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**MACROLEPIDOPTERA OF FIJI AND ROTUMA :
A TAXONOMIC AND BIOGEOGRAPHIC STUDY**

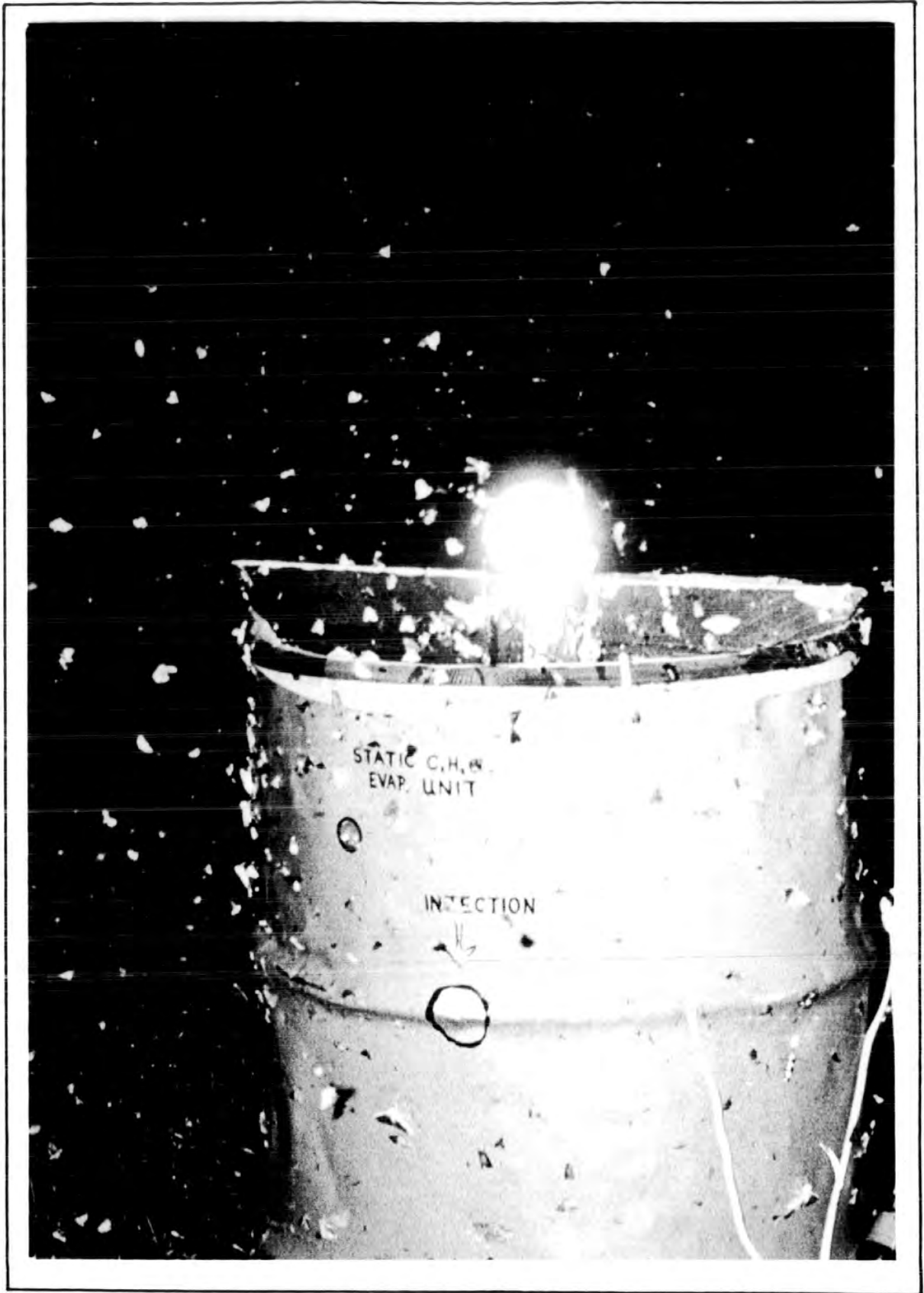
by

GADEN S. ROBINSON, B. Sc.

**being a thesis presented in candidature for the degree
of Doctor of Philosophy in the University of Durham, 1974.**

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in the other copy in Durham University
library. This copy should be used for
reprographic purposes. G.S.R. 10.v.1974.*





Robinson trap No. 5 in operation
at Nandarivatu 21-xi-1971.



Abstract

The 400 species of Macrolepidoptera known to occur in Fiji and Rotuma (including 10 new subspecies, 72 new species and 2 new genera) are described : 11 species remain unplaced. Taxonomic treatment includes restitution of names, establishment of new combinations and establishment of new synonymy. Most species are illustrated, many are redescribed : life history and distributional information is provided where this is known.

The results of light-trapping in Fiji, the New Hebrides and on Rotuma are presented and the difficulties of measuring diversity and assessing distributions from light-trap records are pointed out. A method for processing light-trap records by computer and subjecting these records to cluster analysis to yield groups of species which possess a similar distributional pattern is presented. The method is applied to light trap samples from Fiji, the New Hebrides and Rotuma and the properties of the groups of species obtained are examined.

The Macrolepidoptera fauna of Fiji is discussed biogeographically in the context of the Pacific and the present-day distribution of species related to the geological and palaeogeographic history of the western Pacific : the latter is summarised. The distribution of species within the Fiji group is discussed in relation to vegetation types and vegetational history and the impact of man upon the fauna is examined.

Statement

This work does not constitute a publication by definition of Article 8 of the International Code of Zoological Nomenclature, 1964, and is not intended to do so.

This work does, however, constitute a manuscript intended for publication and is copyright: in this context attention is drawn to item 2 of Appendix A of the Code which has the status of a recommendation.

Acknowledgements

Throughout the period of this work my supervisor, Dr. Lewis Davies, has refrained from use of either whip or carrot but has never quite given me enough rope to hang myself: this situation, stabilised by his continued patience and good humour, has been an easy and fruitful one in which to work and I am exceptionally grateful to him.

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Special mention and thanks are due to Mr. J. Daniels (SPSM Research Station), Mr. D. Burness (Coconut Pests and Diseases Board), Mr. P. Erasito (Agricultural Officer, Rotuma), Mr. S. Ketewai, Mr. R. Lepper (Namale Estate), Mr. E. Morris (Tholoisuva), Mr. R. Mercer (Matanikavika Estate), Mr. J.A. McLean (U.S.P.), Mr. A. Ottoway (Rakiraki), Mr. J. Parham, Mr. D. Paul, Mr. A.S. Petrie, the Robertson family (Mba), Dr. J.B.D. Robinson, Mr. D.T. Saint, Cdr. G.J.B. Simeon, Mr. A. Stone, Mr. R. Stone, and Mr. M. Williams.

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The enormous and tedious task of typing this thesis was undertaken by Mrs. Mavis Beddoes whose magnificent efforts are greatly appreciated and for whom it is difficult to find sufficient thanks.

The job of printing and plate-making fell to Mr. Thomas Fong whose skill in this task is self evident and to whom I am deeply grateful.

The photographs for plates 1 - 10 were taken by my brother, whose efforts speak for themselves.

Both my mother and my fiancée have suffered grass-widowhood from this enterprise : their horse-sense and support is deeply appreciated.

I thank Jo and Harry Sampson for giving me a home and a family in Durham.

My father is the moving spirit behind this work. His knowledge and love of entomology have been a profound influence upon my career and his contribution to this work has been enormous, from the workshop practicalities of light-trap construction to larval skin and genitalia preparations, fieldwork in New Guinea, the Solomon Is., Gilbert Is. and Samoa and finally the preparation of all the photographs in this thesis, supervision of typing and printing and the laborious task of proof-reading. My dedication of this work to him is a less than adequate expression of my gratitude.

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Chapter 1 : The study of Lepidoptera in Fiji and the adjacent islands -
publications and the fate of collected material.

The early history of the collecting of Lepidoptera in Fiji parallels that of many of the Pacific islands: collections were made by casual callers at islands, often members of survey vessel crews (Perry, Walker, Mathew) and tended to be mostly of Rhopalocera. In almost all cases the material came to rest in the British Museum (Natural History) - BM (NH) - and this trend of deposition has been maintained to the present day so that the present author was fortunate to find almost all relevant type material under one roof.

The first species of moth to have been described from a Fijian specimen was perhaps Ericeia leichardtii (Koch)(q.v.) in 1865 but there is doubt as to the provenance of the type specimen. Koch gives the type locality as "N. Australia" - this is erroneous. The source of the specimen, though probably Fiji, might have been Samoa. There are no such doubts about the specimen of the endemic Macaduma corvina (q.v.) described by Felder in 1875. The butterflies got off to a better start; Xois sesara was described in 1865 and Papilio schmeltzi in 1869. Both species are endemic.

Institutions or collections which contain or have contained Fijian lepidopterous material are abbreviated in this thesis as follows:

BM(NH)	- British Museum (Natural History), London.
KRS	- Fiji Dept of Agriculture, Koronivia Research Station, Fiji.
SPSM	- South Pacific Sugar Mills (=C.S.R.Company), Lautoka, Fiji.
MNHN	- Musee Nationale d'Histoire Naturelle, Paris, France.
ZM	- Zoologisches Museum, Hamburg, Germany.
BPBM	- Bernice P. Bishop Museum, Honolulu, Hawaii.
UM	- University Museum, Oxford.
AM	- Australian Museum, Sydney, Australia.
SAM	- South Australian Museum, Adelaide, Australia.
USNM	- U.S. National Museum, Washington D.C., U.S.A.
CAS	- California Academy of Sciences, San Francisco, U.S.A.
NM	- Naturhistorisches Museum, Wien, Austria.
TWD	- Thomas W. Davies collection, San Leandro, California, U.S.A.

The better-known collectors of Lepidoptera from Fiji and relevant information are listed in alphabetical order below:

- BAHR, Dr. Philip (ca. 1910) A few specimens from Tamavua, near Suva, mostly Rhopalocera. BM(NH).
- BAXANDALE, R. (1893-94) Ovalau (mis-spelt "Obalau" on some labels) - Rhopalocera and Heterocera. BM(NH).
- BRYAN, E.H. Jr (1924) A few Lepidoptera collected but activities mostly confined to Coleoptera: examined and listed KRS and SPSM collections (Bryan, 1924). BPBM.
- CATALA, R. (1951) A small mixed collection from 20 km N of Suva (Viette 1951b). MNHN.
- CERF, 1e (?) See Viette (1950f). MNHN.

- DAVIES, T.W. (1963, 1970) Comprehensive collection of Rhopalocera and a few Heterocera from Korolevu. CAS/TWD.
- EVANS, Dr Humphrey Silvester (1922-24) District Commissioner and District Medical Officer, Vanua Mbalavu (1922), Taveuni (1924). Small collection of Rhopalocera. BM(NH).
- FILHOL (1899) Ovalau - a small collection (Viette, 1950f). MNHN.
- GARDE, P. de la (ca.1905) Navua area (S. central Viti Levu): also collected in W. Samoa (Viette, 1954). Small collection. BM(NH) Accession 1906-89. BM(NH).
- GILSON, Prof. Gustav (1899) A short visit: collected some Rhopalocera (Poulton, 1923c). ?BM(NH)
- GRAEFFE, Dr Eduard (1862) Collected for the Hamburg firm of Godeffroy & Sons. Much of his material was purchased by BM(NH) and subsequently described by Butler (1886). Some material from this accession may carry erroneous data. Graeffe's labels are "not too dependable" (Smith, 1955). BM(NH).
- GREENWOOD, William F.N. (1919-32) Employed by the Colonial Sugar Refining Company (C.S.R. - now SPSM - q.v.) as an entomologist and built up the SPSM collection (now badly neglected). A major contributor to Fijian botany (Parham, 1972). Much of Phillips' (q.v.) collection was in the SPSM collection but Phillips took this material away from C.S.R. in 1933. Greenwood sent many specimens to BM(NH) and the Imperial Institute for Entomology for identification and many duplicates of these series of his and Phillips' specimens were retained. SPSM/BM(NH).
- GUTHRIE, Dr T. (1902) A small collection at Lautoka in December. BM(NH).
- JACQUINOT (?) A small collection from "Lovouko" (Levuka, Ovalau) - see Viette (1905f). Perhaps this is Lieut. C.H. Jacquinot who visited Fiji on the "Astrolabe" with Dumont d'Urville in 1827. MNHN.
- JOANNIS, de (?) A small collection (Viette, 1950f). MNHN.
- LEVER, R.J.A.W. (1937-49) Government Entomologist. Contributed material to KRS and BM(NH): many publications on Fijian entomology, mostly in Agric. J., Fiji : see bibliography for papers on Lepidoptera. KRS/BM(NH).
- LUCAS, Dr T.P. (ca 1884) Collected during "a short winter visit to Fiji": material described by Meyrick (1886). Types were retained in the Lucas collection, now said to be in SAM. This is the only collection of Fijian Lepidoptera types of any importance outside BM(NH). SAM.
- MATHEW, Cdr. Gervase F. (ca 1880-85) Ultimately Paymaster-in-Chief of the Royal Navy. Meyrick (1886) described a quantity of Mathew's material: "Mr Mathew's collection was formed during 3 years' stay on the Australian station and was obtained on short, occasional visits to the different islands, whenever an opportunity might occur for landing". Mathew's collection was mostly of Rhopalocera but at Meyrick's request he did collect a few moths. BM(NH) Accession 87-50 was of 1,862 Lepidoptera from the Australian region from Mathew's collection. Mathew himself published two papers on life histories (1885, 1889). Labels not always dependable. BM(NH).

- MOSSE-ROBINSON, Lieut. L.H. (1914) Sent Prof. E.B. Poulton a Spingid found in the stomach of a fish caught by one of his subordinates fishing off H.M.S. "Australia" in Suva harbour - see Poulton (1916). Depository of specimen not known.
- NICOLL, M.J. (ca 1905) A member of the Crawford Expedition (?). Few specimens. Published "Three Voyages of a Naturalist" (untraced) in 1908. BM(NH)
- NORTH, D.A. (ca 1910-1915) A cane experimentalist with the C.S.R. Co.. A small collection of butterflies. BM(NH).
- O'CONNOR, B.A. (1949-62 approx.) Government Entomologist after Lever. Maintained and added material to the KRS collection and supplied specimens to BM(NH) via the Commonwealth Institute of Entomology. KRS/BM(NH).
- PAINE, R.W. (ca 1929) Worked on Levuana with Tothill et al. (see Tothill, Taylor and Paine, 1930). Some Lepidoptera collected. KRS/BM(NH).
- PERRY, W. Wykeham (ca 1873-75) Commander (?) of H.M.S. "Pearl", the survey vessel. Visited Ovalau, Vanua Levu and New Hebrides (see Butler, 1874, 1875, 1875b). BM(NH).
- PHILLIPS, C.S. (1920-38) Collected with his father, R.H. Phillips, at Vunindawa (see below). The father and son labelled their material either "Vunindawa" or "Lautoka" but I believe they collected in additional localities to these. BM(NH)/AM.
- PHILLIPS, Richard Henry (1920-38). Phillips made by far the richest and most important contribution to our knowledge of the Lepidoptera of the Pacific with his painstaking and comprehensive collection of Fijian Lepidoptera. With the exception of a paper by Musgrave (1938), Phillips has received little or no credit or biography and I am indebted to Mr. C.S. Phillips of Bangalow, N.S.W. for the fascinating resumé of his father's life reproduced below.
- PHILLIPS,**
Richard
(b.1866) "My father was the second youngest son (b.1866) of the village doctor (George Marshall Phillips) of Whitwell, Hertfordshire which is now, I believe, a suburb of London. My father was educated at Brentwood while the family lived at Walden, Hitchin. At eighteen years of age he was seen by Lord Dacre (the Queen Mother's father) shooting on his estate and Lord Dacre warned my grandfather who put my father on a boat to Australia forthwith ! Dad's share of the family fortune was sent ahead to an uncle in the Queensland Police Force. Dad arrived to find Uncle recovering from a binge on his nephew's money. There was just enough left to outfit him with a dray to go wool-washing on the Murray River. Ignorance of the climate and the vagaries of rainfall miles away soon ended his hopes for a fortune for the wool was washed away in a flash flood. Having to sell the outfit to make what amends he could left him broke and he took a job on any stations offering. In this way he came to Caradgery near Forbes and Parkes and there became a jackeroo to the family of William Atwood Rae who was a surveyor with a property at Timaldra, a few miles out of Parkes. The master of the house spent long absences from home and his wife found Dad's education just what was needed. He became tutor in the morning and jackeroo in the afternoon: there were nine children in the house so he was a busy man. He cast and made his own .44 bullets and shot

kangaroos for pocket-money. When the Boer War broke out he resigned his job to enlist but was turned down because of a missing left forefinger ! He heard that work was available in Fiji and went there in 1902 (aged 36) and the same afternoon as he landed was painting the yard of Wishart's timber store in Suva. He took on managing Armstrong's store at Taurau (between Mba and Lautoka) and briefly returned to Australia to marry Amy Kate, the third daughter of W.A. Rae, his early employer. In 1905 he worked in Henry Marks' store in Suva then at the beginning of 1908 he joined the Colonial Service as a Third Boarding Officer in the Customs and Excise Department at a salary of £100 p.a. He worked his way up to Senior Customs Officer by 1927 and retired at the end of 1928, aged 63. Just prior to his retirement he had taken up moth-collecting as a hobby and as a result of this got a job with C.S.R. at Lautoka breeding a fly that was being used as a predator on some canefield pest. The 1931 hurricane put a finish to the fly-breeding sheds and the company closed the project. He came to Vunindawa where I had a farm and we jointly worked on his moth collection - there being no distractions in those days !

His private collection of Fijian moths he donated to the Sydney Museum where it was known as the Phillips collection... He had also found the largest wood-boring beetle of all time but the beetle "went astray" while in the care of the Agricultural Dept in Suva, for which crime the old man never forgave them ... Methods of collecting used were looking for and breeding out caterpillars found in the daytime and hanging out a sheet with a v-fold at the bottom with a petrol lamp above it... The British Museum badly wanted information on what these moths fed on and this request was always in our minds when walking through the bush. I did a lot of river-clearing in those days, blasting out stumps, so I did a lot of the work for him but his was the idea and most of the drive. I was raising a family and trying to be solvent at the same time: these were the Depression years you must remember.

He and Mother made one trip to Australia but returned again: but it was a wet year and he took off again and settled at Mosman in Sydney and died there in 1955 in his 90th year. He was a kindly man, always ready to go the extra mile, a pillar of the Church of England (which Church he nevertheless considered dead on its feet !), a good husband and a wonderful father; in short, an old-time English gentleman".

Phillips contributed a large amount of material to BM(NH), some specimens via Greenwood, and many of his Geometrids were described by Prout (1929c, 1930, 1934) although none of his Noctuid material was investigated. Meyrick described many of Phillips' Microlepidoptera. Phillips presented his small personal collection to the AM along with his field notebooks. The latter are still untraced despite laborious investigations by the author. The Phillips Collection in the AM contains specimens but no type material.

Phillips never published any of his observations although he presented a catalogue of his collection (including material sent to BM(NH)) to the Fiji Dept of Agriculture (Phillips, 1937). Phillips' collection is outstanding both in quantity and quality and the author has never ceased to be amazed at the species Phillips collected with the limited means at his disposal. AM/KRS/SPSM/BM(NH).