not been recorded previously from Africa (Ndiritu et al., 2009). Of particular interest is the abundance of one species, *Physarum atacamense,* recently described from the Atacama Desert in northern Chile. The Chilean desert is at a comparable latitude with the Namib Desert, and is a Western desert, bathed also by a cold current that causes abundant coastal fog. However the variety of different substrates used by this microorganism is even greater in Namibia than in Chile or Peru (Lado et al., 2016) and many of the collections are also very large. Another species, *Licea eremophila,* described from arid areas of Argentina and Chile on species of cacti, has also appeared in bark cultures prepared in the present study. These are among the 10 species that have never before been recorded in any African country in spite of more than 50 published studies in the region (Ndiritu et al., 2009). The abundant collections of *Arcyria cinerea* were surprising, with some collections having long stipes and sometimes fused sporocarps reminiscent of the variety *digitata*. This common species has been widely recorded in other African countries (Ndiritu et al., 2009). On the other hand, a species (*Badhamia melanospora)* truly abundant in American deserts was very rare here. This species uses cacti predominantly as a substrate, and many appearances outside the American continent have been related to dispersal patterns of the host plants, often by human introduction (Aguilar et al., 2014). The absence of cacti, as host plants in the area of Namibia surveyed, could be a reason. Three species, one each from the genera *Collaria*, *Didymium*, and *Physarum* have been listed only to the level of genus as they are different from any species in the literature. They may represent new species but the amount of material collected is not enough to describe them here.

The species to genus ratio (S/G) can be used to compare the relative diversity of this with other areas. A lower ratio implies a more diverse assemblage. In this study of the Namib desert the S/G ratio was 3.1 indicating a taxonomic diversity comparable to the Peruvian coastal desert

Table 1
Community similarity values among the myxobiota of some arid areas using the coefficient of community index (CC). Note: CC bottom left, number of species in common top right.

	Namibia	Coastal Peru	Monte desert	Tehuacan	Colorado
Namibia (present study)	***	27	20	23	19
Coastal Desert Peru (Lado et al., 2016)	0.44	***	35	43	31
Monte Desert Argentina (Lado et al., 2011)	0.35	0.46	***	41	29
Tehuacan-Cuicatlan Desert Mexico (Estrada-Torres et al., 2009)	0.31	0.46	0.46	***	44
Colorado Plateau USA (Novozhilov et al., 2003)	0.28	0.36	0.35	0.45	***

(S/G 3.4; Lado et al., 2016) or the Monte desert in Argentina (S/G 3.27; Lado et al., 2011), although the Tehuacan desert in Mexico (S/G 3.9; Estrada-Torres et al., 2009), was slightly less diverse. All these values also fall within the range of taxonomic diversity in tropical and temperate forests (Stephenson et al., 1993) indicating a previously unsuspected richness of these microorganisms in deserts. It is interesting to note, as previously appreciated in the surveys of South American deserts (Lado et al., 2007, 2013, 2016), that myxomycetes appear to form a normal integral and important part of desert microbiota.

To compare the number of species of myxomycetes from Namibia with those of other studies carried out in arid areas, the Sørensen coefficient of community index (CC) was used (Table 1). The highest number of species shared in common with those found in Namibia was for the coastal desert of Peru study, and, of those compared in Table 1, the assemblage of these communities was the most similar (0.44). This is consistent with the fact that the deserts are on the west coast of southern Africa and South America respectively. Both are also areas where coastal fog from cold sea currents augments the minimal moisture of the desert as mentioned above. However, more than 50% of the species found were different. From the data presented in Table 1, the communities most similar to each other were the Monte Desert in Argentina, the Peru coastal desert and the Tehuacan-Cuicatlan Desert in Mexico. Most different from all other areas was the Colorado Plateau, although the latter did have a large number (44) of common species and a community similarity of 0.45 with the Mexican desert. The myxomycete community similarity shown in the results in Table 1 appear to fall into a geographically logical distribution pattern. In comparing community assemblages among studies, the uniformity of sampling method has also to be taken into account. All the studies included in Table 1 had both a field and a moist chamber culture component. All were done in arid or extremely arid areas and, with the exception of Colorado, all the studies were done by the same team, using the same methodology. It is worth noting that in another survey by our team in the South of Madagascar (Wrigley de Basanta et al., 2013), 17 of the species found in Namibia were also found in the dry forests there. The whole survey was not used for Table 1 as it included other non-arid areas in the same survey. However, the time spent on the surveys was different for each, and the Colorado study included decaying wood and other substrates not present in the other four study areas.

All these results seem to confirm that there are some myxomycetes so well adapted to the macro- and micro-environments characteristic of deserts that they are common to most arid areas studied. These include species that also are very common in many other areas, including examples such as *Arcyria cinerea*, but others such as *Echinostelium arboreum* and *Licea succulenticola* common in these environments are not so common elsewhere. The species that have been reported from all the study areas included in Table 1, apart from *A. cinerea,* are *Badhamia melanospora, Comatricha laxa, Didymium anellus, D. dubium, Echinostelium arboreum, E. colliculosum, E. minutum, Perichaena depressa, P. quadrata, P. vermicularis, Physarum bitectum and Physarum pusillum.* Other species appear in some but not other arid areas, and 50% of all the species recovered in these five studies have been found in only one of the areas studied. This could indicate plant or plant group specialization, as is perhaps the case with *Badhamia melanospora*, as stated above, and may be an indication of a close association of the myxomycetes with certain plants. Certainly long-range dispersal could account for some of the similarities between the assemblages of myxomycetes in the desert areas studied, especially the common species, but the fact that more than half the species found in each area with similar macro-environmental characteristics, are different from each other, is more consistent with some form of plant host specificity. Some species may only be able to develop on certain plants and not others, since the plants they were found on in each area were different. In a paper on nivicolous (snowbank) myxomycetes (Ronikier and Lado, 2015) the authors also found different assemblages of myxomycetes with a disjunct distribution in the northern and southern hemispheres. In looking at biogeographical patterns in the Americas, Estrada-Torres et al. (2013) also found some myxomycetes restricted to certain areas and that the geographical patterns so far elucidated for these microorganisms are inconsistent with their previously assumed cosmopolitan distribution.

Further work is necessary to understand the precise mechanisms involved in their distribution patterns, but the study of myxomycetes in the Namib Desert confirms that even in such a dry and ancient desert, with only a few centimeters of rain a year, there are a large number and variety of these free-living protists forming an integral part of this desert ecosystem.

Acknowledgments

The research reported herein was supported by a grant from the National Geographic Society grant number 9379-13 to S.L. Stephenson. The research permit was issued by the Ministry of Environment and Tourism of the Government of the Republic of Namibia; research permit number 1988/2014. The Myxotropic project (CGL2014-52584P), funded by the Spanish government (CSIC), provided technical support for laboratory work. We are grateful to Gillian Maggs-Kölling and her team at the Gobabeb Research and Training centre (www.gobabebtrc.org) for their help on the ground in Namibia, and to Carlos de Mier (RJB) for his help with the graphics.

Appendix A. Appendix

List of collecting localities (see Fig. 1).

NAM-15-01: Namibia. **2315 (Erongo)**: Kuiseb pass, near Kuiseb river, in desert vegetation with *Euphorbia virosa* (-BD), 5 Mar 2015, 23°18′06″S 15°45′30″E, 800 m.

NAM-15-02: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015, 23°33′48″S 15°02′21″E, 389 m.

NAM-15-03: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, dunes, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015, 23°33′52″S 15°02′12″E, 407 m.

NAM-15-04: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora persica* (-CA), 6 Mar 2015, 23°33′47″S 15°02′34″E, 390 m.

NAM-15-05: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Salvadora pérsica* (-CA), 6 Mar 2015, 23°34′04″S 15°02′43″E, 400 m.

NAM-15-06: Namibia. **2314 (Erongo)**: Gobabeb Research and Training Centre, road D1983, 30 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BD), 7 Mar 2015, 23°21′17″S 14°53′24″E, 290 m.

NAM-15-07: Namibia. **2314 (Erongo)**: Gobabeb Research and Training Centre,road D1983, 58 km northwest of Gobabeb, Kuiseb river, riparian trees with *Acacia erioloba, Faidherbia albida* and *Argemone ochroleuca* (-BA), 7 Mar 2015, 23°12′14″S 14°42′28″E, 152 m.

NAM-15-08: Namibia. **2214 (Erongo)**: Walvis Bay, road C-14, 19 km east of Walvis Bay, cross to Duna 7, desert vegetation with *Zygophyllum stapfii* (-DC), 7 Mar 2015, 22°59′10″S 14°36′40″E, 48 m.

NAM-15-09: Namibia. **2314 (Erongo)**: Walvis Bay, road C-14, 27 km east of Walvis Bay, desert vegetation (-BA), 7 Mar 2015, 23°00′11″S 14°41′04″E, 125 m.

NAM-15-10: Namibia. **2314 (Erongo)**: Walvis Bay, road C-14, 42 km east of Walvis Bay, desert vegetation with *Zygophyllum stapfii* (-BB), 7 Mar 2015, 23°01′28″S 14°49′31″E, 304 m.

NAM-15-11: **2315 (Erongo)**: Walvis Bay, road C-14, 60 km east of Walvis Bay, Vogelfederberg, desert vegetation with *Zygophyllum stapfii* (-AA), 7 Mar 2015, 23°03′04″S 15°00′04″E, 497 m.

NAM-15-12: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, road D-2186, 18 km north of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-AC), 7 Mar 2015, 23°24′22″S 15°02′26″E, 452 m.

NAM-15-13: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 26 km east of Gobabeb, 13 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 8 Mar 2015, 23°34′ 30″S 15°15′33″E, 572 m.

NAM-15-14: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 40 km east of Gobabeb, desert vegetation with *Zygophyllum stapfii* (-CB), 8 Mar 2015, 23°32′04″S 15°23′30″E, 735 m.

NAM-15-15: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 43 km east of Gobabeb and 12 km West of Zebra Pan, desert vegetation with *Blepharis grossa* (-CB), 8 Mar 2015, 23°32′02″S 15°24′ 16″E, 729 m.

NAM-15-16: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 58 km east of Gobabeb and 4 km North of Zebra Pan, *Acacia* trees (-AD), 8 Mar 2015, 23°28′49″S 15°29′55″E, 792 m.

NAM-15-17: **2315 (Erongo)**: Gobabeb Research and Training Centre, 65 km east of Gobabeb and 9 km North of Zebra Pan, desert vegetation with *Blepharis grossa* (-BC), 8 Mar 2015, 23°26′42″S 15°31′03″E, 834 m.

NAM-15-18: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 37 km east of Gobabeb, Mirabib, desert vegetation (-AD), 8 Mar 2015, 23°27′44″S 15°22′13″E, 750 m.

NAM-15-19: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 13 km Southeast of Gobabeb, Homeb, *Acacia* trees (-CA), 9 Mar 2015, 23°38′02″S 15°10′33″E, 431 m.

NAM-15-20: Namibia. **2315 (Erongo)**: Gobabeb Research and Training Centre, 29 km east of Gobabeb, 16 km after Homeb turn, Hope Mine, desert vegetation with *Welwitschia mirabilis* (-CB), 9 Mar 2015, 23°34′ 02″S 15°16′54″E, 594 m.

NAM-15-21: Namibia. **2315 (Erongo)**: 129 km East of Walvis Bay, and 19 km North of junction C-14 to Solitaire and C-26 to Windhoek, Kuiseb pass, desert vegetation with *Euphorbia virosa* and *Commiphora* sp. (-BC), 10 Mar 2015, 23°18′40″S 15°44′29″E, 857 m.

NAM-15-22: Namibia. **2316 (Khomas)**: road C-26 Gamsberg Pass, 55 km East of junction with C-14 and 14 km West of Gamsberg Pass, desert vegetation with *Myrothamnus flabellifolium* (-AD), 10 Mar 2015, 23°15′01″S 16°16′49″E, 1360 m.

NAM-15-23: Namibia. **2217 (Khomas)**: road C-23 to Dordabis, 4 km South of junction with B-6, savana vegetation (-CB), 11 Mar 2015, 22°34′12″S 17°21′04″E, 1868 m.

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