II Physical Environment

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Climate

Few climatic data are available for the Study Area with only Yuinmery and Cashmere Downs recording daily rainfall over a sufficient period for calculating meaningful averages (Figure 2). The climate of the Study Area is arid and was described by UNESCO-FAO (1963) as Desert using the system of Bagnouls and Gaussen (1957). Hot, dry summers alternate with cool winters and rain occurs in both. In the Köppen classification the climate is very dry and hot with the possibility of precipitation in any month. According to the Thornthwaite System, which is preferable to the Köppen system for Australian conditions (Gentilli, 1948), the climate is arid mesothermal with rainfall deficient in all seasons. Beard (1976) regards the region as desert with summer and winter rainfall, only the extreme southwest corner falling within the semi-desert Mediterranean climatic zone.

Temperature

The average monthly maximum temperatures are indicated on Figure 2. These indicate that January is the hottest month and July the coldest. Average minimum temperatures have a trend similar to the maximum.

Rainfall

The average annual rainfall varies from *ca.* 250 mm in the south-western corner of the Study Area to *ca.* 200 mm in the north-eastern corner (Anon, 1985). Representative averages are Yuinmery 231 mm (88 years), Cashmere Downs 235 mm (66 years) and Sandstone 237 mm (82 years). Average monthly rainfall is indicated on Figure 2. March-August is the wettest 6 month period in the south-western part and December-May the wettest 6 months in the north-east (Anon, 1985). Light falls of rain in winter are generally associated with the passage of cold fronts from the south-west. Summer rains result from thunderstorms or rain-bearing depressions resulting from degenerated tropical cyclones. Occasionally there are heavy winter falls emanating from jetstreams of tropical maritime air. Rainfall is unreliable and sporadic and its role in allowing plant growth differs for the three main types of precipitation occurring in the Study Area. Light winter frontal rains occur every year but are usually effective only for the growth of herbs. Intense summer convective rains are localized, shortlived and largely lost in run-off, benefitting only the vegetation of creek lines. Rainstorms derived from tropical cyclones are often intense, and widespread and effective for the growth of woody plants. These factors are discussed by Milewski (1981). Since tropical cyclone systems affect the Eastern Goldfields as a whole only a few times each year, the effectiveness of the most frequent types of rainfall occurring in the Study Area is very low: heavy falls of 20 mm or more can be expected to occur not more than two or three times per year on average. This leads to large differences between mean and median rainfall, particularly in the late summer months when most rainfall is the episodic, torrential kind.

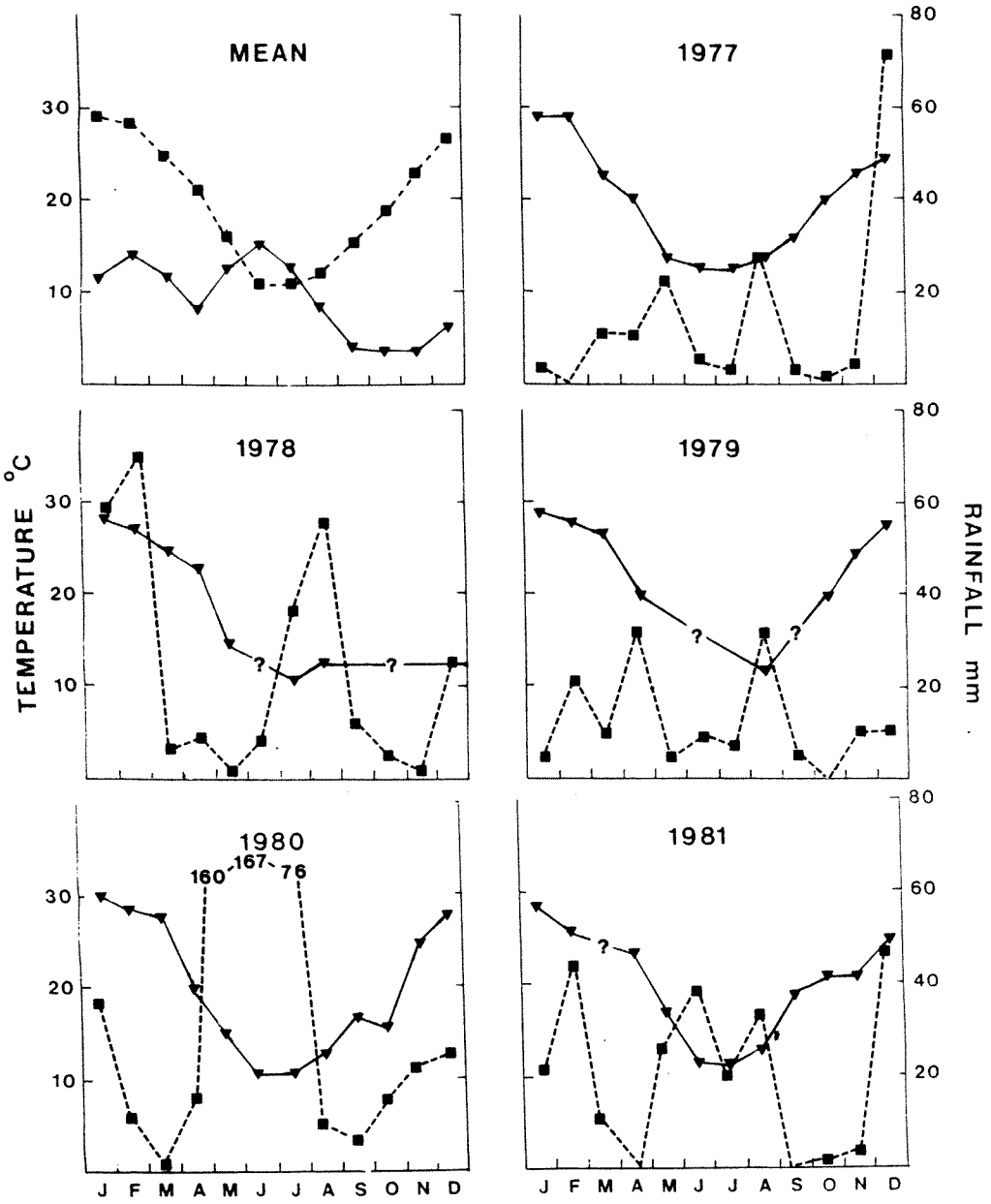

Figure 2 Ombrothermic diagrams showing the mean monthly rainfall and average monthly temperature for the years 1977-1981 and the long-term mean. These figures incorporate data from the Yuinmery (88 years) and Cashmere Downs (66 years) meteorological stations.

Evaporation

Annual evaporation from a free water surface averages 3,000-3,400 mm (Anon, 1985) and is accordingly about 15 times the annual rainfall.

Radiation

The average daily radiation grades from south to north (Anon, 1975); in January it is 830-850 mWh.cm^{-2} and in July 380-410 mWh.cm^{-2}.

Geology and Landforms

The geology of the Study Area is covered by the Youanmi Sheet (Stewart *et al.* 1983) and the western half of the Leonora Sheet (Thom and Barnes, 1977). The Study Area is part of a plain of great age, developed on Archaean rocks, which has not suffered mountain building or glaciation for the last 30 million years. Eroded into the plain are portions of two ancient, shallow river valleys. The topography is generally subdued with a maximum relief of less than 200 m. The Study Area is relatively uniform with an undulating relief of 6-30 m, while a depositional plain of relief less than 15 m is formed by salt lakes which cover several thousand hectares (Campbell *et al.* 1975). The Study Area lies in the salt lakes or Salinaland physiographic division as defined by Jutson (1950).

Gneisses and other granitic rocks of the Yilgarn Block are the main bedrock type over most of the Study Area. These are interrupted in the eastern part by narrow tracts, aligned north-northwest, of layered succession (a complex series of metasedimentary and meta-igneous rocks including metabasalt and banded ironstone). In the west of the Study Area these "greenstones" are confined to an area at Youanmi, an area south of Sandstone (largely lateritized) and an area on the western border (largely dolerite).

The physiography of the Study Area is weakly but significantly related to the underlying rock types. The granitic rocks have formed extensive sandy plains with the configuration of broad, gentle valleys and watersheds, culminating in breakaways of lateritized granite eroded to form a small cliff or bluff. The metasedimentary and meta-igneous rocks have formed gently undulating plains at a slightly elevated level, out of which occasional abrupt, low hills protrude. The bottomlands, in which salt lake features have formed, run roughly east-west across the other landforms.

The Study Area lacks permanent streams or standing bodies of water, and most drainage is of the sheet flooding type. Some areas have a covering 1-2 m deep of sandy soil which rapidly absorbs rain. Run-off consequently occurs only after heavy falls of rain, and mainly on loamy or clayey soils. With falls of 25 mm or more the drainage lines may be briefly charged with water which may remain as soil moisture available to creek-loving plants for several weeks or even months.

The Youanmi-Leonora Study Area is geomorphologically very similar to the Sandstone-Sir Samuel Study Area immediately north of it. It differs, however, from the Barlee-Menzies Study Area to the south which has more extensive areas of Sandplain, Salt Lake Feature and Undulating Plain, with a correspondingly smaller area of Broad Valley and the associated Granite Exposure.

Landform Units

Newbey and Milewski (see Biological Surveys Committee, 1984) have developed a classification of 10 units to describe the landscapes of the Eastern Goldfields. All of these are present in the Study Area; they are shown in Figure 3 and briefly described below.

Breakaway (B): Breakaways in the Study Area generally occupied the high-lying ground within Broad Valley developed over granite. A rough, slightly overhanging bluff 2-4 m high often terminated a gently sloping mesa and thus separated two plains of slightly different elevations. The soil on Breakaway was a stony loam, often with kaolin visible at the base of the bluff, and was poorer in nutrients, more saline and often more sharply texture-differentiated than the soil on Granite Exposure.

A site was examined on the road between Mount Magnet and Sandstone, at 28°01'S, 118°56'E, on the plain immediately above a low breakaway. The site had a gentle, even slope, with loose fragments of nodular laterite at the surface and a relatively pale soil (compared to Broad Valley). Most of the surface was covered by soil rather than rock material, stones covering 1% and pebbles 2%. There were occasional large exposures of ferricrete. Soil texture was Loam or Sandy Clay Loam.

Drainage Line (C): Drainage Lines were relatively uncommon in the Youanmi-Leonora Study Area owing to the scarcity of Undulating Plain which form the main watersheds for abrupt run-off of heavy rainshowers. Drainage Line ranged from minor to well-developed with a creek bed of sandy or gravelly material which separated creek banks up to 2 m high.

Dunefield (D): Dunefields were relatively uncommon in the Youanmi-Leonora Study Area. This was partly a consequence of the relatively small area of Sandplain and Salt Lake Feature found in the Study Area. They were of the siliceous type (associated with Sandplain or the gypseous type (associated with Salt Lake Feature). Dunefields were generally intermediate in soils between those of the Barlee-Menzies Study Area to the south and the Laverton-Leonora Study Area to the east.

Granite Exposure (G): This landform occurred as isolated enclaves in Broad Valley throughout the Youanmi-Leonora Study Area. Minor occurrences were also recorded in other landforms such as Sandplain and Salt Lake Feature. However, bedrock was generally deeply mantled by superficial deposits in these other landforms.

Hill (H): There were relatively few Hills in this Study Area. Soil, mainly duricrust or laterite, varied according to bedrock type which included banded ironstone formation, greenstone, metamorphosed medium to coarse dolerite and gabbro, basalt, quartz and metasediments.

Salt Lake Feature (L): The main salt lake occurring in the Youanmi-Leonora Study Area was the long and narrow Lake Noondie. A minor northeastern extension of Lake Barlee also entered the southeast of the Study Area from the adjacent Barlee-Menzies Study Area.

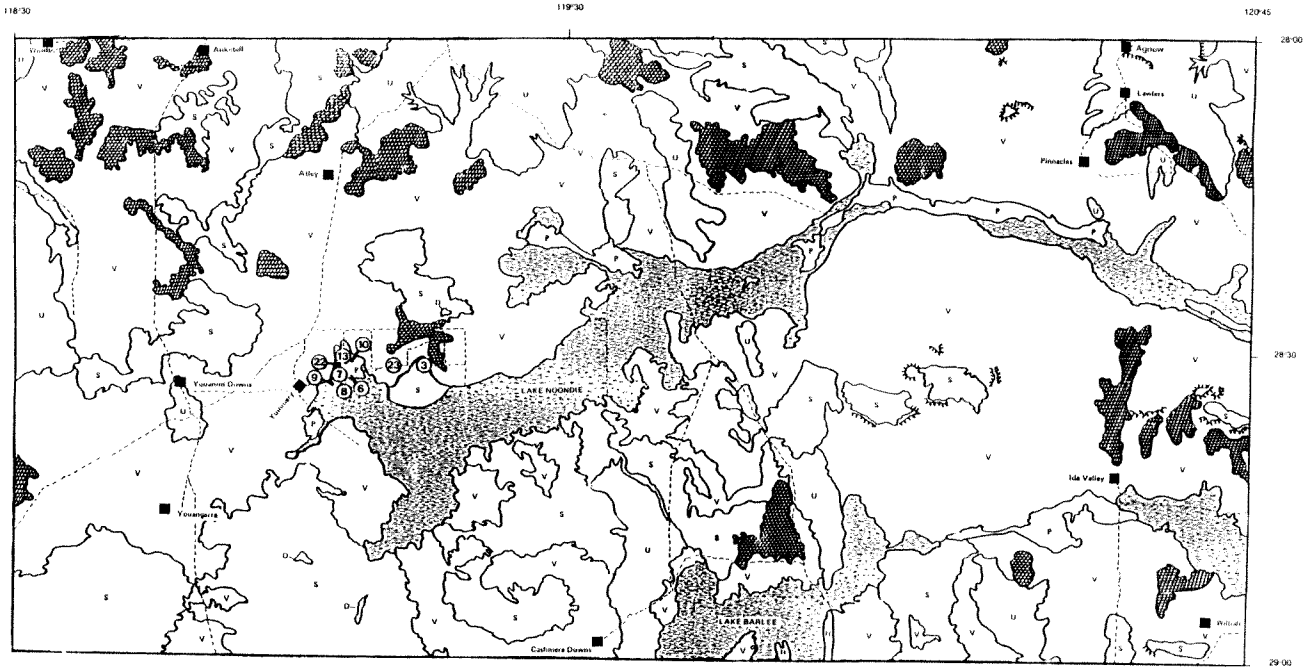

Figure 3. The main landform units of the Youanmi—Leonora Study Area. Numbers indicate the vegetation sites sampled for fauna.

A landform catena was characteristic of Salt Lake Feature, which included soils of varying salinity at slightly different elevations above the salt lake floor. The edges of salt lakes, as well as the floors of small arms of the lake beds themselves, had a saline sandy clay. At a slightly higher level were narrow zones of loamy to sandy soil with a very compact, sodium-contaminated subsoil.

Calcareous Plain (P): Calcrete valley fills formed scattered oblong tracts of Calcareous Plain along the edges of Salt Lake Feature in the Youanmi-Leonora Study Area. The characteristic topography was an abrupt, slightly raised, gently undulating platform, interrupted in places by tongues of lower ground. The soil was calcareous, pale and stony.

Sandplain (S): The main area of Sandplain in the YouanmiLeonora Study Area occurred in the southwest, bordering on the Barlee-Menzies Study Area. Elsewhere scattered large patches were found, often just behind Breakaway. Characteristically, Sandplain included two types of topography, one quite flat and the other slightly elevated and gently undulating. The second type was transitional to Dunefield and included scattered sandridges which are considered separately (see Dunefield). The soil throughout was a simple reddish-coloured earthy sand composed almost exclusively of grains of quartz.

Undulating Plain (U): Undulating Plain occupied only a small area in the Youanmi-Leonora Study Area and were generally similar to those of the Sandstone-Sir Samuel Study Area to the north. The surface was generally stony or gravelly and the soil dark, noticeably darker than the stony, elevated areas within Broad Valley. This difference was due to the different bedrock (greenstone instead of granitic rocks).

Broad Valley (V): Broad Valleys were by far the most extensive landform in the Youanmi-Leonora Study Area. The characteristic topography was wide smooth plains and the characteristic soil a friable loam with a siliceous hardpan at depth.

Soils

The soils of the Study Area have been discussed by Northcote *et al.* (1968) and in general terms by Beard (1976). During this study we recorded soil data at each of the 23 vegetation sample sites; these data are included in Appendix I.

Soils are generally sandy loams although skeletal stony soils occur on rocky ridges, sands occur in dunes, and sandy clays occur in bottomlands. Depressions throughout the Eastern Goldfields are generally saline, and the soil is alkaline and slightly saline where the parent material is basic rock or, in some cases, laterite. Although some landforms are subject to present-day soil formation, in general the soil characteristics are relictual from past geological periods when the climate was first wetter and then drier than that reigning today (Beard, 1976, 1980).

The soils of the Youanmi-Leonora Study Area are generally red and brown hardpan soils with a shallow, stony soil, often over a thin layer of calcrete, on undulating plains

and hills. Clays and gilgai features are uncommon. The siliceous hardpan characteristic of the Study Area (and of the northern part of the Eastern Goldfields generally) has probably been formed by solution and redeposition of silica during periodic deep soaking of the soil by exceptionally heavy rainstorms at the warm time of year (Teakle, 1936). Detailed information on soil textures and the physical features of the soil profiles can be found in Northcote *et al.* (1968). Soils in the Study Area are generally unfavourable for plant growth (Milewski, 1981).

Granite exposure, weathering under present-day climatic conditions, provide a coarse-textured sandy loam composed mainly of quartz grains fairly poor in calcium, but with moderately good nutrient status relative to other soils in the Study Area owing to the presence of feldspar. Mafic rocks, on the other hand, contain large amounts of calcium but relatively little potassium or phosphorus. Away from weathering exposures of bedrock the soils are further impoverished by leaching of useful elements and proportional accumulation of sodium, an element generally useless to plants. Most of the calcium in the Youanmi-Leonora Study Area has been removed from the original soils and concentrated into fossil alluvial beds in the floors of the main valleys. These generally persist today as slightly elevated platforms, often dotted by shallow depressions or dissected into a series of narrow platforms separated by swales. The platforms consist of a deep rubble of mixed siliceous and calcareous materials. The calcareous plains are a distinctive feature of the northern parts of the Eastern Goldfields and are generally associated with small or narrow salt lakes. Although common in the Youanmi-Leonora Study Area they are not present in the Barlee-Menzies Study Area to the south.