

# A PHYTOCHEMICAL SURVEY OF MALAYA

## PART II. ALKALOIDS

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A phytochemical survey has been made of the plants of Malaya. The results of screening for alkaloids in 708 species of plants belonging to 104 families and 408 genera is reported.

In Part I (Douglas and Kiang, 1957) and in a communication to the Third Congress of the Pan Indian Ocean Science Association (Kiang and Douglas, 1957), the results were reported of the screening of the first 200 plants of the Malayan flora for the presence of alkaloids. These marked the beginnings of a systematic survey which has received much stimulation from, and is closely associated with, the phytochemical surveys conducted in the neighbouring countries especially in Australia (Webb, 1949), Papua-New Guinea (Webb, 1955), Borneo (Arthur, 1954) and South Moluccas (Bisset, 1957).

The collaboration between the University of Malaya in Singapore and various other institutions in Malaya in the Phytochemical Survey has been described in Part I. This report contains the screening results of 708 species of plants belonging to 104 families and 408 genera. Many of the plants screened are reputed by the aborigines, or recorded in the literature (Burkill, 1935), to possess medicinal or poisonous properties.

Amongst the plants screened, 144 species marked with \* were collected in Singapore in the Botanic Gardens and around the University campus and 18 species were collected in Selama, Perak, by Miss B. E. Copeland, who was attached to the St. John's Ambulance in Perak in 1957. The rest of the plants were collected by an officer of the Department of Chemistry, Federation of Malaya, often with the aid of one or two aborigines, in the following districts: Pulau Langkawi, Kedah; Fort Kemer, Perak; National Park, Pahang; and Ulu Langat Forest Reserve, Selangor.

The plants were identified by Professor H. B. Gilliland, Mr. Wong Phui Weng and Mr. K. M. Kochuman and herbarium specimens are kept in the herbaria of the Botany Department of the University of Malaya in Singapore, the Botanic Gardens, Singapore, and the Forest Research Institute, Kepong, Selangor.

### PROCEDURE

The procedure for alkaloid screening is as follows. 15 g. of finely-ground, well-dried plant material is mixed thoroughly with 15 ml. 2 N ammonium hydroxide and packed into a Soxhlet extractor using a 150 ml.

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capacity flask and extracted continuously with chloroform for about 6 hr. The chloroform extract is concentrated under reduced pressure at 50 to 70°. The solvent-free residue is rubbed thoroughly with 6 ml. 2 N hydrochloric acid. The acid extract, filtered through paper, if necessary, is divided into three equal quantities and placed in three test-tubes (capacity 4 ml. approx.). Each test solution is treated with 4 to 8 drops of one of the alkaloid reagents, Bouchardat, Dragendorff and Mayer. The production of a precipitate is indicative of the presence of alkaloidal material. A visual assessment of the quantity is made, for each of the reagents, on the following basis: heavy precipitate + + + +, strong precipitate + + +, weak precipitate + +, negligible precipitate +. The Bouchardat's reagent is prepared by dissolving 4 g. potassium iodide and 2 g. iodine in 100 ml. water. The Dragendorff's reagent is prepared by adding 8 g. bismuth nitrate, 20 ml. concentrated nitric acid, 27.2 g. potassium iodide to 50 ml. water, decanting off the supernatant from the deposited potassium nitrate and diluting the solution in 100 ml. with water.

RESULTS

The list of plants screened is given in Table I.

We have found that in the isolation of crude alkaloids from 2 to 5 kg. quantities of materials, generally plant parts giving strong precipitates with all three reagents would yield favourable amounts of alkaloids. Sixty-six species (9.3 per cent of total species tested) which have given strong precipitates are listed in Table II. From most plants we had selected from this table and from the similar table in Part I, we have been able to isolate crude alkaloids in various quantities. These plants and their approximate alkaloidal contents are listed in Table III. It is noteworthy that we have found that with *Trivalvaria pumila* (Anonaceae), *Lindera pipericarpa* (Lauraceae), *Coptosapelta flavescens* (Rubiaceae) and *Uncaria pteropoda* (Rubiaceae), the crude alkaloids could not be extracted by dilute acids from the residues of alcoholic extracts of the plant materials. The alkaloids were best isolated by treating the residues with ammonia and extracting with chloroform.

TABLE I

LIST OF PLANTS SCREENED FOR ALKALOIDS

(Plant parts are in parenthesis; l = leaves, s = stems, b = bark, r = root, p = pericarp, wp = whole plant, flr = flower, frt = fruit, sd = seed.)

- ACANTHACEAE—*Acanthus ilicifolius* (l, s); *Andrographis paniculata* (l and berries, s, r); *Asystasia coromandeliana*\* (l); *Gendarussa vulgaris* (l, s, r); *Pyssiglottis obovata* (l, s, r); *Rhaphidophora korthalsia* (wp); *Sanchehia nobilis*\* (l); *Staurogyne longifolia* (l, s, r); *Thunbergia laurifolia*\* (l, s).
- ALANGIACEAE—*Alangium javanicum* (l, s, b, frt).
- AMARYLLIDACEAE—*Curculigo villosa*\* (wp).
- ANACARDIACEAE—*Mangifera* sp. (l, frt); *Spondias pinnata* (r, frt).
- ANISOPHYLLEACEAE—*Anisophyllea* sp. (l, s, r).
- ANONACEAE—*Anaxagorea javanica* (l, s); *Cyathostemma hookeri* (l, s, r); *Desmos chinensis* (r); *Enicosanthum macaranthum* (s, r); *E. membranifolium* (l, s, r, b, frt); *Fissistigma* sp. (l, s, r); *Goniothalamus curtisii* (l, b); *G. giganteus* (l, s, r, b, flr, frt); *G. ovariodes* (l, s, r, b, frt); *G. ridleyi* (l, s, r, b, frt); *G. tenuifolius* (l, s); *Miliusa longipes* (l, s, b, r, frt); *Mitrephora maingayi* (l, s, r, b, frt); *Monocarpia marginalis* (l, r, frt); *Orophea polycarpa* (r); *Oxymitra affinis* (b, r, frt); *O. biglandulosa* (l, s, r); *O. kingii* (l, s, r); *O. latifolia* (l, s, r, frt); *O. sp.* (l, s, r, b); *Phaeanthus nutans* (l, s, b); *P. ophthalmicus* (l, s, r, b); *Polyalthia bullata* (l, s, r); *P. cauliflora* (l, s); *P. cauliflora* var. *desmantha* (l, s, r, b, p); *P. cinnamomea* (l, s, r, b, frt); *P. clavigera* (r, b); *P. laterifolia* (l, s, r, b); *P. rumphii* (l, s, r, b, frt); *P. stenopetala* (l, b, frt); *P. sumatrana* (l, s, r, b, frt); *P. sp.* (l and flr, r, b); *P. sp.* (l, r, b); *Popowia pisocarpa* (l, s, r, b, frt); *P. ramosissima* (l, s, r, b); *P. tomentosa* var. *crinita* (l, r, s); *P. sp.* (l, s, r, b); *Pseuduvaria setosa* (l, s, r); *Sageraea elliptica* (l, b, frt); *Trivalvaria macrophylla* (l, s, r); *T. pumila* (l, s, r); *Uvaria grandiflora* (l, s, frt); *U. sp.* (l, s, b, r).

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TABLE I—continued.

- APOCYNACEAE—*Aganosis marginata* (l, s, r); *Alstonia spatulata* (l, s, b, r); *Cerbera manghas* (l, s); *Chloocarpus costatus* (l, s, r, p, sd); *Chonemorpha penangensis* (l, s); *Epigynum maingayi* (r); *Hunteria corymbosa* = *H. zeylanica* (l); *Leuconotis griffithii* (l, s, r); *Lochnera rosea*\* (l, s, r); *Strophanthus caudatus* var. *marckii* (l, s); *Tabernaemontana coronaria* (l, s); *T. curtisii* (l, s, r); *T. malaccensis* (l, s, r); *T. pedunculata* (l, s, r, b); *Thevetia neriiifolia* (sd); *Willughbia coriacea* (r, b, frt).
- ARACEAE—*Aglagonema oblongifolium* (wp); *Amorphophallus campanulatus* (l, s, r, frt); *A. variabilis* (wp); *A. sp.* (s, tuber); *Anadendrum marginatum* (wp); *Colocasia antiquorum* (r); *Epipremnum giganteum* (l, s, r); *Homalomena propinqua* (l, s, r); *Scindapsus picta* (l, s); *Syngonium phodophyllum* (l, s).
- ARALIACEAE—*Aralidium pinnatifidum* (l, s, r, b, frt, sd); *Arthrophyllum borneense* (l, s, r); *A. diversifolium* (s, r, b, frt); *Scheffera fernata* (l, s, r); *S. subulata* (s, r, frt); *S. venulosa* var. *curtisii* (l, s, r); *Trevesia cheiranthia* (l, s, b, r, frt).
- ARISTOLOCHIACEAE—*Aristolochia curtisii* (r); *Thottea parviflora* (s, r).
- ASCLEPIADACEAE—*Hoya diversifolia*\* (l, s); *H. ridleyi* (l, s).
- BIGNONIACEAE—*Arrabidaea corymbosa*\* (l, s); *A. magnifica* (l, s); *Bignonia magnifica*\* (l, s); *Oroxylum indicum* (l, s, r); *Stenolobium stans*\* (l, s, frt).
- BIXACEAE—*Bixa orellana*\* (l, s, r, frt); *Hydnocarpus kurzii*\* (l, s).
- BOMBACACEAE—*Durio griffithii* (l, s, r, b, frt); *D. lowianus* (r, b, p, sd).
- BORAGINACEAE—*Cordia cylindristachya*\* (l, s, r); *Heliotropium indicum* (l, s).
- BURSERACEAE—*Canarium littorale* (l, s, r, frt); *C. maluense* (l, s, r, b, frt); *C. sp.* (l, s, r, b, frt); *Dacryodes floribunda* (l, s, r, b, frt); *D. rostrata* (l, s, r, b, frt); *D. aff. rugosa* (r, b); *Pachylobus edulis*\* (l, s); *Saniria laevigata* (r, b, frt); *S. rubiginosa* (l, s, r); *S. sp.* (l, s, b, frt); *Triomma malaccensis* (l, s, b, frt).
- CAMPANULACEAE—*Isotoma longiflora* (l, s, r, frt); *Pentaphragma begoniifolium*\* (l, s, r); *P. horsfieldii* (l, s, r).
- CAPPARIDACEAE—*Capparis* sp. (l, s, r).
- CASUARINACEAE—*Casuarina equisetifolia*\* (l, s).
- CELASTRACEAE—*Euonymus javanicus* (l, s, r, b, frt); *Glyptopetalum quadrangulare* (l, s, r); *Kurrimia paniculata* (r, frt).
- CHLORANTHACEAE—*Chloranthus officinalis* (l, s, r, wp).
- COMBRETACEAE—*Quisqualis indica*\* (l, s); *Terminalia belerica* (l, r, b, frt); *T. inelleri*\* (l, s).
- COMMELINACEAE—*Floscopa scandens* (wp); *Forrestia cf. griffithii* (l, s, r); *Pollia sorzogonensis* (wp).
- COMPOSITAE—*Ageratum conyzoides* (l, s, r, frt); *Same sp.*\* (l, r, frt); *Blumea myrtocephala* (l, r, s); *Cosmos bipinnatus* (s); *Elephantopus scaber* (l, s, r); *Erechthites valerianifolia*\* (l, r, frt); *Leuzea speciosa*\* (l, s); *Mikania scandens* (wp); *Synedrella nodiflora*\* (l, s).
- CONNARACEAE—*Cnestis palala* (l, s, r, sd); *Connarus* sp. (l, s, r, b, frt); *Rourea fulgens*\* (l, s).
- CONVOLVULACEAE—*Argyrea capitata* (l, s, r); *A. kunstleri* (l, s, r, b, frt); *Maripa nicaranguensis*\* (l, s).
- CORNACEAE—*Aralidium pinnatifidum* (l, s, r).
- CUCURBITACEAE—*Gymnomorium integrifolium* (frt); *Hodgsonia capnicarpa* (l, s, r, b, sd, p); *Melothria affinis* (wp); *Trichosanthes celebica* (wp).
- CYPERACEAE—*Hypolytrum latifolium*\* (l); *Scleria* sp.\* (wp).
- DILLENIACEAE—*Dillenia eximia* (l, s, r, b, frt); *D. ovata* (r, b, frt); *Tetracera akara* (l, s, r, frt); *T. fagifolia* var. *fagifolia* (l, s, r); *T. scandens* (l, s, sd, frt); *T. sylvestris*\* (l, s); *Wormia suffruticosa* (l, s, r, frt, frt); *Same sp.*\* (l, s).
- DIOSCOREACEAE—*Dioscorea glabra* var. *pahangensis* (l, s, r); *D. hispida* (l, s, r); *D. piscatorium* (s, tuber); *D. scortechinii* (l, s, r, frt); *D. sp.* (s, tuber); *D. sp.*\* (wp).
- DIPTEROCARPACEAE—*Shorea ovalis* (l, s, r).
- EBENACEAE—*Diospyros argentea* (l, s, r, b); *D. malabarica* (l, b, r, frt); *D. malayana* (l, s, r, b, frt); *D. notans* (b, frt); *D. oblonga* (l, s, b, frt); *Same sp.*\* (l, s); *D. pendula* (l, s, r); *D. subrhomboides* (l, s, r, b, frt); *D. sumatrana* var. *decipiens*\* (l and twigs, s, r); *D. sumatrana* var. *flavicans* (l, s, r, b); *D. wallichii* (l, s, r, b, frt).
- ELAEOCARPACEAE—*Elaeocarpus petiolatus* (l, s, r, b, frt, frt); *E. sphaericus* (l, r, b, frt); *E. stipularis* (l, s, r); *E. sp.* (l, s, r, frt).
- EUPHORBIAEAE—*Acalypha macrophylla*\* (l, s); *A. siamensis* (l, s); *Same sp.*\* (l, s); *Antidesma bunius*\* (l); *A. stipularis* (l, s, r, frt); *A. velutinum* (l, r, s, b, frt); *Aporosa arborea* (l, s, r); *A. aurea* (l, s, r, b, frt); *A. benthamiana* (l, s, r, b, frt); *A. confusa* (l, s, r, b, frt); *A. nervosa* (l, r, b); *A. selangorica* (l, s, r, b); *A. sympleocoides* (l, s, r, b, frt); *Baccaurea brevipes* (l, s, r, b, frt); *B. griffithii* (l, s, r, b, frt); *B. lanceolata* (l, s, r, b, frt); *B. macrophylla* (l, s, frt); *B. motleyana* (l, s, p, frt); *Same sp.*\* (l, s); *B. parviflora* (l, s, r, b, frt); *Same sp.*\* (l, s); *B. sapida* (l, s, r, b, frt); *B. sp. aff. lanceolata* (l, r, frt); *B. sp.*\* (l, s, frt); *Blumeodendron tokbrai* (b, frt); *Bridelia tomentosa* (l, s, r, frt); *Same sp.*\* (l, s); *Claoxylon longifolium* (b, frt); *Cleistanthus hirsutus* (l, s, r, b, frt); *Coccoceras muticum* (l, s, r, b, frt); *Croton argyратum* (r); *C. caudatus* (l, s, r, b); *C. griffithii* (l, s, r, b, frt); *C. sp.*\* (l, s); *C. sp.* (l, s, r, b, frt); *C. sp.* (l, s, r, b, frt); *Elaterospermum tapos* (l, s, frt); *Endospermum malacense* (l, s, r); *Epirinus malayana* (l, s, r, b, frt); *Euphorbia heterophylla* (wp); *E. neriiifolia*\* (l, s); *Excoecaria agallocha* (l, b, s); *Galearia fulva* (l, s, r); *G. phleboearpa* (l, s, r, b); *Glochidion superbum* (l, s, r, b, frt); *Hevea brasiliensis*\* (l, s, r, sd); *Jatropha curcas* (l, s); *J. gossypifolia* (l, s, r); *Macaranga hypoleuca* (b); *M. lowii* (l, r, b); *M. robinsonia* (l, s, b); *M. tanaria* (l, s, r); *M. triloba* (l, s, r, b, frt); *Mallotus paniculatus* (l, s, r, b, frt); *M. portierianus* (l, s, b); *Neoscortechina paniculata* (l, s, r, frt); *Phyllanthus frondosus*\* (l, s, r); *Pimeleodendron griffithianum* (l, s, r, b, frt); *Trigonostemon longifolium* (l, s, r); *T. villosus* (l, s, r).
- FAGACEAE—*Castanopsis curtisii* (r, frt); *Pasania encleisocarpa* (r, b, frt); *P. semiserrata* (l, r, b, frt); *Quercus spicata* (l, r, b, frt).
- FLACOURTIACEAE—*Barleria cristata*\* (l, s); *Casearia clarkeii* (l, s, r, b); *C. sp.* (l, s, r, b, frt); *Flacourtia rukam*\* (l, s); *Hydnocarpus* sp. (l, s, frt); *Osmelia maingayi* (l, s, r, b, frt); *Pangium edule* (l, r, b); *Ryparosa fasciculata* (l, s); *R. scortechinii* (l and frt, r).
- FLAGELLARIACEAE—*Susum malayanum* (wp, frt).
- GESNERIACEAE—*Cyrtandra cupulata* (l, s, r); *C. lanceolata* (l, s and R); *C. pilosa* (l, s, r); *Cyrtandromoea acuminata*\* (l, s, r).
- GNETACEAE—*Gnetum gnemon*\* (l, s); *G. gnemon* var. *domesticum* (l, s, r); *G. gnemon* var. *tenerum* (l, s, r); *G. macrostachyum* (l, s, r, frt); *G. tenuifolium* (l, s, r); *G. aff. tenuifolium* (s, r, b, frt).
- GRAMINEAE—*Bracharia mutica*\* (wp); *Centotheca lappacea*\* (wp); *Lophatherum gracile* (r).
- GUTTIFERAE—*Calophyllum inophylloide* (r, b, frt); *Garcinia atroviridis* (l, s, r); *G. bancana* (l, s, r, frt); *G. dulcis*\* (l, s); *G. eugeniaefolia* (l, s, r, b); *G. prainiana* (l, s, r, b, frt); *G. sp.* (l, s, r, b); *G. sp.* (l, s, r, b, frt); *G. sp.* (l, s, r, b, frt); *G. sp.* (l, s, r, b, frt); *G. sp.* (l, s, r, b); *G. sp.*\* (l, s); *Kayea racemosa* (l, r, b, frt).
- HYPERICACEAE—*Cratoxylon* sp.\* (l, s).
- ICACINACEAE—*Gomphandra affinis* (l, s, r); *Phytocrene bracteata* (s, r, b, frt); *P. oblonga* (l, s, r, b, frt); *Sarcostigma aff. kleinii* (s, r, frt).
- LABIATEAE—*Gomphostemma scortechinii* (l, s, r); *Hyptis capitata* (wp); *Orthostiphon grandiflorus*\* (l).

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TABLE I—continued.

- LAURACEAE**—*Actinodaphne glomerata* (s, r); *Actinodaphne sesquipedalis* (l, s, r, b, frt); *Alseodaphne peduncularis* (l, s, r); *A. petiolaris* (l, s, r, b, frt); *Beilschmiedia* sp. (r, b, frt); *Cinnamomum iners* (l, s, r, b, frt); *C. iners*\* (l, s); *Cryptocarya griffithiana* (l, s, r, frt); *Lindera pipericarpa* (l, r, b); *Litsea cubeba* (l, s); *L. firma* (l, s); *L. robusta* (l, s, r, b, frt); *L. spathacea* (l, s, r, b, frt); *L. spathacea* var. *tomentosa* (l, s, r); *L. sp.* (l, s, r); *L. sp.* (l, s, b, frt); *Nothophoebe panduriformis* (l, s, r, b); *Phoebe opaca* (l, s, r, b); *P. taroyana* (l, s, r); *Stemmatodaphne perakensis* (l, s, r, b, frt).
- LECYTHIDACEAE**—*Barringtonia cylindristachya* (l, s, r, b, frt); *B. fusiformis* (l, s, r, b); *B. macrostachya* (l, s, r, b, frt); *Courotropia glandinifera*\* (l).
- LEGUMINOSAE**—*Adenanthera pavonina*\* (l, s, sd); *Alysicarpus nummularifolius* (wp); *Andira surinamensis*\* (l, s); *Bauhinia calycina* (s, r, b, frt); *B. integrifolia* (l, s, r, b); *B. purpurea* (wp); *B. sp.*\* (l, s); *Caesalpinia pulcherrima*\* (l, s, sd); *Calapogonium mucunoides* (l and s); *Calliandra surinamensis*\* (l, s); *Camoensia maxima*\* (l); *Cassia leschenaultiana* (wp); *C. nodosa* (l, s, frt); *C. occidentalis*\* (l, s, r, sd); *C. surattensis*\* (l, s, frt); *Centrosema pubescens* (l and s); *Clitorea* sp.\* (l, s, r, sd); *Crotalaria striata*\* (l, s, r, sd); *C. verrucosa*\* (l, s, r, sd); *Cynometra inaequifolia* (l, s, r, b, frt); *Derris malaccensis* var. *aptera* (l, s, frt); *D. sinuata*\* (l); *D. sp.* (l, s, r, frt); *Desmanthus virgatus* cf. *also D. depressus* (s, r); *Desmodium ovalifolium*\* (l, r, frt); *Entada scandans* (l, s, r, b, frt); *E. spiralis* (l, r, b); *Euterolobium samar*\* (s, l); *Flemingia congesta*\* (l, s, r, sd); *F. strobilifera* (l, s, r); *Glyricidia maculata* = *G. sepium* (l, s, frt); *Same* sp.\* (l, s); *Indigofera teysmanii* (l, s); *Koompassia malaccensis* (l, s, r, b, frt); *Leucaena glauca*\* (l, s, sd); *Milletia albiflora* (l, s, r, b, frt); *M. atropurpurea*\* (l, s); *Mundulea sericea* (l, s, r); *Padbruggea mangayi* (s, b, sd); *Parkia singularis* (l, r, p); *P. speciosa*\* (l, s, frt); *Peltophorum pterocarpon*\* (s); *Phyllolcarpus septentrionalis*\* (l, s); *Pithecellobium jiringa*\* (l, s); *Poinciana regia*\* (l, s, frt); *Pterocarpus indicus* (l and s, b); *Pueraria phaseoloides* (l and s); *Saraca* sp.\* (l, s); *Sesbania punctata* (l, s, r); *Swartzia pinnata*\* (l, s); *Tephrosia maxima*\* (l, s, r, sd); *Xylocarpus kerrii*\* (l, s).
- LILIACEAE**—*Dianella ensifolia* (wp); *Dracaena conferta* (l, s, r); *D. congesta* (wp); *D. finlaysonii* = *D. graminifolia* (l, s, r); *D. graminifolia*\* (l, s); *D. umbratica* (l, s, r, b, frt); *Peliosanthes lurida* (wp); *Smilax barbata* (l, s); *Same* sp.\* (l, s); *S. calophylla* (l, s, r); *S. mysositifera* (l and s, r and tuber).
- LINACEAE**—*Ixonanthes icosandra*\* (l, s); *R. griffithiana* (l, s, r, b); *Same* sp.\* (l, s); *R. griffithii* (l, s, r).
- LOGANIACEAE**—*Fagraea* sp. (l, s, r); *Strychnos ovalifolia* (s, r).
- LORANTHACEAE**—*Dendrophthoe grandifrons* (l, s, r).
- LYCOPODIACEAE**—*Lycopodium cernuum*\* (wp).
- LYTHRACEAE**—*Duabanga sonneratioides* (l, r, b, frt); *Lafoesia punicea* (l, s).
- MALPIGHIACEAE**—*Brysonima crassifolia*\* (l, s).
- MALVACEAE**—*Hibiscus macrophyllus*\* (s, r); *Sida rhombifolia* (l, s, r); *Urena lobata*\* (l, s).
- MARANTTIACEAE**—*Angioperis evecta* (wp).
- MELASTOMACEAE**—*Allomorphia malaccensis* (l, s, r); *Anplectrum pallens* (l, s, r, frt); *Blastus caudatus* (l, s, r, frt); *Clidemia hirta* (l, s, r); *Dissochaeta hirsuta* (l, s, r, frt); *Marumia rufolanata* (l, s, r); *Medinilla speciosa* (l, s, frt); *Melastome* sp. (l, s, r, frt); *Memecylon coeruleum*\* (l, s); *M. dichotomum* (l, s, r, b, frt); *M. minutiflorum* (l, s, r, b); *M. myrsinoides* (l, s, b); *Phyllagathis rotundifolia* (l and s, r, frt); *Pogonathera pulverulenta* (l, s, r, frt); *Pternandra echinata* (l, s, r, b); *Same* sp.\* (l, s); *Sonerilla begoniaefolia* (wp); *S. heterostemon* (wp).
- MELIACEAE**—*Aglaia argentea* (l, s, b, frt); *Amoora ridleyi* (p, sd); *Carapa granatum*\* (l); *C. guianensis*\* (l, s); *Chikrasia tabularis* (r, b, frt); *Chisocheton macrothyrsus* (s, r, b, rb); *C. sp.* (r, b, p, sd); *C. sp.* (l, s, r, b, frt); *C. sp.* (l, s, r, b); *C. sp.* (l, s, b, frt); *Dysoxylum arboreescens* (l, s, r, frt); *D. cauliflorum* (l, s, r); *D. costatum* (b, frt); *D. thyrsoideum* (r, b, p, sd); *D. sp.* (r, b, p, sd); *D. sp.* (l, s, r, b, frt); *D. sp.* (l, s, r, b, frt); *D. sp.* (l, s, r, b); *D. sp.* (l, s, r, b, frt); *Lansium domesticum* (l, s, r, b, frt); *Melia indica* (l, s, frt).
- MENISPERMACEAE**—*Arcangelisia loureiri* (l and s, r); *Oscinium wallichianum* (l, s); *Cyclea laxiflora* (wp); *Fibraurea chloroleuca* (l, s, r, frt); *Limacia oblonga* (l, s, r); *L. velutina* (l, s, r); *L. sp.* (l, s, b, r); *Timoniscium petiolare* (l, s, r, frt); *Tinospora tuberculata* = *T. crispata* (s).
- MORACEAE**—*Artocarpus gomezianus* (r, frt); *Same* sp.\* (l, s); *A. griffithii* (l, s, r, b, frt); *A. integer* (l, s); *Same* sp.\* (l, s); *A. lanceifolius* (l, b, frt); *A. lowii* (s); *A. kemando* (l, s, p, sd); *Conocephalus* sp. (l, s, r); *Ficus alba* (l, s, r, b, frt); *F. annulata* (l, b, r, frt); *F. aurantiaca* (l, s, r, frt); *F. aurata* (l, s, r, frt); *F. deltoidea* var. *litocens* (l, s, r, b); *F. depressa* (s, b, frt); *F. fistulosa* (l, s, r, b, frt); *Same* sp.\* (l, r, sd); *F. fulva* (l, s, b, frt); *F. geocarpioides* (l, s, b, frt); *F. kurzii*\* (l, s); *F. lepicalpa* (l, s, r, frt); *F. montana* var. *arbuscula* (l, s, frt); *F. villosa*\* (l, s); *F. sp.* (l, s, r, frt); *F. sp.*\* (l, s); *Hulletia dimosa* (l, s, r); *Sloetia elongata* (l, s, r); *Treculia africana*\* (l, s).
- MYRISTICACEAE**—*Gymnacranthera forbesii* (l, s, r, b, frt); *Horsfieldia superba* (l, s, r, b, frt, sd); *Knema curtisii* (l, s, r, b, frt); *K. glaucescens* var. *patentinervia* (l, s, r, b); *K. laurina* (l, s, r, b, frt); *K. oblongifolia* var. *monticola* (l, s, r, b, frt); *K. cf. laurina* (r, b, sd, p); *Myristicea hollnugii* (l, s, r, b, frt).
- MYRSINACEAE**—*Ardisia andamanica* (l, s, r); *A. colorata* var. *complanata* (l, s, r); *A. fulva* (l, s, r); *A. goodenoughii* forma (l, s, r); *A. lanceolata* (l, s, r, b, frt); *A. lurida* (l, r, b); *A. solanacea* (l, s, r); *A. villosa* (wp); *A. sp.* (l, s, r, b); *Embelia garciniaefolia* (s, r); *E. ribes*\* (l, s, r, frt); *E. rugosa* (b, r, frt); *Labisia ptochina* (l, r); *L. ptochina* var. *alata* (l, s, r); *Maesa macrothyrsa* (l, s, r, b, frt); *M. ramentacea* (l, s, r, b, frt).
- MYRTACEAE**—*Eugenia grandis* (l, s, b, frt); *E. macrocalyx*\* (l); *E. nigricans* (b, r, frt); *E. pachyphylla* (l, s, r, frt); *E. papillosa* (l, s, r, frt); *E. polyantha* (l, s, r); *Same* sp.\* (l, s); *E. scortechinii* (l, r, frt); *E. tumida* (l, r); *E. variolosa* (l, s, b, frt); *Lectythis ollaria*\* (l, s); *Psidium guajava*\* (l, s); *Rhodamnia trinervia*\* (l).
- OCHNACEAE**—*Gomphia lanceolata* (l, s, r, b).
- OLACACEAE**—*Erythrophalum scandens* (l, s, r); *Ochanostachys amentacea* (l, s, r, b, frt); *Phlebocalymna pyriforme*\* (l, s); *Phytocrene bracteata* (s).
- OLEACEAE**—*Jasminum bifarium* (l, s); *Linociera insignis* (l, s, r, b, frt); *Myoxopyrum nervosum* (l, s, r, frt).
- ORCHIDACEAE**—*Calanthe ceciliae* (wp); *Ceratostylis subulata* (wp); *Corymborchis veratrifolia* (l and s, r); *Oberonia anceps* (wp).
- OXALIDACEAE**—*Oxalis corniculatus*\* (wp).
- PALMAE**—*Calamus orantus* (l, s, frt, p, sd); *C. sp.* (l, s); *C. sp.* (l, s, frt); *C. sp.* (l, s, frt); *C. sp.* (l, s, r, frt); *C. sp.* (l, s, r); *Caryota mitis* (l, r, s); *Orania macrocladus* (l, frt, Palm Cabbage); *Pinanga cf. disticha* (l, s, r); *Plectocomopsis geminiflorus* (l, s, frt).
- PASSIFLORACEAE**—*Adenia* sp. (l, s, r, frt); *Passiflora foetida*\* (l, r, frt); *P. laurifolia* (l and s).
- PIPERACEAE**—*Peperomia pellucida*\* (wp); *Piper caninum* (l, s, r); *P. kurzii* (l, s, r); *P. muricatum* (l, s, r); *P. porphyrophyllum* (l, s, r); *P. ribesoides* (l, s, r); *P. ridleyi* (l, s, r); *P. sarmentosum*\* (wp); *P. semangkoanum* (l, s, r); *P. stylosum* (l, s, r); *P. triandrum* (l, s, r); *P. sp.* (wp).
- PLUMBAGINACEAE**—*Plumbago zeylanica* (l, s, r).
- POLYGALACEAE**—*Polygala venosus* (l, s, r); *Xanthophyllum affine* (l, s, r, b, frt); *X. palembanicum* (l, s, r, b).
- POLYPODIACEAE**—*Antrophyum callifolium* (wp).
- PROTEACEAE**—*Buckinghamia celsissima*\* (l, s); *Helicea attenuata* (l, s, r, b, frt).
- RHAMNACEAE**—*Ventilago malaccensis* (l, s, r, b).

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TABLE I—continued.

- RHIZOPHORACEAE—*Anisophylos corneri* (s, r, frt); *A. griffithii* (r, b, frt); *Bruguiera cylindrica*\* (l); *Carallia suffruticosa* (l, s, r); *Pellacolla axillaris* (s, r, b).
- ROSACEAE—*Eriobotrya japonica*\* (l, s); *Parastemon urophyllum*\* (l, s); *Pyrus gramelosa* (l, s, r, b, frt); *Raphiolepis indica*\* (l, s).
- RUBIACEAE—*Argostemma elaiostemma* (wp); *Aulacodiscus premnoides* (l, s, r, b); *Canthium horridum* (l, s, r); *Chasalia pubescens* (l, s, r); *Coptosapelta flavescens* (l, s, r); *Greenia jackii* (l, s, r); *Hedyotis congesta* (l, s, r); *H. capitellata* (l, s, r); *Ixora congesta* (l, s, r); *I. javanica* (s, r); *I. kingstonii* (l, s, r, b, frt); *I. pendula* (l, s, r); *I. sp.*\* (l, s); *Lasianthus attenuatus* (l, s, r); *L. maingayi* (l, s, r); *L. sp.* (l, s, r); *Morinda citrifolia* (l, s, r); *M. elliptica*\* (l, r, b, frt); *Mussaenda glabra* (l, s); *M. mutabilis* (l, b); *M. oblonga* (l, s, r); *M. villosa* (l, s, r, b, frt); *Mycetia javanica* (wp); *Nauclera junghuhnii* (l, r, b); *N. maingayi* (s, r); *N. subdita* (l, s, r, b, frt); *Ophiorrhiza communis* (l, s, r); *O. discolor* (l, s, r, frt); *O. hispidula* (s, r); *Pavetta graciliflora* (l, s, r, frt); *P. indica* (l, s, r, b); *Psychotria calocarpa* (l, s, r); *P. griffithii* (l, s, r); *P. malayana* (l, s, r, b, frt); *P. montana* (l, s, r); *P. sarmentosa* (l, s, r); *P. viridiflora* (l, s, r, b, frt); *P. viridifolia*\* (l, s, r, frt); *Randia anisophylla* (l, r, b, frt); *R. densiflora* (l, s, r, b, frt); *R. exaltata* (l, s, r, b, frt); *R. scortechinii* (l, s, r, b, frt); *R. stenopetala* (s, r); *Rennellia speciosa* (l, s, r); *Stylocoryne mollis* (l, s, r, b, frt); *Tarenna salicina* (l, s, r); *T. wallichii* (s, r); *Timonium wallichianus* (l, s); *Uncaria gambir* (s, r); *U. glabrata*\* (l, s, r); *U. parviflora* (l, s, r); *U. pteropoda* (l, s, r); *U. sclerophylla* (l, s, r, b); *Urophyllum blumeanum* (l, s, r); *U. glabrum* (l, s, r, frt); *U. griffithianum* (l, s, r); *U. trifurcum* (l, s, r, b, frt); *U. umbellatum* (l, s, r, b, frt); *Xanthophyllum sp.* (l, s, r).
- RUTACEAE—*Clausena harmadilana*\* (l); *Evodia latifolia* (l, s, r, b, frt); *E. cf. macrocarpa* (r); *Glycosmis sapindoides* (l, r); *G. chlorosperma* (l, s, r, b); *G. malayana* = *G. chlorosperma* (l, s, r); *Micromelum pubescens* (l, s, r); *Paranigma lobata* = *P. andamanica* (r); *Tetractomia roxburghii* (l, s, b, frt); *Xanthophyllum obscurum* (l, s, r, b, frt).
- SAPINDACEAE—*Lepisanthes cuneata* (l and frt, s); *L. sp.* (l, s, r); *Nephelium lappaceum* (l, s, r); *N. malaïense*\* (l, s); *N. mutabile* (l, s, r, b); *Pometia pinnata* (l, s, r, b, frt); *Same sp.*\* (l, s); *Xerospermum sp.* (l, s, r, b).
- SAPOTACEAE—*Chrysophyllum cainito*\* (l, s); *Madhuca longifolia*\* (l, s); *Manilkara kauki*\* (l, s); *Mimusops elengi*\* (l, s); *Palaquium hispidum* (l, frt); *Payena lucida* (l, b, r, frt); *Same sp.*\* (l, s); *Pouteria sp.* (r, b, frt).
- SCHIZAEACEAE—*Lygodium circinnatum* (l, s, r); *Schizaea digitata* (wp).
- SCROPHULARIACEAE—*Curanga amara* (wp).
- SIMARUBACEAE—*Eurycoma apiculata* (l, s, r); *E. longifolia* (l, s, r, wood).
- SOLANACEAE—*Solanum torvum* (s, r); *S. verbascifolium* (l, s, r).
- STERCULIACEAE—*Pterospermum jackianum* (B); *Scaphium macropodum* (b); *Sterculia laevis* (l, s, r); *S. macrophylla* (l, r, p, sd); *S. parviflora* (l, s, r, b, p, sd).
- TACCACEAE—*Tacca cristata* (wp).
- TERNSTROEMACEAE—*Adinandra dumosa*\* (l, s); *Saurauja cauliflora* (l, r, b); *S. nudiflora* (l, s, r, b, frt); *S. tristyla* (l, s).
- THEACEAE—*Pyrenaria acuminata* (l, s, r, b, frt).
- THYMELAEACEAE—*Linostoma pauciflora* (r).
- TILIACEAE—*Grewia antidemifolia* (l, s, r, frt); *G. umbellata* (l, s, r); *Honckenia ficifolia* (l, s); *Trichospermum kurzii* (l, s, r, b, frt); *T.ymbiforme* (l, s, r).
- TURNERACEAE—*Turnera ulmifolia* (l, s, r).
- ULMACEAE—*Gironneria nervosa* (l, s, r, b, frt); *Same sp.*\* (l, s); *Trema amboinensis* (l, s, r).
- URTICACEAE—*Elatostema latifolium* (wp); *E. repens* (wp); *E. cf. integrifolia* (wp); *Laportea stimularis* (l, s, r); *Poikilospermum subtrivernium* (wp); *Pouzolzia viminea* (l, s, r); *Sloetia elongata*\* (l, s); *Streblus asper*\* (l).
- VERBENACEAE—*Avicennia alba*\* (l); *Callicarpa furfuracea* (l, s, r, frt); *C. reeresii*\* (l, s); *Clerodendron fragrans* (l, s, r); *C. serratum* (l, s, r, frt, frt); *C. thomsonae*\* (l, s); *C. umbratile* (l, s, r); *C. villosum* (l, s, r); *Duranta repens*\* (l, s, frt); *Faradaya papuana*\* (l, s); *Gmelina arborea*\* (l, s); *Premna foetida* (l, s); *Stachytarpheta indica* (l, s, r); *Sphenodesme trifolia* (l, s); *Vitex heterophylla* (l, s, b, frt); *V. negundo* (l, s, r); *Same sp.*\* (l, s); *V. pubescens* (l, s, b, r); *V. vestita* (l, s, r, frt).
- VIOLACEAE—*Alsodeia sp.* (l, s, r, b, frt); *Linoria sp.* (l, s, b, frt).
- VITACEAE—*Leea sambusina* (s, b, frt); *L. sp.* (l, s, r, b); *Pterisanthes cissoides* (wp); *Vitis augustifolia* (l, s, b). *V. curtisii* (l, s, b, frt); *V. furcata*\* (l, s); *V. glaberima* (wp); *V. kunstleri* (l, s, frt); *V. lawsoni* (l, s, r); *V. lanceolaria* (l, s, frt); *V. mollissima* (l, s, r, frt); *V. novemfolia* (l, s, r); *V. pendularis* (l, s, r, frt); *V. cf. scortechinii* (l, s, r, frt).
- ZINGIBERACEAE—*Achasma sphaerocephalum* (l, s, r); *Alpinia rafflesiana* (s, r); *Amomum hastilabium* (l, s, r, p, sd); *Costus lucanngianus*\* *C. ridleyi* (l, s); *C. speciosa* (l, s, r); *Globba aurantica* (l, s); *Hornstedtia sp.*\* (wp); *Languas melanocarpa* (r); *Zingiber griffithii* (l, s, tuber).

TABLE II

PLANTS SOME PARTS OF WHICH HAVE GIVEN STRONG PRECIPITATES WITH EACH OF THE BUCHARDAT'S, DRAGENDORFF'S AND MAYER'S REAGENTS, AND WHICH ARE CONSIDERED TO CONTAIN ALKALOIDS

(Parts in parenthesis; abbreviations same as those in Table I.)

- ACANTHACEAE—*Gendarusa vulgaris* (s, r).
- ANONACEAE—*Cyathostemma hookeri* (r); *Fissistigma sp.* (s); *Milusa longipes* (s, b, r); *Monocarpia marginalis* (r); *Oxymitra sp.* (l, s, r, b); *Phaenanthus nutans* (l, b); *P. ophthalmicus* (l, s, r, b); *Popovia piscocarpa* (l, b, s); *P. ramosissima* (l, s, r, b); *P. sp.* (l, s, r, b); *Trivalvaria macrophylla* (l, s); *T. pumila* (r).
- APOCYNACEAE—*Alstonia spatulata* (b); *Chilocarpus costatus* (r); *Chonemorpha penangensis* (l, s); *Leucotonis griffithii* (l, s, r); *Lochnera rosea* (l, s, r); *Tabernaemontana coronaria* (l, s); *T. malaccensis* (l, s, r); *T. peduncularis* (l, r).
- BORAGINACEAE—*Heliotropium indicum* (s).
- CAMPANULACEAE—*Isotoma longiflora* (l, frt, r).
- CONNARACEAE—*Connarus sp.* (frt).
- DIOSCORACEAE—*Dioscorea hispida* (s, r).
- EBENACEAE—*Diospyros subrhomboides* (s, frt).
- EUPHORBACEAE—*Baccarea motleyana* (frt).
- ICACINACEAE—*Gomphandra affinis* (l, s, r); *Phytocrene bracteata* (frt); *P. oblonga* (frt).
- LAURACEAE—*Actinodaphne sesquipedalis* (l, s, r, b); *Aloedaphne peduncularis* (l, s, r); *A. petiolaris* (l, s, r, b, frt); *Lindera pipericarpa* (r); *L. spathacea* (r); *L. spathacea var. tomentosa* (r); *Phoebe opaca* (l, s, r, b); *P. taroyna* (l, s, r); *Stemmatodaphne perakensis* (l, s, r, b, frt).

PHYTOCHEMICAL SURVEY OF MALAYA. PART II

TABLE II—continued.

LEGUMINOSAE—*Dracaena conferta* (l); *Enterolobium saman* (l, s); *Indigofera teysmanii* (s); *Pterocarpus indicus* (l).  
 LOGANIACEAE—*Strychnos ovalifolia* (s, r).  
 MENISPERMACEAE—*Arcangelisia loureiri* (l, s, r); *Coscinium wallichianum* (l, s); *Cyclea laxiflora* (wp); *Fibraurea chloroleuca* (b, r); *Limacia oblonga* (r); *Tinomisium petiolare* (s, r).  
 PALMAE—*Plectocomiopsis geminiflorus* (frt).  
 PIPERACEAE—*Piper porphyrophyllum* (l, s, r).  
 RUBIACEAE—*Coptosapelta flavescens* (r); *Hedyotis capitellata* (r); *Nauclea maingayi* (s, r); *Pavetta graciflora* (l, s, frt); *P. indica* (l); *Psychotria montana* (l, s, r); *Randia stenopetalata* (r); *Uncaria gambir* (s, r); *U. parviflora* (l, s, r); *U. pteropoda* (l, s, r); *U. umbellatum* (l).  
 RUTACEAE—*Evodia latifolia* (r); *Glycosmis sapindoides* (l, r); *G. malayana* (r).  
 SIMBARUBACEAE—*Eurycoma apiculata* (s, r).  
 OL. NACEAE—*Solanum verbascifolium* (r).

TABLE III

LIST OF PLANT MATERIALS FROM WHICH CRUDE ALKALOIDS HAVE BEEN ISOLATED

Alkaloids which have been isolated in crystalline form are mentioned in the remarks column. Some investigations (†) have been carried out by Dr. I. J. Pachter in the Smith, Kline and French Laboratories in Philadelphia. Abbreviations: wb = weak bases (extracted at pH ca. 9); sb = strong bases (extracted at pH > 10); tb = total bases = wb + sb; qb = quaternary bases; rb = reduced bases. Abbreviations for parts of plants are the same as those in Table I.

Plant	Part	Per cent alkaloids	Remarks
ANONACEAE <i>Desmos chinensis</i> .. .. .	r	0.05 wb	Paper chromatogram shows 8 to 10 bases present†
<i>Popowia pisocarpa</i> .. .. .	l and s	0.02 tb†	
<i>Trivalvaria pumila</i> .. .. .	l and s s and r	0.71 qb† 0.09 wb	Paper chromatogram shows 2 to 3 bases present†
APOCYNACEAE <i>Chonemorpha penangensis</i> .. .. .	s	0.08 wb	
<i>Hunteria corymbosa</i> .. .. .	s	0.33 sb	
<i>Tabernaemontana malaccensis</i> .. .. .	l	0.15 wb	
	l	0.02 sb	
	s	0.11 wb	Crystalline alkaloid C <sub>21</sub> H <sub>27</sub> N <sub>3</sub> O <sub>3</sub> , m.p. 220°, isolated (Chan, 1959)
	s	0.18 wb	
LAURACEAE <i>Andrographis paniculata</i> .. .. .	l and s	0.02 wb	
<i>Lindera pipericarpa</i> .. .. .	r	0.03 wb	
LEGUMINOSAE <i>Enterolobium saman</i> .. .. .	l	1.54 sb	
LOGANIACEAE <i>Fagraea fragrans</i> .. .. .	s	0.03 wb	
	s	0.07 rb	
MAGNOLIACEAE <i>Michelia champaca</i> .. .. .	l	0.07 wb	
	l	0.035 sb	
	s	0.10 wb	
	frt	0.10 wb	
OLACACEAE <i>Phlebocalymna pyriforme</i> .. .. .	s	0.003 wb	
PALMAE <i>Plectocomiopsis geminiflorus</i> .. .. .	frt	0.45 sb	Principal alkaloid is plectocomine, C <sub>11</sub> H <sub>15</sub> N <sub>3</sub> O <sub>4</sub> , m.p. 294° (new alkaloid). Crystalline salts: acetate, m.p. 295°; picrate, m.p. 240°; hydrochloride and sulphate, m.p. > 300° (Chan, 1959)
RUBIACEAE <i>Coptosapelta flavescens</i> .. .. .	r	0.04 wb	
	r	0.03 sb	
	r	trace qb	
<i>Nauclea maingayi</i> .. .. .	r	0.024 wb	
<i>Pavetta indica</i> .. .. .	l	0.25 tb	
<i>Randia nacranta</i> .. .. .	l	0.08 tb	
<i>Uncaria pteropoda</i> .. .. .	r	0.2 wb	Crystalline alkaloids isolated C <sub>21</sub> H <sub>24</sub> N <sub>2</sub> O <sub>4</sub> , m.p. 202–203°, [α] <sub>D</sub> <sup>20</sup> - 14°; C <sub>21</sub> H <sub>28</sub> N <sub>2</sub> O <sub>4</sub> , m.p. 215–216°, [α] <sub>D</sub> <sup>20</sup> - 76°
SIMARUBACEAE <i>Eurycoma longiflora</i> .. .. .	r	0.03 wb	Paper chromatogram gave 5 spots under ultra-violet and 2 spots with Dragendorff's reagent
	s	0.045 wb	

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