

## The Vegetation of the Western Australian Deserts

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### Abstract

The internal area of W. Australia has arid climate and conditions for plant growth are particularly difficult. The surface of this huge, almost uninhabited territory consists of four landscape systems: the Great Sandy Desert, the Little Sandy Desert, the Great Victoria Desert, the Gibson Desert. The four deserts extend between 21-26° of southern latitude, linking to the central Australian deserts and the Nullarbor Plain in the South. Meteorological stations are only in settlements of the surrounding semi-desert areas (Wiluna, Meekatharra, Cue, Warburton), and all show around 200-250 mm yearly rainfall; in the centre of the deserts rainfall is still much lower, and indicated as “erratic and unreliable”; some areas may lack rain for several years. Despite of the particularly severe ecological conditions, most of the surface is covered by vegetation (at least a discontinuous one) and during expeditions in 2001 and 2002 over 700 species were collected and more than 350 phytosociological relevés were carried out. Two main habitat types can be recognized:

Mulga – scattered growth of treelets (*Acacia aneura*, generally about 3-4 m height), with open understorey (*Senna*, *Eremophila*, *Solanum*) and herbs usually covering less than 20 % of the surface; in the Gibson Desert mulga occurs mainly on hard rock substrate (granite, laterite). Because of the discontinuous plant cover, fire can spread only over limited areas.

Spinifex – Quite a compact cover of perennial grasses (several species of *Triodia*, with sharply pointed leaves in dense tussocks 3-5 dm high, panicles up to 1 m and higher) in monospecific populations covering 60-80 % of the surface; in the sandy deserts, on siliceous sand. In *Triodia*, leaves are dry for most of the year and fire can spread over vast surfaces. After fire different vegetation with annuals or short living perennials appears: Chloanthaceae (*Dicrastylis*), Goodeniaceae, *Aristida*, *Eragrostis*, *Ptilotus*, *Corchorus*, *Tribulus*, *Cleome* etc.

In depressions (claypans) halophytic vegetation with succulents, mostly chenopods, occurs. Sources with fresh water are extremely rare but, in general, with a rich vegetation of annual Cyperaceae, Juncaceae and other herbs (*Ammania*, *Marsilea*, *Trianthema* etc.). The dominating tree species there is *Eucalyptus camaldulensis*.

### 1. Introduction

Australia is an arid continent, and in the central part is almost completely occupied by deserts. Indeed, these are particular deserts, where the surface is almost covered by vegetation. In Western Australia, in the arid subtropical belt, 4 geographical units with character of deserts are included in the area between 21° - 26°30' latitude S and 121° - 125°30' longitude W:

Little Sandy Desert  
Great Victoria Desert

Great Sandy Desert  
Gibson Desert

During millennia Aboriginals found sufficient resources for survival in this hostile environment moving from one to another source of water (rock hole, gnamma, well); later this life style was abandoned (PEASLEY 1983), and presently there are no inhabited oases or other type of settlements, and not a single human person is permanently living in the deserts. We had the possibility to cross the deserts following the main trucks (Canning Stock Route, Gary, Gunbarrel, Talawana) during the winter period (August 2001 and June-July 2002) under the guide of Dr. W. Peasley, and study the vegetation in cross-country excursions across open vegetation.

During the two visits in the desert, more than 1500 herbarium specimens were collected, and 350 relevés were carried out, as well as some microclimatic measures to understand the natural conditions of plant growth; all prospectations are geo-referenced with the GPS coordinates. The herbarium materials are conserved in the Botanical Garden of the Palermo University. The first results of these explorations will be summarised here.

## 2. General notes on the environment

The climate of the subtropical deserts is incompletely known, because of the fact that meteorological stations (Meekatharra, Wiluna, Cue, Warburton) are in pastoral or mining areas with sparse settlements, surrounding the true desert. Under these conditions, there are long term yearly averages of ca. 22° C and 200-250 mm rainfall, but it seems likely that in the desert more severe conditions occur, and in particular lower rainfall. In winter the weather is permanently clear, and we never recorded rain; temperatures at noon are of 30-35° C, whereas the night is cold (0-12° C, frequently also with frost, up to -3°). There is not a humid season, and rain is scattered along the year and mostly unpredictable: it is described as “erratic” by BEARD (1990).

The substrate is extremely monotonous. The Sandy Deserts and the Victoria Desert consist of quartzite sand, forming the quaternary sandplain with longitudinal dunes, whereas the Gibson Desert is a laterite landscape on Mesozoic sandstone; some Proterozoic siliceous rocks locally occur.

The flora of the deserts in the whole continent is described in JESSOP (1981). This is an accurate work, with a large information; nevertheless, the publication of many volumes of the Flora of Australia during the last decades demonstrates that the floristic stock in the deserts is still much richer than indicated by JESSOP. Difficulty for identification of several species remains. For the vegetation of the Western Australian Deserts the main source is in J.S. Beard’s data from the Vegetation Survey of Western Australia, summarised in BEARD (1990, pag. 223-259), with a synthetic description of the most widespread formations. A study of wetland vegetation is published in PIGNATTI & PIGNATTI (2005), some data on vegetation on laterite in pre-desert area near Paynes Find in PIGNATTI & PIGNATTI (1997).

The desert vegetation in Western Australia consists of two large environmental units, which are individuated by their plant cover: Mulga and Spinifex (WALTER & BRECKLE 1984). These can be considered as the climax vegetation of the desert countries in Western Australia.

Mulga is an aboriginal word for the *Acacia aneura* open community, covering with woody vegetation most of the hard substrates: laterite, mainly in the Gibson Desert.

Spinifex is the name given by explorers and prospectors to the vegetation of pungent grasses belonging to the genus *Triodia* (Poaceae) and widespread on sandy sub-

strate in the deserts. *Triodia* has not to be confused with the genus *Spinifex* (also of the Poaceae), occurring with two species in coastal habitats of the eastern Indian Ocean, but never in mainland or in deserts.

In addition, in the deserts there are other habitats: wet habitats on the one extreme, and saline habitats on the other. The vegetation of these habitats will not be discussed here.

### 3. Vegetation on rocky habitats

*Acacia aneura* is a small tree (2-4 m, rarely more) or erect shrub, mainly diffused throughout the desert portion of the Australian continent. It occurs in deserts, mainly on hard substrates, indicated as laterite, duricrust, red earth etc. The mulga community is in general open, with 4 vegetation layers (lower trees, higher shrubs, lower shrubs, herbs) each of them covering only a part of the surface, alternating with extended gaps, almost without any plant cover. In general the aspect of discontinuous woodland is prevailing, and only rarely Mulga can resemble a savanna, with umbellate treelets emerging over a more or less continuous grass layer. For this reason mulga vegetation is considered in literature under several distinct names, as scrub, shrubland, shrub steppe, open woodland, mulga parkland.

The upper layer of the vegetation mostly consists only of *Acacia aneura*, sometimes associated with other erect *Acacia* (e.g. *A. tetragonophylla*) etc.; in the upper shrub layer there are species of *Senna* (= *Cassia*), *Grevillea* and *Hakea*, whereas the lower shrub layer is mostly composed by *Eremophila* (Myoporaceae, some dozens of species, some of them incompletely identified). In the herb layer some Poaceae (*Eragrostis*, *Enneapogon*, *Aristida*) occur, together with dwarf shrubs: *Solanum*, *Corchorus*, *Sida*, *Ptilotus* etc. The vegetation is composed of 10-15 and sometimes over 20 species, but these totals can be reached only if the study area is enlarged to 500-1000 m<sup>2</sup>. Flowering is not bound to a special season, and in winter many of the species are not in flower. The *Acacia aneura* vegetation is first described with phytosociological records in PIGNATTI & PIGNATTI (1997), as the type community of a particular vegetation class Acacietea aneurae, endemic in Australia.

Because of the stony substrate, the mulga vegetation is widespread in the areas where the scarce water resources of the desert occur: rock holes, giving in 3-5 m depth some gallons of water supply, a precious reserve when the desert was occasionally inhabited by nomads. Under rocks it is possible to observe the places of ancient Aboriginal camps with fascinating examples of rock art, and in the vicinity, very rare populations of *Nicotiana* sp. pl., the only synanthropic species in the desert.

### 4. Vegetation on sand: two still undescribed vegetation classes

The first explorers of the Australian deserts describe the difficulty in crossing the Spinifex country, e.g. CARNEGIE (1898) in his epic expedition during the year 1896. DIELS (1906), on the contrary, did not have the occasion to cross the desert and Spinifex is not mentioned in his book. Spinifex is the Australian designation for grasses of the genus *Triodia*, with tussock growth and needle pointed convolute leaves, which compose the natural plant cover of sandy deserts. The substrate is in most cases red quartzite sand, extremely dry and incoherent. The Spinifex vegetation forms a compact layer, covering almost completely the surface and extending over a huge extension (in W.Australia some hundred thousands of square km). The Spinifex layer occupies

the space where in general a herb layer would be expected, but it is difficult to consider such unpalatable spiny plants as “herbs” in a true sense. The complete set of the present species is reached in 100 m<sup>2</sup>, and the total number of species remains very low (5-10): in general only 1 species of *Triodia* is dominant, whereas others occur more or less accidentally and with low frequency. These grasses are the main component of the plant cover of the desert sandplain.

It seems possible to recognize in the Spinifex vegetation complex a cyclic succession driven by fire. In the sandy desert fire occurs frequently, as a natural event, or provoked by man: in former times firestick farming was practiced by Aborigines for increasing food supply and hunting purpose. Under favourable wind conditions, fire can propagate very rapidly and burn the plant cover on large extensions (to many km<sup>2</sup>) glowing for weeks. This occurs because Spinifex in general has a more or less continuous cover of the sandplain, and only major dunes, sometimes, have the effect of a barrier to the spreading fire; in the mulga ecosystem, on the contrary, the woody layer is discontinuous and fire cannot expand. During the complete combustion of the aerial plant material most plants die and the *Triodia* community disappears. After occasional rain, a completely new flora composed of pyrophytic species germinate, among which *Dicrastylis exsuccosa* and other Chloanthaceae, Amaranthaceae, Goodeniaceae, Asteraceae, occur. This vegetation remains for several years, then the caryopses of grasses enter progressively in germination and seedlings of *Triodia* appear, leading to the concluding phase of the cyclic succession with re-colonisation and a new expansion of Spinifex species. In conclusion, on the same surface, the communities of two different vegetation classes alternate: *Triodia* grass layer and pyrophytic *Dicrastylis* vegetation. A synthetical description follows:

(1) class “Triodietea”, communities of spinescent grasses endemic in the Australian sandy deserts – *Triodia* is the largest genus of the tribe *Triodiinae*, which is characterized by 3-lobed lemmas and is considered endemic to Australia. In the recent revision by LAZARIDES (1997) there are 64 species of *Triodia*, most of them, with the peculiar spinescent growth form, are the dominant element of Spinifex communities. In W.Australia, the *Triodia basedowii* community (Tab. 1) is the typical component of the Spinifex vegetation; other communities with dominance of *T. helmsii*, *T. irritans*, *T. melvillei*, *T. pungens*, *T. schinzii* are widespread. Other grasses occur on sandy substrate, mainly *Aristida* species and *Amphipogon caricinus*.

(2) class “Ptiloto-Dicrastyletea”, including post-fire (pyrophytic) herbaceous vegetation, endemic in the Australian sandy deserts – The communities following fire in the sandy desert consist of herbaceous species or low shrubs with short life cycle: relevés with over 20 species on 100 m<sup>2</sup> are frequent and, as a gross total, we listed more than 100 species occurring in the post-fire vegetation. As a typical example, the floristic composition of the *Dicrastylis exsuccosa* community is given in Tab. 2. It is a peculiar flora mainly composed of Dicotyledons, whereas Spinifex elements are lacking. This vegetation stands out among the desert plant life for its elevate biodiversity and the complete adaptation to the desert environment; endemic species, limited to the central zone of the Australian continent, are frequent, whereas weeds of Mediterranean or S. African origin are completely lacking. The most significant components are:

*Ptilotus* (Amaranthaceae) – we observed at least 16 species, but probably more would be detected with a larger investigation; the genus includes ca. 100 species of plants well adapted to life on the unstable environment of the sandy desert, all endemic to Australia.

Tab. 1: *Triodia basedowii* community

All relevés in 380–470 m elevation, latitude South and longitude E – Locations: 1, Everard Junction 25.10.34 / 24.39.45, 21.Jun.2002; 2, unnamed loc. 23.56.44 / 125.14.37, 23.Jun.2002; 3, Charles Knob 25.03.08 / 124.58.27, 28.Jun.2002; 4–5, Talawana-Jigalong Junction 22.50.29 / 121.10.55, 28.Aug.2001; 6, unnamed loc. 25.21.40 / 120.59.58, 20.Aug.2001; 7, unnamed loc. 24.36.27 / 121.52.22, 21.Aug.2001; 8, Well 9, 24.52.51 / 121.37.59, 22.Aug.2001; 9, near Yawl Yawl Bore 24.28.08 / 124.30.16, 13.Jun.2002; 10, near Yawl Yawl Bore 24.28.16 / 124.29.39, 13.Jun.2002. – Typus rel.: num. 1 – Substrate: EL – Earthy Loam; L – Laterite; RS – Red Sand.

| Num. of relevés                           | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | Frequency % |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------------|
| Shrub layer cover %                       |     |     |     | 10  | 15  | 15  | 10  | 10  |     |     |             |
| Spinifex cover %                          | 85  | 95  | 60  | 80  | 75  | 90  | 70  | 80  | 80  | 70  |             |
| Herb layer cover %                        |     |     |     | <1  | <1  | <1  | -   | <1  |     |     |             |
| Surface of rel. m <sup>2</sup>            | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |             |
| Species num.                              | 6   | 7   | 4   | 6   | 6   | 5   | 5   | 7   | 6   | 6   |             |
| Substrate                                 | EL  | L   | L   | RS  | RS  | L   | L   | RS  | RS  | RS  |             |
| <b>Shrub layer (B)</b>                    |     |     |     |     |     |     |     |     |     |     |             |
| <i>Acacia aneura</i>                      |     | +   |     |     |     | 1.1 |     | 1.1 |     |     | 30          |
| <i>Eremophila latrobei</i>                |     |     |     |     |     | +   | 1.1 | +   |     |     | 30          |
| <i>Eremophila miniata</i>                 |     |     |     |     |     | 1.1 | +   | 1.1 |     |     | 30          |
| <i>Acacia pyrifolia</i>                   |     |     |     | 1.1 | +   |     |     |     |     |     | 20          |
| <i>Acacia synchronicia</i>                |     |     |     | +   | 1.1 |     |     |     |     |     | 20          |
| <i>Grevillea eriostachya</i>              |     |     |     |     |     |     |     |     | 1.1 | 1.1 | 20          |
| <i>Senna sturtii</i>                      |     | +   | +   |     |     |     |     |     |     |     | 20          |
| <i>Sida</i> cfr. <i>cryphiopetala</i>     | +   |     |     | +   |     |     |     |     |     |     | 20          |
| <i>Acacia maitlandii</i>                  | +   |     |     |     |     |     |     |     |     |     | 10          |
| <i>Acacia grasbyi</i>                     |     |     |     |     |     |     | 1.1 |     |     |     | 10          |
| <i>Acacia pruinocarpa</i>                 |     |     |     |     |     |     |     |     | (+) |     | 10          |
| <i>Acacia pachyacra</i>                   |     |     |     |     | +   |     |     |     |     |     | 10          |
| <i>Grevillea</i> cfr. <i>juncifolia</i>   |     |     |     |     | 1.1 |     |     |     |     |     | 10          |
| <i>Grevillea pterosperma</i>              |     | +   |     |     |     |     |     |     |     |     | 10          |
| <i>Hakea suberea</i>                      |     | +   |     |     |     |     |     |     |     |     | 10          |
| <i>Ptilotus obovatus</i>                  |     |     |     |     |     |     |     | +   |     |     | 10          |
| <b>Spinifex elements (C1)</b>             |     |     |     |     |     |     |     |     |     |     |             |
| <i>Triodia basedowii</i>                  | 5.5 | 5.5 | 4.4 | 5.5 | 4.5 | 5.5 | 4.5 | 4.5 | 4.5 | 3.5 | 100         |
| <i>Triodia melvillei</i>                  |     | 1.2 | 1.2 |     |     |     |     |     |     | 1.2 | 30          |
| <i>Aristida obscura</i>                   |     |     |     |     |     |     | 1.2 |     |     |     | 10          |
| <i>Amphipogon caricinus</i>               | +2  |     |     |     |     |     |     |     |     |     | 10          |
| <i>Eragrostis eriopoda</i>                |     | +2  |     |     |     |     |     |     |     |     | 10          |
| <i>Enneapogon oblongus</i>                |     |     |     |     |     | +2  |     |     |     |     | 10          |
| <i>Aristida browniana</i>                 | +   |     |     |     |     |     |     |     |     |     | 10          |
| <i>Aristida contorta</i>                  |     |     |     |     |     |     |     | 1.2 |     |     | 10          |
| <b>Herb layer (C2)</b>                    |     |     |     |     |     |     |     |     |     |     |             |
| <i>Solanum</i> sp.                        |     | +   | .   |     |     |     |     |     | +   |     | 30          |
| <i>Eremophila latrobei</i>                |     |     |     |     |     |     |     | 1.1 | +   |     | 20          |
| <i>Dicrastylis exsuccosa</i>              |     |     |     |     |     |     |     |     |     | 1.2 | 10          |
| <i>Disphania plantaginella</i>            | +   |     |     |     |     |     |     |     |     |     | 10          |
| <i>Eremophila</i> cfr. <i>scoparia</i>    | +   |     |     |     |     |     |     |     |     |     | 10          |
| <i>Eriachne aristidea</i>                 |     |     |     | +   |     |     |     |     |     |     | 10          |
| <i>Enneapogon</i> cfr. <i>cylindricus</i> | (+) |     |     |     |     |     |     |     |     |     | 10          |
| <i>Goodenia azurea</i>                    |     |     |     |     |     |     |     | +   |     |     | 10          |
| <i>Ptilotus polystachyus</i>              |     |     |     | +   |     |     |     |     |     |     | 10          |
| <i>Trianthema triquetra</i>               |     |     |     |     | +   |     |     |     |     |     | 10          |
| <i>Waitzia acuminata</i>                  |     |     |     |     |     |     |     |     | (+) |     | 10          |
| <i>Maireana georgei</i>                   |     |     | 1.2 |     |     |     |     |     |     |     | 10          |

Tab. 2: *Dicrasytis exsuccosa* community

All relevés in 380-470 m elevation, latitude South and longitude E – Locations: 1-2, next L. Cohen 24.45.52 / 125.00.11, 22.Jun.02; 3-4, Yawl Yawl Bore, 24.26.41 / 124.29.28, 11.Jun.02; 5, unnamed loc., 24.12.43 / 125.10.40, 23.Jun.02; 6, unnamed loc., 24.21.40 / 125.05.40, 26.Jun.02; 7, near Warri Well, 24.44.45 / 125.00.16, 27.Jun.02; 8, Tyukayria, 26.49.52 / 124.25.01, 16.Jun.02; 9, pr. Mulundella rockhole, 26.40.34 / 124.24.36, 18.Jun.02; 10, pr. Mulundella rockhole, 26.44.23 / 124.22.56, 18.Jun.02; 11, unnamed loc., 26.15.67 / 124.41.19, 18.Jun.02; 12-13-14, unnamed loc., 24.52.21 / 125.06.38, 28.Jun.02 – Typus rel.: num. 8 – Substrate: EL – Earthy Loam; L – Laterite; RS – Red Sand.

|                                    | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10    | 11  | 12  | 13  | 14  | Frequency % |
|------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|-----|-----|-----|-----|-------------|
| Num. of relevés                    | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10    | 11  | 12  | 13  | 14  |             |
| Shrub layer cover %                |     |     | <1  |     |     |     |     | 5   |     |       |     | 20  |     |     |             |
| Spinifex cover %                   | 5   | 20  | 5   | -   | 10  | 3   | -   | 5   | 25  | 30    | 10  | 80  | 75  | 70  |             |
| Herb layer cover %                 | 30  | 50  | 50  | 50  | 80  | 75  | 60  | 65  | 70  | 70    | 40  | 5   | 70  | 30  |             |
| Surface of rel. m <sup>2</sup>     | 100 |     | 100 |     |     | 250 | 500 |     | 500 | 400   | 400 | 200 | 200 | 200 |             |
| Years after fire (estimate)        | 3   | 3   | 10  | 15  | 15  | 5   | 5   | 25  | 10  | 15-20 | 10  | 50  | 50  | 50  |             |
| Species num.                       | 13  | 21  | 18  | 9   | 15  | 23  | 24  | 19  | 16  | 21    | 26  | 15  | 22  | 12  |             |
| Substrate                          | EL  | EL  | RS  | RS  | L   | RS  | RS  | RS  | RS  | RS    | RS  | EL  | EL  | EL  |             |
| <b>Shrub layer (B)</b>             |     |     |     |     |     |     |     |     |     |       |     |     |     |     |             |
| <i>Codonocarpus cotinifolius</i>   |     | +   |     |     | +   |     |     | 1.1 |     | +     | +   |     | +   | +   | 50          |
| <i>Eremophila leucophylla</i>      |     | +   |     |     | +   |     |     |     |     |       | 1.1 | 1.1 | +   | +   | 43          |
| <i>Acacia</i> cf. <i>monticola</i> |     |     |     |     |     | +2  |     |     |     |       |     | 1.2 | 1.2 | (+) | 29          |
| <i>Acacia maitlandii</i>           |     |     | +   |     |     |     |     |     |     |       |     |     |     | +   | 14          |
| <i>Hakea suberea</i>               |     |     |     |     |     | +2  |     | +   |     |       |     | +   |     | +   | 14          |
| <i>Acacia aneura</i>               |     |     |     |     |     |     |     |     |     |       |     |     |     | +   | 14          |
| <i>Acacia pruinocarpa</i>          |     |     |     |     |     |     |     |     |     | +     |     |     |     | +   | 14          |
| <i>Thryptomene maisonnewitii</i>   |     |     |     |     |     |     |     |     |     | +     |     |     |     | +   | 14          |
| <b>Spinifex elements (C1)</b>      |     |     |     |     |     |     |     |     |     |       |     |     |     |     |             |
| <i>Aristida brownnea</i>           | 1.1 | 1.1 |     |     | 1.1 | 1.2 | +   |     | 2.2 | 2.2   | +   | +   | +2  | +2  | 79          |
| <i>Amphipogon caricinus</i>        |     | 1.2 | 1.2 |     |     | +   |     |     |     | 1.2   | +2  | +2  | +2  | +2  | 57          |
| <i>Triodia schinzii</i>            | +   | 1.2 |     |     | 1.2 | +2  | +   | 1.2 |     |       | 1.2 |     |     |     | 50          |
| <i>Triodia basedowii</i>           | 1.1 | 1.1 |     | +   |     | +   |     |     | 1.2 | +     |     | 1.2 | 1.2 |     | 50          |
| <i>Aristida contorta</i>           |     |     |     |     |     |     |     | +   | 1.2 | +     | 1.2 |     | +   |     | 50          |
| <i>Aristida latifolia</i>          |     |     |     |     |     |     |     |     | +   | 1.2   | 1.2 | 4.3 | 3.3 | 4.3 | 21          |
| <i>Triodia melvillei</i>           |     |     |     |     |     |     |     |     |     |       |     |     |     |     | 21          |
| <b>Herb layer (C2)</b>             |     |     |     |     |     |     |     |     |     |       |     |     |     |     |             |
| <i>Dicrasytis exsuccosa</i>        | +   | +   | 1.1 | 1.1 | 4.5 | 3.2 | 3.2 | 2.2 | +   | 1.2   | +   | 1.1 | 2.1 | 1.2 | 100         |
| <i>Eragrostis eriopoda</i>         |     |     | 1.1 |     | 1.2 | +   | +   | 1.1 | 2.3 | +2    | 1.1 | +   | +2  | +2  | 71          |
| <i>Goodenia azurea</i>             | +   | +   | +   | +   |     | +   | 1.1 | 1.1 | +   |       | +   | +   | +   | +   | 71          |



*Dicrastylis*, *Newcastelia*, *Pityrodia* (Chloanthaceae) – numerous species; this is a specialized family closely related to the polymorphic group of Verbenaceae, with a dozen of genera and more than 60 species, in general endemic to Australia and Tasmania (2 genera also in the pacific islands, East Africa and Madagascar).

*Bonamia* (Convolvulaceae) – In the desert, the only representative (with no winding stems) of a large pantropical genus.

*Brunonia* (Brunoniaceae) – A monotypic family (related to Goodeniaceae) with only one species, endemic in Australia.

*Goodeniaceae* – Large family with ca. 500 species, centred on the Australian continent, some of them radiating over the coasts of the Indian Ocean and to Africa and S. America; many species of *Dampiera*, *Goodenia*, *Scaevola*, *Velleia* occur in the vegetation after fire.

*Monotaxis luteiflora* (Euphorbiaceae) – Endemic to Australia and Tasmania (fire opportunist).

*Trachymene glaucifolia* (Apiaceae) – A toxic species, endemic in the desert.

## 5. Surviving strategies of desert plants

Mulga and Spinifex are very particular models of vascular plants: *Acacia aneura* is a small tree or shrub, developing phyllodes (modified stems) instead of true leaves, whereas in *Triodia* sp. pl. leaves are convolute and end in a pungent point. In both cases the modified photosynthetic organ seems to be an adaptation to the principal ecological factor in the desert: drought. The diffusion of Mulga and Spinifex over the arid portion of the continent, demonstrate that these uncommon eco-morphological features have been a successful response to the severe life conditions in this environment. Indeed, such transformations of leaves can occur also in plants not living in deserts (e.g. phyllodes in *Ruscus* and spiny leaves in the thorny cushions of *Astragalus*). In consequence, the question arises, how can such adaptations give to plants an advantage for surviving in the desert. Some responses, at least preliminary ones, are based on a careful microclimatic investigation. Crossing the desert, we had the occasion to camp inmidst of completely natural, undisturbed vegetation, hundreds km distant from any human settlement and far away from the normal itineraries. There we had the opportunity to take measures of light irradiation (Photosynthetic Active Radiation = PAR), Temperature (T) and Humidity (H) in the natural environment and on plants.

The normal conditions of a winter day in ca 21° latitude S can be shortly described. At dawn (ca. at 6 a.m.) T is at minimum, near to 0°C and H at maximum: 30-35 %, sometimes more, up to 60 %. Sun radiation increases very rapidly, whereas T and H change slowly: at 8 a.m. we measure PAR 300 (near to the daily maximum), T increases to 12° and H drops to 20-25 %. At noon we have the maximum of PAR (300-380) and T (30-35°) and the minimum of H (10-12 %). In the afternoon, PAR is declining with the declining of Sun, and the same happens with T, but with a certain delay: at sunset (ca. 6 p.m.) PAR drops to 0, T is at 15°. Variations of H are very slow and at sunset values can remain under 15 %. During the night there are further increase of H and decrease of T, until pre-dawn values are reached. The behaviour of Mulga and Spinifex has to be interpreted in this frame. In the night, photosynthesis is obviously impossible, and the whole metabolic activity is reduced to the minimum because of the low temperatures. During the hot period of the day, humidity is extremely low and plants are exposed to strong water stress. It can be supposed that under such conditions plants

react closing the stomata and strongly limiting gas exchanges with the atmosphere: photosynthesis is suspended or reduced to a minimum, and this condition lasts until sundown. In consequence, environmental conditions are completely negative for assimilation during most of the day and the whole night.

*Acacia aneura* and *Triodia basedowii* have distinct eco-morphological adaptations, and correspondingly, problems appear in both cases quite different.

Mulga is a woody plant with a big root system, deeply penetrating in the laterite substrate; we were never able to excavate a complete root of *Acacia aneura*. Probably the root system has access to some deep water vein. At dawn, in all occasions we observed that during a short time just after sunrise, the temperature of the phyllode (= leaf) surface is rapidly increasing and remains for a time span of 1-1 1/2 hours markedly higher than the T in air. The difference can reach +2° to +4° C. When the air T increases, ca. at 8 a.m., the difference is progressively annulated. From these measures we understand that in the period immediately after sunrise, the phyllodes (i. e. the photosynthetic organs) during a short time have a rapidly increasing T, whereas H remains relatively elevate, and plenty of PAR is available. Our hypothesis is that *Acacia aneura* may have an advantage in performing photosynthesis under favourable environmental conditions during the first time after sunrise.

In *Triodia basedowii*, roots develop mainly near the surface; in this case the access to water in the deep substrate is very difficult. As to microclimatic conditions, during the first hour after sunrise, T measured at the leaf surface is lower than in the surrounding atmosphere. The difference in this case can reach -1° to -2.5° C. These values are important, because air T is often near to 0, and in this case leaves may have negative values. In addition, H is higher than in the Mulga community: e. g., at dawn of the 22.06.2002 we measured at 7.30 a. m. (1 1/4 after sunrise) leaf surface T from -0.4° to -1.2° and air H increasing from 43 % to a maximum of 72 %. This condition lasts for one hour or little more: between 7.30 and 8 a. m. differences in T become progressively smaller, although leaf T remains lower than air T during the whole day. Such conditions can offer a possible advantage for *Spinifex* because the possibility that T reaches the dew point and the leaf can act as the surface for condensation of air humidity. From leaves, water would drop along the culms to the plant basis and to the roots.

The general conclusion is a work hypothesis: that the survival of plants in the desert depends on this “temporal window”, immediately after sunrise, when Mulga can profit of the adaptations of photosynthetic organs to catch the thermal radiation and accelerate photosynthesis, and *Spinifex* can earn some water as a form of “occult rain”. The temporal window is not repeated at sunset, because of the low atmospheric humidity: stomata remain close and water condensation would occur only with much deeper temperatures. The short period in the morning with a combination of favourable ecological factors is not surprising, because animal life too is particularly active during this short time, before the atmosphere becomes too hot and dry and most vital activities in the desert must be suspended. Data are evidently not definitive and the possibility exists, that a more detailed investigation reveals other patterns. It is possible that the differences may be the effect of casual variations or instrumental errors. Indeed, reasoning with our human logic, the time after sunrise is the only moment with favourable conditions for metabolic activity: intense photosynthetic radiation, sufficient warmth and not too low humidity. And the evidences seem to support this hypothesis. In any case, the real existence of this window remains still to be demonstrated with direct investigations on the metabolic activity.

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