THE DISTRIBUTION OF ALKALOIDS IN ORCHIDS FROM THE TERRITORY OF PAPUA AND NEW GUINEA

L. J. Lawler and M. Slaytor
Department of Biochemistry, The University of Sydney, Sydney, N.S.W. 2006, Australia
(Communicated by Professor T. G. Vallance)

[Read 29th October, 1969]

Synopsis

Three hundred and fourteen orchids from the Territory of Papua and New Guinea have been screened for alkaloids. The uses of those employed in native medicine are recorded and the screening results are discussed from a taxonomic viewpoint.

Introduction

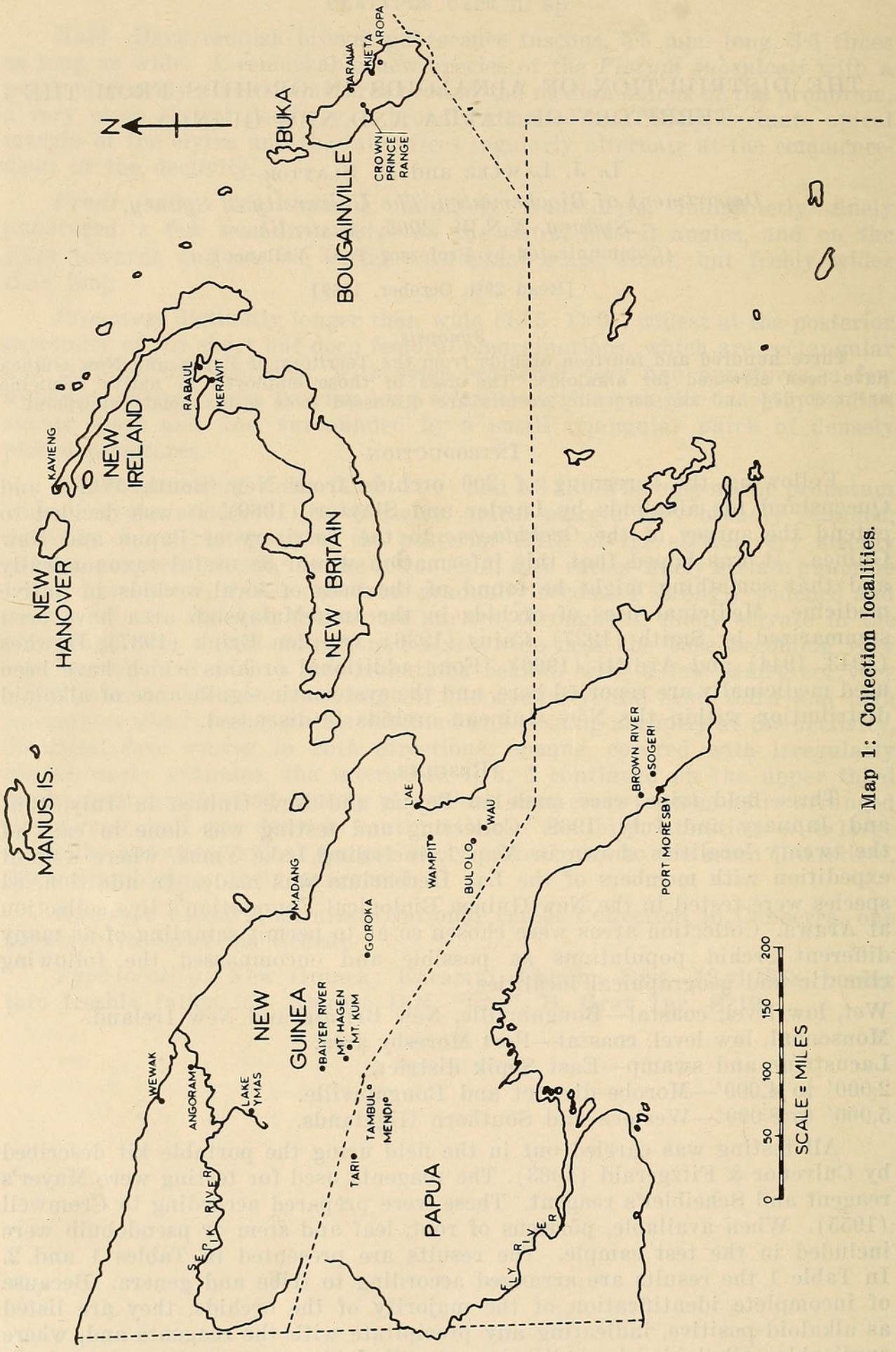
Following the screening of 200 orchids from New South Wales and Queensland for alkaloids by Lawler and Slaytor (1969), it was decided to extend the survey of the *Orchidaceae* to the Territory of Papua and New Guinea. It was hoped that this information would be useful taxonomically and that something might be found of the uses of local orchids in native medicine. Medicinal uses of orchids in the Indo-Malaysian area have been summarized by Smith (1927), Caius (1936), van den Brink (1937), Hawkes (1943, 1944) and Arditti (1966). Four additional orchids which have been used medicinally are reported here, and the systematic significance of alkaloid distribution within the New Guinean orchids is discussed.

Results

Three field trips were made to Papua and New Guinea in July, 1967 and January and July, 1968. Collecting and testing was done in each of the twenty localities shown in Map 1, including Lake Ymas, where a joint expedition with members of the Lae Herbarium was made. In addition, 84 species were tested in the New Guinea Biological Foundation's live collection at Arawa. Collection areas were chosen so as to permit sampling of as many different orchid populations as possible and encompassed the following climatic and geographical localities:

Wet, low level, coastal—Bougainville, New Britain and New Ireland.
Monsoonal, low level, coastal—Port Moresby area.
Lacustrine and swamp—East Sepik district.
2,000′ to 4,000′—Morobe district and Bougainville.
5,000′ to 8,000′—Western and Southern Highlands.

All testing was carried out in the field using the portable kit described by Culvenor & Fitzgerald (1963). The reagents used for testing were Mayer's reagent and Scheibler's reagent. These were prepared according to Cromwell (1955). When available, portions of root, leaf and stem or pseudobulb were included in the test sample. The results are presented in Tables 1 and 2. In Table 1 the results are arranged according to tribe and genera. Because of incomplete identification of the majority of the orchids, they are listed as alkaloid positive, indicating any precipitate with the reagents and, where applicable, alkaloid-rich, indicating an alkaloid concentration of at least



Map 1: Collection localities.

TABLE 1
Alkaloid Distribution at Generic Level

Tribe	Genus	Alkaloid-rich species	Alkaloid-positive species
Cypripediloideae			
Subtribe Cypripedileae ..	Paphiopedilum	—	1/1
Ophrydoideae			
Subtribe Habenarieae ..	Habenaria	1	2/3
Polychondreae			
Subtribe Cryptostylideae ..	Cryptostylis	1	1/1
Vanilleae	Vanilla	—	1/1
Physureae ..	Anoectochilus	—	1/1
	Cheirostylis	—	0/1
	Goodyera	—	3/3
	Hetaeria	—	1/2
	Macodes	—	1/1
	Zeuxine	1	2/2
	Lepidogyne	—	1/1
Tropidieae	Corymborkis	—	1/1
Kerosphaereae			
Subtribe Liparideae	Liparis	4	8/8
	Malaxis	6	9/9
	Hippeophyllum	1	1/1
	Oberonia	—	5/8
Collabieae ..	Mischobulbum	—	1/1
Coelogyneae ..	Coelogyne	—	8/9
	Pholidota	—	1/3
	Dendrochilum	—	1/1
Dendrobieae ..	Cadetia	—	1/2
	Dendrobium	1	40/90
	Diplocaulobium	—	0/4
	Ephemerantha	—	3/4
	Eria	1	8/10
Glomereae	Ceratostylis	—	3/6
	Agrostophyllum	—	5/6
	Epiblastus	—	1/2
	Glomera	—	3/7
	Giulanetta	—	1/1
	Mediocalcar	—	2/3
	Glossorhyncha	—	1/2
Podochileae ..	Podochilus	—	3/3
	Appendicula	—	4/4
Phajeae	Calanthe	—	2/3
	Phaius	—	3/5
	Plocoglottis	2	2/2
	Spathoglottis	—	2/4
Bulbophylleae ..	Bulbophyllum	4	30/50
Cymbidieae ..	Dipodium	—	0/1
	Grammatophyllum	—	0/1
Thelasieae	Phreatia	—	3/15
Thecosteleae ..	Acriopsis	—	1/1
Sarcantheae ..	Thrixspermum	—	2/3
	Sarcochilus	—	0/1
	Vanda	—	1/1
	Renanthera	—	1/1
	Saccolabium	1	2/2
	Taeniophyllum	1	1/2
	Tricholglottis	—	1/2
	Luisia	—	1/3
	Pomatocalpa	1	2/3
	Vandopsis	1	7/9
	Schoenorchis	—	1/1
	Ascoglossum	—	0/1
	Porphyrodesme	—	1/1

0·1%. This was estimated by comparison with dendrobine from *Dendrobium nobile*. A number of these incompletely identified alkaloid-rich species, including a *Dendrobium* sp. (section *Monanthos*) are now growing in the Departmental collection, and will be identified or described later. In Table 2 are, listed alphabetically, all those orchids which could be identified down to species level. Here, it seems justified to record the alkaloid concentration more accurately.

TABLE 2

Alkaloid Distribution at Species Level

Ascoglossum colopterum, 0 ; *Bulbophyllum fritillariiflorum*, 0 ; *B. lycastoides*, 0 ; *B. macranthum*, 0 ; *B. macrophyllum*, 0 ; *Calanthe chrysantha*, 1 ; *C. engleriana*, 0 ; *Coelogyne aspulata*, 1 ; *C. pustuloga*, 2 ; *Cryptostylis fulva*, 4 ; *Dendrobium antennatum*, 0 ; *D. appendiculata*, 0 ; *D. bambusaefolium*, 0 ; *D. conanthum*, 0 ; *D. chrysotoxum*, 0 ; *D. d'albertisii*, 0 ; *D. erectifolium*, 2 ; *D. gouldii*, 0 ; *D. gouldii* v. *acutum*, 0 ; *D. hollrungii*, 1 ; *D. johnsonii*, 0 ; *D. musciferum*, 0 ; *D. ophioglossum*, 0 ; *D. ostrinoglossum*, 0 ; *D. quadrangulare*, 0 ; *D. sophronites*, 0 ; *D. spectabile*, 0 ; *D. tangerinum*, 0 ; *D. veratrifolium*, 0 ; *D. wardianum*, 0 ; *D. williamsianum*, 0 ; *Dendrochilum longifolium* v. *papuanum*, 2 ; *Dipodium pandanum*, 0 ; *Ephemerantha comatum*, 2 ; *Eria hirsuta*, 0 ; *Goodyera papuana*, 2 ; *Grammatophyllum scriptum*, 0 ; *Habenaria papuana*, 3 ; *Macodes sanderiana*, 1 ; *Paphiopedilum violascens*, 1 ; *Phaius montanus*, 1 ; *Pomaiocalpa marsupiales*, 2; *Porphyrodesme papuanum*, 1 ; *Renanthera eldfeldii*, 2 ; *Thrisxpermum arachnites*, 1 ; *Vanda hindsii*, 1 ; *Vandopsis longicaulis*, 1 ; *V. muelleri*, 0 ; *V. wracquianum*, 1.

Precipitates were graded as follows: 4 (> 0·1%), 3 (0·1%), 2 (0·01%), 1 (< 0·01%), 0 (no alkaloid detectable); the alkaloid content in brackets being estimated by comparison with dendrobine from *Dendrobium nobile*.

DISCUSSION

Five of the orchids which have been tested for alkaloids have been used for medicinal purposes. These are a *Dendrobium* sp. (section *Monanthos*) used in Bougainville to treat internal bleeding; a *Diplocaulobium* sp. used by the natives to treat infected wounds; *Dipodium papuanum*, an aqueous infusion of the leaves of which is drunk for respiratory infections in Bougainville; a *Vanilla* sp. used as a vermifuge for domestic swine in Bougainville and *Grammatophyllum scriptum*, the seeds of which are mixed with coconut milk and used in Bougainville to treat skin infections in children. The medicinal use of this orchid in the Malay Peninsula has been reported by Smith (1927). Of these, only the *Dendrobium* contains a significant amount of alkaloid. This orchid has been collected in quantity and the isolation and testing of its alkaloids is being carried out. The concentration of alkaloids in the *Vanilla* is too low for normal isolation.

The classification of the *Orchidaceae* in this paper follows that of Schlecter as summarized by Withner (1959). A major difficulty in working with New Guinean orchids is the lack of means of identification of the plants tested due to the large number of species in the area and to the lack of comprehensive taxonomic work there. Despite the problems of identification the results from New Guinea are interesting in that they supplement the data already found by Lüning (1964, 1967) and Lawler and Slaytor (1969). The orchids under discussion fall into four tribes, *Crypripediloideae*, *Ophrydoideae*, *Polychondreae* and *Kerosphaereae*. Only species from a single genus have been tested in each of the first two tribes. *Habenaria papuana* is the only alkaloid-rich species which has so far been found in the tribe *Ophrydoideae*. In the tribe *Polychondreae*, there is a random distribution of alkaloid-rich species. These occur in *Cryptostylis* and *Zeuxine*. The alkaloids from *Cryptostylis fulva* have since been characterized by Leander and Lüning (1968) and contain the same 1-phenyl-1, 2, 3, 4-tetrahydroisoquinoline skeleton

as those from the Australian *C. erecta* (Slaytor, 1969). Most of the alkaloid-rich species come from the tribe *Kerosphaereae*. This tribe contains the subtribe *Liparideae* which has the greatest concentration of alkaloid-rich species which has been found in any subtribe. Four genera, *Liparis, Malaxis, Hippeophyllum* and *Oberonia* contain high percentages of alkaloid-rich species. The subtribe *Coelogyneae,* considered by Lüning (1966) almost alkaloid-free, has at least 10 species containing low levels of alkaloids. The other subtribes show only scattered alkaloid-rich species. These are, in the subtribe *Dendrobieae, Eria* and sections *Monanthos* and *Grastidium* of the genus *Dendrobium; Agrostophyllum, Mediocalcar* and *Glossorhyncha* in the subtribe *Glomereae; Podochilus* in the subtribe *Podochileae; Plocoglottis* in the subtribe *Phajeae; Bulbophyllum* in the subtribe *Bulbophylleae; Saccolabium, Taeniophyllum, Pomatocalpa* and *Vandopsis* in the subtribe *Sarcantheae.*

Acknowledgements

We wish to thank Mr. A. W. Dockrill, Keeper of the Lae Herbarium, for assistance in the field and for identifying all the orchids except those at the New Guinea Biological Foundation, which were identified by Mr. F. McKillop of Arawa Plantation, Bougainville. We also wish to thank Mrs. A. Millar for help in the field and Mr. J. Womersley, Chief, Division of Botany, Department of Forests, Lae, for use of the facilities of the Lae Herbarium. The following bodies supported this project by generous donations to the University of Sydney: The New Guinea Biological Foundation, The Bushell Trust, British Drug Houses (Aust.) Pty. Ltd., Tuta Laboratories (Australia) Pty. Ltd., H. B. Selby & Co. Pty. Ltd., and Ortho Pharmaceutical Co.

References

Arditti, J., 1966.—Orchids. *Scientific American*, 214 (1): 70–78.

Van Den Brink, R. C. B., 1937.—Synopsis of the Vernacular Names and the Economic use of the Indiginous Orchids of Java. *Blumea Suppl.*, 1: 38–51.

Caius, J., 1936.—The Medicinal and Poisonous Orchids of India. *J. Bombay Nat. Hist. Soc.*, 38: 791–799.

Cromwell, B. T., 1955.—In "Modern Methods of Plant Analysis, " IV Edited by K. Paech and M. V. Tracey, Springer-Verlag, Berlin.

Culvenor, C. C. J., and Fitzgerald, J. S., 1963.—A Field Method for Alkaloid Screening of Plants. *J. Pharm. Sciences*, 52: 303–304.

Donau, 1968.—Personal Communication at Arawa Plantation, Bougainville.

Hawkes, A. D., 1943.—Economic Importance of the Orchidaceae. *Am. Orchid Soc. Bull.*, 11: 412–415.

————, 1944.— Economic Importance of the Orchidaceae II. *Am. Orchid Soc. Bull.*, 13: 56–58.

Lawler, L. J., and Slaytor, M., 1969.—The Distribution of Alkaloids in New South Wales and Queensland *Orchidaceae. Phytochemistry*, in press.

Leander, K., and Lüning, B., 1968.—Studies in Orchidaceae Alkaloids IX *Tetrahedron Letters*, 1393–4.

Lüning, B., 1964.—Studies on *Orchidaceae* Alkaloids I. *Acta Chem, Scand.*, 18: 1507–1516.

————, 1966.—Chemotaxonomy in a *Dendrobium* Complex. *Proc. Fifth World Orchid Conf.*, 211–215.

————, 1967.—Studies of *Orchidaceae* Alkaloids IV. *Phytochemistry*, 6: 857–861.

McKillop, F., 1968.—Personal Communication.

Millar, A., 1968.—Personal Communication.

Ona, 1968.—Personal Communication at Arawa Plantation Bougainville.

Slaytor, M., 1969.—To be published.

Smith, J. J., 1927.—Orchids of Utility. *Orchid Review*, 35: 323.

Withner, C., 1959.— "*The Orchids: A Scientific Survey,*" The Ronald Press Company, New York.