

A DEGREE REFERENCE SYSTEM FOR CITING BIOLOGICAL RECORDS IN SOUTHERN AFRICA

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Distribution data for biological specimens are cited in various ways, such as the kilometre grid system used in Europe and the old vice-county system formerly used in Britain (JONES 1968; GRADWELL 1968). Gould has recently put forward a comprehensive system, termed the Geocode, which is applicable on a world-wide basis (GOULD 1968; PERRING 1967).

The Degree Reference System (DRS) discussed here was put forward in 1967, being a slight modification of a latitude-longitude system used for a number of years by zoologists and cartographers in South Africa. Formerly, plant distributions were usually given in terms of magisterial districts, as these administrative areas are locally well-known and easily identify the area where a plant is found. EDWARDS and JESSOP (1967), however, pointed out various confusing features resulting from numerous district boundary changes, the creation of new districts and the large disparities in size between districts. District changes could be expected to continue with the development of the countries of Southern Africa, leading to an increasing lack of uniformity between the older and the newer botanical works, and between botanists themselves through their lack of familiarity with recent changes. A further disadvantage of the magisterial district system is that special district maps are needed by both the field collector and the herbarium worker.

In seeking an alternative means for citing biological records, it was evident that such system should include the following features:

- (1) It should be simple and easily understood;
- (2) Be easily applied without the necessity for special maps and be applicable in areas or countries where only relatively small scale maps are available;
- (3) The geographic location should be easily identifiable;
- (4) The system should be adaptable to modern data processing techniques;
- (5) The system should be flexible enough to permit subdivision or regrouping of the basic units, concomitant with a continental or local scale of work required by a particular worker (and perhaps according to the amount of geographic information available for a particular distribution record);
- (6) Areas of the basic units should be comparable; and
- (7) The system should preferably be of world-wide application.

A grid system appeared the logical alternative to the magisterial district

system. Arbitrary grids drawn to meet the purpose, and standard grids other than latitude and longitude, have the advantage of providing exactly equal areas for comparison, but suffer from the considerable practical disadvantages that special maps with special grids are required and it would be preferable that there should be agreement on a particular grid between biologists working in different countries. Of the various grid systems, that based on latitude and longitude was preferred, since it met most closely all the basic requirements. As indicated later, in Southern Africa the reduction in area of latitude-longitude units from the equator to the southernmost tip of the continent is relatively small and was considered to be of insufficient importance to outweigh the advantages of the system.

THE DEGREE REFERENCE SYSTEM

The Degree Reference System is based on the method used by the South African Trigonometrical Survey Department to number its maps and to record progress in the preparation of map sheets at various scales (see Map Catalogue, Republic of South Africa, 1970). In 1957 at the C. C. T. A. / C. S. A. Meeting at Bakavu, Lwiro, DAVIS of the Medical Ecology Research Centre in Johannesburg showed the use of degree- and quarter-degree squares for recording the distribution of vectors and hosts concerned in the maintenance and transmission of animal diseases of medical importance. Use of the latitude-longitude based system was implicit in the recommendations of the C. C. T. A. / C. S. A. Meeting for the preparation of an atlas on vector and disease distribution, as it was also in recommendations of the 1963 Symposium of the Zoological Society of Southern Africa (ROWAN 1965). This system did not, however, prove fully acceptable to Southern African botanists, apparently largely because in citing specimens, as in a flora or monograph, a purely numerical designation of a square was less directly informative for the distribution of a species than were the district place names.

To overcome this difficulty, EDWARDS and JESSOP (1967) proposed that the one-degree square of latitude and longitude be considered the basic unit of area, and that this square be known by the degrees of latitude and longitude of the north-west or top lefthand corner¹ and by a town or other feature of importance in the square. As in the Trigonometrical Survey system used by DAVIS, the one-degree square is divided into four half-degree squares ($30' \times 30'$), numbered A, B, C and D from left to right and top to bottom, and each half-degree square may be further subdivided into quarter-degree squares ($15' \times 15'$), again numbered A, B, C and D. Designation of a particular square, or portion of a square of latitude and longitude, could then be either by Degree Reference, by town alone, or by Degree Reference and

1 The reason for numbering at the northwest or top lefthand corner is simply due to Southern Africa's position in the southeastern quadrant in relation to the point of origin at the intersection of the 0° co-ordinates of latitude and longitude.

town. For example, the quarter-degree square $25^{\circ}45'S$ — $26^{\circ}00'S$ by $28^{\circ}00'E$ — $28^{\circ}15'E$ is referred to simply as 2528CC, as Pretoria CC, or as 2528CC (Pretoria)¹.

Although the Degree Reference immediately and unambiguously identifies the main geographic co-ordinates, it is desirable to standardize the place names used. These are given for South Africa and South West Africa at the end of this paper. These names were selected on the basis that they are well-known, occur in the South African Postal Guide and do not occur on the boundaries of latitude-longitude squares. Most names are found in the "Times Atlas", on the Southern Africa 1 : 2 500 000 Map (Trigonometrical Survey 1965), SA 1 : 500 000 Topo Series Maps (Trigonometrical Survey), and on the South West Africa 1 : 1 000 000 Topocadastral Map (Surveyor General, Windhoek, 1966).

SOME FEATURES OF THE DEGREE REFERENCE SYSTEM

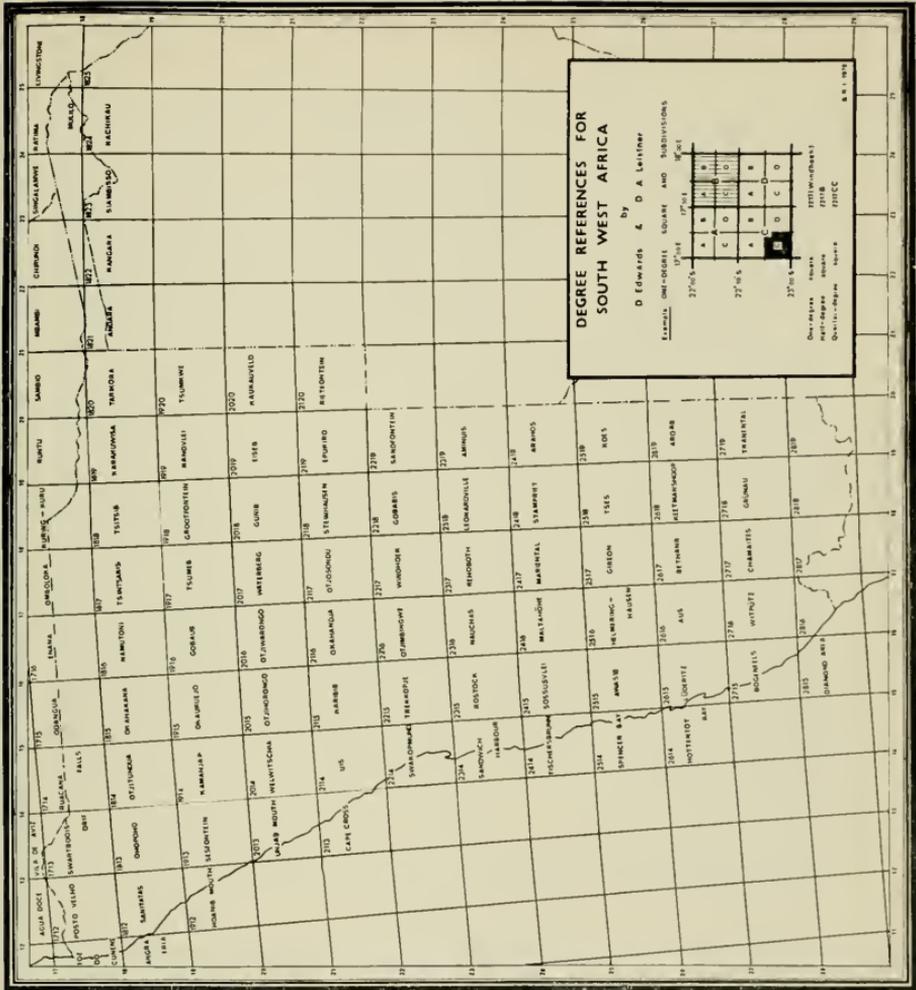
For comparative purposes it may be noted that on the 1950 District Map of South Africa the country was divided into 296 magisterial districts. On the Degree Reference System, South Africa comprises 151 one-degree squares, 522 half-degree squares and 2052 quarter-degree squares. The approximate size of a one-degree square ranges from 110 km \times 110 km at the equator, to 110 km \times 105 km at $20^{\circ}S$ in the vicinity of Bulawayo in Rhodesia, to 110 km \times 92 km at $34^{\circ}S$ in the vicinity of Cape Town. The area of a degree square at Cape Town near the southernmost tip of the African continent is thus about 84% of one on the equator. The area of a quarter-degree square is roughly six times larger than the 10 km squares used to map plant and animal distributions in Britain.

Subdivision of the one-degree square into half- and quarter-degree units has proved convenient to both biologists and map-makers. It has also been useful for filing vegetation photographs and for ordering and referring to various kinds data in a simple geographical manner. Smaller subdivisions may be better suited to particular requirements. If collector's locality records are given to the nearest minute of latitude and longitude any subdivision of a degree square from a minute square is obviously possible, one minute representing roughly 1.6 km.

USE OF DEGREE REFERENCE BY COLLECTORS AND HERBARIUM WORKERS

For South Africa it has been recommended that collectors of botanical specimens should give general localities for specimens to within a quarter-degree square, for example, 2528AC (Pretoria). More specific localities should also be given, either in precise latitude and longitude and/or in terms

1 The Degree Reference Number 2528 is best read as "twenty five — twenty eight", since these two sets of figures represent the co-ordinates of the northwest corner.



of local place names and mileages, for example, 2824DB (Kimberley): Kimberley, western edge of Big Hole; 2530DD (Lydenburg): 25°50'S, 30°57'E, Cythna Letty Nature Reserve.

For the conversion of existing herbarium locality data to the Degree Reference System, MORRIS and LEISTNER (1971) have prepared an Index of Place Names for Southern Africa. The South African Postal Guide and the index to a good atlas are also useful.

CITATION OF SPECIMENS

The following procedure for citing specimens in taxonomic work has been adopted by the Botanical Research Institute and the Journal of South African Botany. Major political boundaries are accepted so that distribu-

tion data are given separately for each country or province. Within each country or province, Degree References are listed in numerical sequence, that is, from west to east and from north to south. If a Degree Reference falls into more than one country or province, the Degree Reference is listed for each country or province provided that the specimen has been recorded from the respective portions of the square.

When citing specimens, the collector's name and number are printed in italics to avoid confusion with Degree Reference Numbers. In certain taxonomic works, such as the Flora of Southern Africa currently in preparation, one-degree references only are used, such as in the following example: NATAL. — 2829 (Harrismith): Cathedral Peak Forest Station, *Killick 1527*. 3030 (Port Shepstone): Izotsha Falls, c. 10 miles W of Port Shepstone, *Strey 7550*. CAPE. — 2420 (Union's End): . . .

In other taxonomic works, distribution records for specimens are preferably given to within a quarter-degree square. To avoid repetition of the Degree Reference Number, quarter-degree references are preceded by a dash and are given in brackets following each separate locality. Quarter-degree subdivisions are listed in alphabetical order within the Degree Reference. When the locality record is not precise enough, no quarter-degree reference is given and the record is included under the one-degree reference. For example: NATAL. — 2731 (Louwsburg): 10 miles E of Nongoma (-DD), *Pelser 354*; near Dwarstrand, *Van der Merwe 4789*. 2829 (Harrismith): near Groothoek (-AB), *Anon 234*; Cathedral Peak Forest Station (CC), *Killick 1572*; 2 miles ESE of Frere Station (-DD), *Anon 479*; 2 miles NE of Frere Station (DD), *Xantos 123*; near Camelot, *Marais 3456*. CAPE. — 3228 (Butterworth): . . .

LIST OF ONE-DEGREE SQUARES IN SOUTH AFRICA

2227 (Palapye)	2426 (Mochudi)	2528 (Pretoria)
2228 (Maasroom)	2427 (Thabazimbi)	2529 (Witbank)
2229 (Waterpoort)	2428 (Nylstroom)	2530 (Lydenburg)
2230 (Messina)	2429 (Zebediela)	2531 (Komatipoort)
2231 (Pafuri)	2430 (Pilgrim's Rest)	2532 (Lourenco Marques)
	2431 (Acornhoek)	
2326 (Mahalapye)	2432 (Mapulanguene)	2620 (Twee Rivieren)
2327 (Ellisras)		2621 (Khuis)
2328 (Baltimore)	2520 (Mata-Mata)	2622 (Tsabong)
2329 (Pietersburg)	2522 (Sanie)	2623 (Morokweng)
2330 (Tzaneen)	2523 (Pomfret)	2624 (Vryburg)
2331 (Phalaborwa)	2524 (Vergeleë)	2625 (Delareyville)
	2525 (Mafeking)	2626 (Klerksdorp)
2420 (Union's End)	2526 (Zeerust)	2627 (Potchefstroom)
2425 (Gaborone)	2527 (Rustenburg)	2628 (Johannesburg)

2629 (Bethal)	2919 (Pofadder)	3128 (Umtata)
2630 (Carolina)	2920 (Boomrivier)	3129 (Port St. Johns)
2631 (Mbabane)	2921 (Kenhardt)	3130 (Port Edward)
2632 (Bela Vista)	2922 (Prieska)	
	2923 (Douglas)	3217 (Vredenburg)
2720 (Noenieput)	2924 (Hopetown)	3218 (Clanwilliam)
2721 (Tellery Pan)	2925 (Jagersfontein)	3219 (Wuppertal)
2722 (Olifantshoek)	2926 (Bloemfontein)	3220 (Sutherland)
2723 (Kuruman)	2927 (Maseru)	3221 (Merweville)
2724 (Taung)	2928 (Marakabei)	3222 (Beaufort West)
2725 (Bloemhof)	2929 (Underberg)	3223 (Rietbron)
2726 (Odendaalsrus)	2930 (Pietermaritzburg)	3224 (Graaff-Reinet)
2727 (Kroonstad)	2931 (Stanger)	3225 (Somerset East)
2728 (Frankfort)		3226 (Fort Beaufort)
2729 (Volksrust)	3017 (Hondeklipbaai)	3227 (Stutterheim)
2730 (Vryheid)	3018 (Kamiesberg)	3228 (Butterworth)
2731 (Louwsburg)	3019 (Loeriesfontein)	3229 (Talemofu)
2732 (Ubombo)	3020 (Brandvlei)	
	3021 (Vanwyksvlei)	3317 (Saldanha)
2816 (Oranjemund)	3022 (Carnarvon)	3318 (Cape Town)
2817 (Violsdrif)	3023 (Britstown)	3319 (Worcester)
2818 (Warmbad)	3024 (De Aar)	3320 (Montagu)
2819 (Ariamsvlei)	3025 (Colesberg)	3321 (Ladismith)
2820 (Kakamas)	3026 (Aliwal North)	3322 (Oudtshoorn)
2821 (Upington)	3027 (Lady Grey)	3323 (Willowmore)
2822 (Glen Lyon)	3028 (Matatiele)	3324 (Steytlerville)
2823 (Griekwastad)	3029 (Kokstad)	3325 (Port Elizabeth)
2824 (Kimberley)	3030 (Port Shepstone)	3326 (Grahamstown)
2825 (Boshof)		3327 (Peddie)
2826 (Brandfort)	3117 (Lepelfontein)	
2827 (Senekal)	3118 (Vanrhynsdorp)	3418 (Simonstown)
2828 (Bethlehem)	3119 (Calvinia)	3419 (Caledon)
2829 (Harrismith)	3120 (Williston)	3420 (Bredasdorp)
2830 (Dundee)	3121 (Fraserburg)	3421 (Riversdale)
2831 (Nkandla)	3122 (Loxton)	3422 (Mossel Bay)
2832 (Mtubatuba)	3123 (Victoria West)	3423 (Knysna)
	3124 (Hanover)	3424 (Humansdorp)
2916 (Port Nolloth)	3125 (Steynsburg)	3425 (Skoenmakerskop)
2917 (Springbok)	3126 (Queenstown)	
2918 (Gamoep)	3127 (Lady Frere)	

LIST OF ONE-DEGREE SQUARES IN SOUTH WEST AFRICA

1612 (Agua Doce)	1913 (Sesfontein)	2315 (Rostock)
1613 (Vila de Aviz)	1914 (Kamanjab)	2316 (Nauchas)
	1915 (Okaukuejo)	2317 (Rehoboth)
1711 (Foz do Cunene)	1916 (Gobaub)	2318 (Leonardville)
1712 (Posto Velho)	1917 (Tsumeb)	2319 (Aminuis)
1713 (Swartbooisdrif)	1918 (Grootfontein)	
1714 (Ruacana Falls)	1919 (Kanovlei)	2414 (Fischersbrunn)
1715 (Ondangua)	1920 (Tsumkwe)	2415 (Sossusvlei)
1716 (Enana)		2416 (Maltahöhe)
1717 (Omboloka)	2013 (Unjab Mouth)	2417 (Mariental)
1718 (Kuring-Kuru)	2014 (Welwitschia)	2418 (Stampriet)
1719 (Runtu)	2015 (Otjhorongo)	2419 (Aranos)
1720 (Sambio)	2016 (Otjiwarongo)	
1721 (Mbambi)	2017 (Waterberg)	2514 (Spencer Bay)
1722 (Chirundi)	2018 (Gunib)	2515 (Awasib)
1723 (Singalamwe)	2019 (Eiseb)	2516 (Helmeringhausen)
1724 (Katima Mulilo)	2020 (Kaukauveld)	2517 (Gibeon)
1725 (Livingstone)		
	2113 (Cape Cross)	2518 (Tses)
1811 (Angra Fria)	2114 (Uis)	2519 (Koes)
1812 (Sanitatas)	2115 (Karibib)	
1813 (Ohopoho)	2116 (Okahandja)	2614 (Hottentot Bay)
1814 (Otjitundua)	2117 (Otjosondu)	2615 (Lüderitz)
1815 (Okahakana)	2118 (Steinhausen)	2616 (Aus)
1816 (Namutoni)	2119 (Epukiro)	2617 (Bethanie)
1817 (Tsintsabis)	2120 (Rietfontein)	2618 (Keetmanshoop)
1818 (Tsitsib)		2619 (Aroab)
1819 (Karakuwisa)	2214 (Swakopmund)	
1820 (Tarikora)	2215 (Trekopje)	2715 (Bogenfels)
1821 (Andara)	2216 (Otjimbingwe)	2716 (Witpütz)
1822 (Kangara)	2217 (Windhoek)	2717 (Chamaïtes)
1823 (Siambisso)	2218 (Gobabis)	2718 (Grünau)
1824 (Kachikau)	2219 (Sandfontein)	2719 (Träental)
1912 (Hoanib Mouth)	2314 (Sandwich Harbour)	2815 (Diamand Area)

SUMMARY

The Degree Reference System based on latitude and longitude has been found to be a practical and flexible grid method for recording distribution data for biological specimens in Southern Africa, as well as for other purposes requiring geographical co-ordinates. The basic unit is the one-degree square of latitude and longitude, which is designated by a Degree Reference Number composed of the degrees of latitude and longitude of the northwest corner (in Southern Africa) and by a town or feature of importance. Subdivisions of the one-degree square by successive quarterings provide half- and quarter-degree squares that are each numbered A, B, C and D from left to right and top to bottom. Quarter-degree citation, involving four digits and two letters that are simply derived, is suggested for general use, but larger or smaller grid squares are possible for a particular purpose.

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