
*The*

*Papua New Guinea*

# *Agricultural Journal*

**Vol 23.** **DECEMBER, 1972** **Nos. 3 and 4**

## CONTENTS

# NEW SCOLYTIDAE AND PLATYPODIDAE FROM THE PAPUAN SUBREGION AND NEW CALEDONIA I. 271. CONTRIBUTION TO THE MORPHOLOGY AND TAXONOMY OF THE SCOLYTOIDEA

KARL E. SCHEDL*

## ABSTRACT

*Descriptions are given of seven new species of Scolytidae*—Cryphalops dispar, Cyrtogenius peregrinus, Mimiophthorus orientalis, Ips inclinans, Xyleborus circumspinosus, Xyleborus immersus *and* Xyleborus papatrae, *and nine new species of Platypodidae*—Crossotarsus gressitti, Crossotarsus spinipennis, Platypus advena, Platypus diffinis, Platypus distinctipes, Platypus diversiporus, Platypus fracticostis, Platypus grayi *and* Platypus vesculus *and of the subspecies* Platypus grayi immersus *nov. subsp. Descriptions are also given for the first time of the females of* Platypus enormis *Schedl fem. nov. and* Platypus praepositus *Schedl fem. nov.*

## INTRODUCTION

In New Guinea the majority, if not all, of forest trees are attacked by Scolytidae and Platypodidae soon after felling, thus reducing their merchantable value either directly by the construction of galleries in the outer zones of the logs, or indirectly by allowing spores of wood-destroying fungi an opportunity to enter the wood. As a first step to the future control of these bark and timber beetles a survey of species involved was commenced in 1967 by the Entomology Section of the Department of Forests based at Bulolo in Papua New Guinea. A taxonomic monograph of these two families is the aim of these investigations. While the investigations have been restricted initially to the New Guinea mainland, it is intended to include in this study the whole chain of islands down to New Caledonia.

The plans of the Department of Forests are supplemented by a more general survey of insects of New Guinea being undertaken by a field station of the Bernice P. Bishop Museum at Wau. A large collection of Scolytidae and Platypodidae from the field station has been examined and descriptions of new species are given in this paper.

Further descriptions of new species will be published in a series of papers under the heading "New Scolytidae and Platypodidae from the Papuan subregion and New Caledonia", while the very numerous new locality and host records of known species are to be included in the monograph at a later date.

In the paper the following abbreviations are used: Bishop (Bernice P. Bishop Museum collection with number allocated to holotype); Dist. (District); For all collections made by the Department of Forests the district is given, while for those made by the Bishop Museum, four quadrants of New Guinea are used; these are noted NE., SE., SW. and NW. respectively.

## A. SCOLYTIDAE

### *Cryphalops dispar* nov. sp.

*Male* ferrugineous, 1.7 (1.6 to 1.8) mm long, 2.16 times as long as wide. The new species is easily recognized by its sexual differences which, so far, are not known for the genus *Cryphalops* Reitter.

*Front* convex, subopaque, minutely punctulate and finely punctured below, more shining and the punctation gradually reduces above, sparsely placed fine hairs on the anterior half.

*Pronotum* wider than long (23.5:19.7), postero-lateral angles rectangular and slightly rounded, sides subparallel on the basal fourth, thence gradually incurved, apex drawn out to a beak-like structure armed at the tip with

*Lienz, Osttirol, Austria.

six fine pointed teeth, subapical constriction distinct, summit in the centre of the pronotum, anterior area rather sharply convex and moderately densely covered by small asperities, the latter gradually fading away towards the beak, basal area subopaque, densely granulate-punctate, the entire pronotum with very short, rather densely placed, erect setae. Scutellum triangular, distinctly punctured.

*Elytra* only slightly wider (24.0:23.5) and 1.6 times as long as the pronotum, sides parallel on the basal two-fifths, thence gradually and rather strongly incurved, apex somewhat angulately rounded, declivity commencing after the basal two-fifths, uniformly obliquely convex; disc indistinctly striatepunctate, the interstices wide and densely covered with fine punctures, each with a median row of short semi-erect scales, accompanied on each side with a row of minute inclined reddish hairs; scales slightly more prominent on the declivity.

*Female* slightly stouter, with similar sculpture as in the male, but the pronotum without beak-like structure at the apex, anterior margin oval in outline, with four pointed asperities in the middle.

*Holotype* and allotype in the Australian National Insect Collection in Canberra, 3 male, 3 female paratypes in Collection Schedl, 5 male, 12 female paratypes in the collection of the Department of Forests in Bulolo, 2 paratypes in the Bernice P. Bishop Museum collection in Honolulu.

*Type-localities*: New Ireland Dist., Karbil, 28.IV.1969, in freshly fallen log of *Intsia bijuga,* B. Gray; Manus Dist., Peaga, 21.IV. 1969, in freshly fallen log (paratypes), B. Gray.

***Cyrtogenius peregrinus* nov. sp.**

*Female* ferrugineous, 2.1 to 3.2 mm long, 2.4 times as long as wide. Somewhat allied to *Cyrtogenius perakensis* Schedl but the pronotum distinctly stouter, more convex, and the basal area less coarsely punctured, the elytral disc with the punctures of the main rows of the same size as those of the interstices, so that these two series are difficult to distinguish.

*Front* slightly concave, very densely punctured, and with a short brush of yellow hairs.

*Pronotum* not much longer than wide (35: 33), widest shortly before the base, posterolateral angles nearly rectangular and strongly rounded, the sides subparallel on the basal fourth, thence gradually incurved, apex rather broadly rounded, subapical constriction evident; disc ascending convex, extremely densely covered by small asperities on the distal three-fifths, densely punctured behind, the punctures of medium size, pubescence consisting of moderately long erect hairs restricted to the sides and the anterior sloping area. Scutellum of medium size, convex and polished.

*Elytra* slightly wider (35:33) and 1.37 times as long as the pronotum, widest at the commencement of the declivity, sides straight but faintly divergent on the basal three-fifths, apex very broadly rounded, declivity commencing shortly after the basal half and rather steeply convex, disc shining and very densely covered with rows of medium-sized deep punctures, so that the two series, the main striae and those of the interstices, are difficult to separate, the interspaces from puncture to puncture much shorter than puncture diameter (in both directions); declivity with the suture feebly elevated, the second interstice somewhat depressed, each interstice densely and finely punctured and with sparsely placed gradulules which are missing on a small area of the second interstice, apical margin finely crenulate, some short semi-erect hairs originating from some of the interstitial punctures, especially towards the sides of the declivital convexity.

*Male* of similar size and proportions to the female but the front convex, shining and densely, more coarsely punctured above, with a transverse lunate impression below which has finer punctures, a fringe of downwardly directed hairs along the anterior margin, a few erect setae around the anterior-lateral angles, elytral declivity with the second interstice more strongly depressed, the suture a little more elevated and the granules of interstices 1 and 3 more prominent.

*Holotype* female (Bishop 8935) allotype male and 17 paratypes in the Bernice P. Bishop Museum, 2 male, 2 female paratypes in Collection Schedl, 1 male, 2 female paratypes in collection of Department of Forests, Bulolo.

*Type-localities*: New Guinea (NW.), Wisselmeren, Enarotali, 1,850 m, 2-3.VIII.1962, J. Sedlacek (holotype); New Guinea (NE.), 13 km SE. of Okapa, 1, 650 to 1,870 m, 26.VIII. 1964, J. Sedlacek (allotype). Paratypes: 1 male, 3 females same data as for holotype; 3 female, same locality, 1,850 to 1,900 m, 19.VII.1962, 1 female, 3 male, same locality, 1,800 to 1,900 m, 26.VII.1962, 1 male, 1 female, same locality, 1,750 to 1,900 m, 11.VIII. 1962, J. Sedlacek, 7 female, 9 male, 13 km SE. of Okapa, 1,650 to 1,870 m, 26.VIII. 1964, J. & M. Sedlacek, 1 female, Purosa, 20 to 26 km SE. of Okapa, 1,800 to 2,020 m, 28.VIII.1964, J. & M. Sedlacek.

***Mimiophthorus orientalis*** **nov. sp.**

*Female* testaceous, 1.53 to 1.59 mm long, 2.9 times as long as wide. Allied to *Mimiophthorus villiersi* Lepesme but smaller stouter, the elytral disc rather strongly striate-punctate, and the declivity without a longitudinal impression.

*Front* aplanate, extremely densely and finely punctured, with a short dense brush of erect yellow hairs, the latter being a little longer around the margin than in the centre.

*Pronotum* distinctly longer than wide (18: 16), postero-lateral angles rectangular and somewhat rounded, the sides parallel on the basal two-fifths, apex semicircularly rounded, summit distinctly before the centre, anterior area convex and densely covered by small asperities, the long basal area densely and coarsely punctured, pubescence short and erect, more dense on the sides and before the summit. Scutellum small, triangular, impunctate.

*Elytra* as wide and 1.5 times as long as the pronotum, the sides parallel on little more than the basal half, apex broadly rounded, declivity commencing just behind the basal half and obliquely convex; disc shining, striate-punctate, the strial punctures of medium size and rather closely placed, interstices with a few extremely fine punctures bearing, as far as not abraded, very short fine hairs; declivity with the striae more strongly impressed, the strial punctures a little larger and more closely placed, the punctures of the interstices more distinct and closely placed and the setae arising from them longer and more prominent, apical margin subacute and finely crenulate.

*Male* same colour, size and proportions as the female but the front shining, convex, rather coarsely and densely punctured, pubescence rather sparse, inconspicuous except for a fringe along the anterior margin which consists of rather long downwardly directed setae; elytral declivity more convex, the suture distinctly elevated, the first striae deeply impressed but the strial punctures obscure, suture and third interstices with a row of fine setose granules, smaller granules towards the sides.

*Holotype* female (Bishop 8935) allotype (male), 1 paratype in Bernice P. Bishop Museum, 1 female, 1 male paratype in Collection Schedl, 1 female paratype in collection of Department of Forests, Bulolo.

*Type-locality*: New Guinea (NW.), Nabire, S. Geelvink Bay, 10 m, 25-27.VIII.1962, light trap, J. Sedlacek.

***Ips inclinans*** **nov. sp.**

*Male* testaceous, 2.0 to 2.3 mm long, 3.3 times as long as wide. Of similar shape to *Ips adusticollis* Motsch., but the elytra strongly striate-punctate, the declivity more obliquely trunctate and the conical teeth on interstices 2 and 4 smaller.

*Front* trapezoid in outline between the large eyes, about as high as wide, brightly shining, coarsely and densely punctured, with short sparse pubescence.

*Pronotum* much longer than wide (25.8: 19.2), postero-lateral angles rectangular and slightly rounded, sides parallel on the basal two-fifths, thence gradually incurved, apex broadly rounded, summit distinctly before the centre, anterior area convex and densely covered with minute asperities, the long basal area shining, remotely punctured, pubescence erect and rather long, more conspicuous on the sides and on the anterior area. Scutellum small, shining, impunctate.

*Elytra* as wide and 1.4 times as long as the pronotum, sides parallel on the basal two-fifths, apex broadly rounded, apical margin finely carinate, declivity restricted to the distal two-fifths, obliquely truncate, disc strongly striate-punctate, the strial punctures rather coarse and

closely placed; the striae deeply impressed, the interstices narrow, each with a series of numerous small punctures; the suture unarmed at the commencement of the declivity, second and fourth interstices with a small pointed tubercle, three small setose granules between the tooth of the fourth interstice and the carinate, slightly crenulate apical margin, the distance between the two teeth about as wide as that between the first pair; rather long setae along the side margins of the elytra above.

*Holotype* male (Bishop 8937) in the Bernice P. Bishop Museum, 1 paratype in Collection Schedl, 1 paratype in the collection of the Department of Forests, Bulolo.

*Type-locality*: New Guinea (NW.), Bodem, 100 m, 11 km SE. of Oerberfaren, 10-16.XII. 1959, M. V. light trap, T. C. Maa.

*Xyleborus circumspinosus* nov. sp.

*Female ferrugineous*, dark brown to nearly black towards and on the elytral declivity, 2.5 mm long, 2.5 times as long as wide. Closely allied to *Xyleborus impexus* Schedl, but a little larger, the truncate declivity aplanate, and with two conical tubercles on the first interstices in the lower third.

*Front* silky shining, convex, minutely punctulate, rather coarsely, but shallowly punctured, with few fine erect hairs and the usual fringe of longer hairs along the anterior margin.

*Pronotum* longer than wide (31.0:25.5), postero-lateral angles rectangular and rather strongly rounded, sides parallel on the basal two-fifths, apex semi-circularly rounded, subapical constrictions not evident; summit shortly before the centre, anterior area convex and very densely covered by small asperities, basal area shining, minutely reticulate and with remotely placed small punctures, pubescence short, erect, more conspicuous on the sides and on the anterior area. Scutellum small, triangular, impunctate.

*Elytra* slightly wider (26.0:25.5) and 1.4 times as long as the pronotum, widest at the commencement of the declivity, sides straight, slightly divergent on the basal three-fifths of the elytra, apex rather abruptly and very broadly rounded, declivity obliquely truncate, slightly concave in the upper two-thirds; disc shining, with rows of extremely fine widely spaced punctures, the interstices with similar punctures but more irregularly spaced, the strial punctures becoming larger and situated in faintly impressed lines just before the declivity, the interspacial punctures (as far as not abraded) with longish semi-erect hairs; at the well-developed upper margin of the declivity each interstice produced into a short conical tubercle, the lower half of the declivital margin with numerous cylindrical teeth, declivital face shining, the punctures of the main striae large but shallow, disc-like, the interstices with some minute punctates on the first interstice with a blunt tubercle at the beginning of the lower third.

*Holotype* female (Bishop 8938) in the Bernice P. Bishop Museum, 1 paratype in Collection Schedl, 1 paratype in the collection of the Department of Forests, Bulolo.

*Type-locality*: New Guinea (NE.), Umboi I., 1 km N. of Awelkon, 600 m, 21-28.II.1967, light-trap, G. A. Samuelson.

*Xyleborus immersus* nov. sp.

*Female* ferrugineous, brightly shining, 2.1 mm long, 3.0 times as long as wide. Closely allied to *Xyleborus africanus* Egg., but slightly more slender, elytral disc coarsely striate-punctate, punctation more pronounced on the declivity and the apical margin more distinctly carinate.

*Front* convex, subopaque, minutely punctulate, sparsely punctured and with few short setae.

*Pronotum* longer than wide (23:20), postero-laternal angles strongly rounded, sides subparallel on the basal half, semicircularly rounded at the apex, a subapical constriction not noticeable, the apical margin with numerous low and small asperities; summit a short distance before the centre, anterior area convex and densely covered with small asperities, basal area polished, with fine widely placed punctures, short erect hairs along the sides and on the anterior area. Scutellum small, triangular, impunctate.

*Elytra* just wider (21:20) and 1.6 times as long as the pronotum, sides parallel on the basal half, thence gradually narrowed in straight lines (slightly cuneiform), apex rather abruptly

incurved, apical margin broadly somewhat angulately rounded, declivity restricted to the distal two-fifths, obliquely convex, disc shining, striate-punctate, the punctures of moderate size but not closely placed, the interstices fairly wide and each with a few fine punctures; the strial punctures becoming larger, the striae more deeply impressed towards and on the declivity, a pointed granule on the first interstices just after the beginning of the convexity, another similar pointed granule half-way along the third interstices, distance between the sutural granules distinctly shorter than between granules 1 and 2.

*Holotype* in the Australian National Insect Collection in Canberra, 1 paratype in Collection Schedl.

*Type-locality*: Lakunai, East New Britain Dist., 2.V.1969, in freshly fallen log of *Melochia odorata*, B. Gray.

*Xyleborus papatrae* nov. sp.

*Female* ferrugineous, elytra faintly darker, 2.1 to 2.3 mm long, 2.1 times as long as wide. More closely allied to *Xyleborus approximatus* Schedl, but the pronotum more broadly rounded in front, the elytral disc very finely punctured, with a single conical tooth on the third interstices at the beginning of the declivital face and the apical margin of the elytra carinate and curved more angulately.

*Front* convex, subshining, minutely punctulate, finely punctured towards the anterior margin.

*Pronotum* wider than long (30:25), widest just before the base, postero-lateral angles of more than 90 deg, slightly rounded, sides carinate and distinctly divergent on the basal fourth, apex semicircularly rounded, without noticeable subapical constriction, apical margin with six pointed asperities, the median two distinctly larger than the others; summit very high, situated in the centre of the pronotum, anterior area steeply convex densely covered with asperities, these being very fine above, gradually increasing in size towards the anterior margin, basal area minutely chagrined, very finely punctured, without remarkable pubescence. Scutellum small, triangular, impunctate.

*Elytra* as wide and 1.5 times as long as the pronotum, sides subparallel on the basal fifth, thence almost parallel, abruptly incurved at the beginning of the distal fourth, apex angulately rounded, declivity comprising the distal four-fifths of the elytra, obliquely convex, nearly aplanate behind; disc very short, confusedly finely punctured and with some fine wrinkles, thence gradually striate-punctate, the interstices finely reticulate, the third interstices each with a small conical tooth on a somewhat raised base on the upper third of the declivital face, the other two-thirds of the declivity distinctly striate-punctate, the medium-sized strial punctures very distinct, the striae slightly impressed, the interstices finely reticulate and each with a median row of minute punctures; apical margin carinate up to the seventh interstices.

*Holotype* female in the Australian National Insect Collection in Canberra, 2 paratypes in Collection Schedl, 2 paratypes in the collection of the Department of Forests, Bulolo, 1 in the Bernice P. Bishop Museum in Honolulu.

*Type-locality*: Rapontamon, New Ireland Dist., 30.IV.1969, in branch of fallen tree, B. Gray.

## B. PLATYPODIDAE

*Crossotarsus gressitti* nov. sp.

*Male* testaceous, head and elytral declivity dark red, 2.7 mm long, 3.3 times as long as wide. Allied to *Crossotarsus ventrispinis* Schedl, but smaller, the elytral declivity shorter and the postero-lateral processes reduced to inconspicuousness, small and pointed angles not exceeding the apical margin when viewed from above.

*Front* fairly shining, flat, minutely punctulate, shallowly reticulate-punctate, with few erect hairs along the anterior margin, on the sides in front and on the vertex.

*Pronotum* a little longer than wide (23:22), widest behind the deep and short femoral emarginations, the latter angulate on both ends, disc shining, minutely chagrined, median sulcus very short, punctation very sparse and fine.

*Elytra* slightly wider (24:22) and 1.8 times as long as the pronotum, sides parallel on the basal three-fifths, thence incurved, apex wide and transverse, the postero-lateral angles indicated by very small pointed teeth; disc shining, with rows of extremely fine submerged punctures, the latter becoming larger and rising to the

surface towards the declivity, the interstices nearly impunctate, the third with four to five sparsely placed granules towards the base; declivity restricted to the distal third of the elytra, convex, deeply striate-punctate, the interstices carinate, each with a row of distinct punctures giving rise to short semi-erect setae, apical margin broadly concave when inspected from behind, rather acute and accompanied by a narrow groove-like structure. Hind coxae well developed, second abdominal sternite with a thin pointed tooth in the middle.

*Holotype* male (Bishop 8939) in the Bernice P. Bishop Museum, 1 paratype in Collection Schedl.

*Type-locality*: New Guinea, Papua, Western Dist., Oriomo Gov. Station, 26-28.X.1960, Malaise trap, J. L. Gressitt.

***Crossotarsus spinipennis* nov. sp.**

*Male* testaceous, head, pronotum and apex of the elytra ferrugineous, 3.2 to 3.4 mm long, 3.1 times as long as wide. A peculiar new species resembling *Crossotarsus brownei* Schedl, but distinctly smaller, the elytral interstices 1 to 5 terminating as short blunt spines behind and the lateral interstices 7 to 9 drawn out to a triangular postero-lateral process much longer than the interstices 1 to 5.

*Front* flat, coarsely punctured on the upper two-thirds, the punctures much finer on the sides below, nearly impunctate in the centre, with sparse and very short pubescence above.

*Pronotum* longer than wide (31:27), femoral emarginations shallow, disc minutely chagrined and very finely punctured, the density of the fine punctation varied, median sulcus moderately long and fine, with a series of short setae along the anterior margin originating from somewhat coarser punctures.

*Elytra* slightly wider (30:27) and 1.7 times as long as the pronotum, the sides straight and subparallel throughout, distally terminating into triangular postero-lateral processes distinctly exceeding in length the horizontal teeth of interstices 1 to 5 of the elytral disc, the latter shining, with rows of extremely fine sparsely placed punctures, the interstices wide, subimpunctate, the punctures of the main rows becoming slightly larger and situated in deeply impressed striae immediately before the apex, the small teeth of interstices 1 to 5 gradually becoming shorter from suture to sides; below serrate apical margin of elytra a narrow impressed shining lunate furrow from side to side. Abdomen concave, hind coxae rather prominent.

*Female* larger, 3.5 to 3.7 mm long and 3.5 times as long as wide. Front more shining than in the male, the coarse setose punctation restricted to the sides in the upper two-thirds, slightly impressed in the centre, the impression and the anterior part brightly shining, subimpunctate, pronotum as wide as the elytra, the latter cylindrical, the sides straight and subparallel on the basal two-thirds, thence slightly constricted, apex broad and transverse, so that the postero-lateral angles distinctly measure more than 90 deg, disc horizontal in the basal four-fifths, with similar punctation as in the male, but third interstices with a very short longitudinal set of fine granules near the base, distal fifth of elytra subopaque and slightly convex, extremely finely rugose and with very short semi-erect setae, followed by a nearly perpendicular lunate face, apical margin slightly biconvex when viewed from behind. Abdomen ascending convexly.

*Holotype* and allotype in the Australian National Insect Collection in Canberra, a pair of paratypes in Collection Schedl, 1 male, 2 female paratypes in the collection of the Department of Forests, Bulolo.

*Type-locality*: Tonolei, Bougainville Dist., 8.V.1969, in freshly fallen log of "white wood", B. Gray.

***Platypus advena* nov. sp.**

*Male* ferrugineous, 4.2 mm long, 3.6 times as long as wide. Closely allied to *Platypus setaceus* Chap., but the pronotum without a patch of punctures surrounding the median sulcus, all interstices of the elytral disc finely carinate (without fine granules on the first and second), and the declivity with a single tubercle in the continuation of the third interstices near the apical margin.

*Front* flat, of a silky texture, minutely punctulate, shallowly areolate-punctate, a few setae directed downwards near the anterior margin, convex towards the vertex, the latter with a transverse row of setose punctures.

*Pronotum* longer than wide (39:33), widest behind the posterior angulate extremity of the well-developed femoral emarginations, disc brightly shining, irregularly covered with fine punctures, median sulcus long but shallow, a few punctures across the anterior margin.

*Elytra* slightly wider (36:33) and 1.6 times as long as the pronotum, widest at the commencement of the declivity, sides straight, subparallel on the basal two-thirds of the elytra, apex rather broadly rounded, declivity restricted to the distal third, obliquely convex; disc fairly shining, sulcate-striate, the striae shallow towards the base, more distinctly sulcate behind, the strial punctures obscure, the interstices subconvex, with very scattered minute punctures, the low interstitial carinae ceasing at the beginning of the declivital convexity, but continued on the declivital face with rows of setose granules on the upper half, fading away lower down, entire declivital face opaque, minutely punctulate, more shining in the lower third, where a secondary swollen area on each side of the suture bears a small tubercle in continuation of the third interstices of the disc. Abdomen opaque, sternites 3 and 4 with a ridge-like dentate elevation on each side near the anterior margin.

*Holotype* male (Bishop 8940) in the Bernice P. Bishop Museum, 1 paratype in Collection Schedl.

*Type locality*: New Guinea (NW.), W. of Sentani, 75 m, 24-25.VI.1959, T. C. Maa; New Guinea, Papua, Western Dist., Oriomo Gov. Station, 26-28.X.1960, Malaise trap, J. L. Gressitt.

***Platypus diffinis* nov. sp.**

*Female* dark reddish brown, very shiny, 3.7 to 4.0 mm long, 4.4 times as long as wide. This new species which is represented by the female only is rather difficult to place in any of the known groups of the genus *Platypus* Herbst but it might belong to the *Platypi semidepressi* group, probably near *Platypus distinctipes* nov. sp.

*Front* about as high as wide, finely impressed, minutely punctulate, therefore silky shining, rather coarsely punctured, the punctures larger in the upper half and all bearing semi-erect setae, a short longitudinal carina above the centre, convex towards the vertex, the latter with a transverse row of larger setose punctures.

*Pronotum* much longer than wide (33:23), widest at the posterior angulate extremity of the well-developed femoral emarginations, disc shining, with irregularly scattered minute punctures, median sulcus very fine and long, surrounded by an oval patch of deep punctures (as if pierced with a needle), these very fine near the base, somewhat larger in the anterior half.

*Elytra* a little wider (25:23) and 1.8 times as long as the pronotum, sides parallel on the basal two-thirds, thence very slightly incurved, apex biconvex (a very shallow triangular emargination between the suture and the short postero-lateral angles when seen from above), declivity restricted to the distal fourth of the elytra, evenly convex above, subperpendicular below; disc brightly shining, with rows of extremely fine rather remotely placed punctures, those of the first in finely impressed striae, interstices wide, nearly impunctate, third interstice triangularly widened and transversely rugose towards the base; upper convex part of the declivity coarsely and irregularly punctured, the punctures bearing short semi-erect setae, the lower lunate perpendicular part less shining and granulate punctate, the apical margin when viewed from behind forming a wide triangular emargination.

*Holotype* female (Bishop 8941) and 5 paratypes in the Bernice P. Bishop Museum, 2 paratypes in Collection Schedl and 1 paratype in the collection of the Department of Forests, Bulolo.

*Type-locality*: 5 female New Guinea (NE.), Wau, Morobe Dist., Kunai Creek, 1,250 m, 26.VIII.1963, Malaise trap, J. Sedlacek, Wau, 1,190 m, 15.IX.1964, Malaise trap, 1 female same locality, 21.IV.1962, 1 female same locality, 1,200 m, 29.VIII.1963, M. V. light trap, J. Sedlacek (all), 1 female same locality, 1,200 m, 24.XII.1965, Malaise trap, J. & M. Sedlacek, 1 female same locality, 1,200 m, 26.XII.1961, G. Monteith (holotype).

***Platypus distinctipes* nov. sp.**

*Male* ferrugineous, 4.2 mm long, 4.1 times as long as wide. A new species to be provisionally placed in the *Platypi semidepressi* group, with

the apical margin of the elytra extended to two triangular appendages, the tips being situated in continuation of the third interstices and separated by a triangular emargination.

*Front* much higher than wide, shallowly impressed, very densely and rather coarsely punctured, with short sparse pubescence, a plush pile of somewhat longer and inwardly directed hairs along the sides in front of the eyes, convex towards the vertex, the latter densely and coarsely punctured and with some scattered setae.

*Pronotum* longer than wide (35:23), widest at the angulate posterior extremity of the well-developed femoral emarginations, disc shining, very finely and irregularly punctured, medium sulcus rather short, surrounded by a cordiform patch of rather deep punctures.

*Elytra* just wider (30:29) and twice as long as the pronotum, sides parallel on the basal two-thirds, thence gradually and slightly incurved, apical margin with a triangular extension in the continuation of the third interstices separated from each other by a shallow wide trapezoid emargination at the suture, disc shining, the main rows of punctures largely obscure, the first row narrowly striate, some fine punctures evident towards the sides, interstices wide and subimpunctate, the third triangularly widened and transversely rugose near the base; declivity restricted to the distal fourth of the elytra, evenly convex above, obliquely truncate below, the upper convexity covered by confusedly placed rather coarse setose punctures, the lower truncate part separated from the upper convexity by obliquely elevated ridges, the lower part with conical tubercles, sometimes followed by small setose granules in continuation of the third interstices just above the triangular extensions of the apical margin.

*Holotype* male (Bishop 8942) and 4 paratypes in the Bernice P. Bishop Museum, 2 paratypes in Collection Schedl, 1 paratype in the collection of the Department of Forests, Bulolo.

*Type-locality*: New Guinea (NE.), Wau, Kunai Creek, 1,270 m, 22.VIII.1963, J. Sedlacek (holotype), same locality, 1,250 m, 26. VIII. 1963, Malaise trap, same locality, 1,190 m, 15.IX.1964, same locality, 1,180 m, 20.IX. 1964, New Guinea (NE.), 6 km W. of Wau, Nami Creek, 1,700 m, 15.VI.1962, Malaise trap, all J. Sedlacek.

***Platypus diversiporus*** **nov. sp.**

*Female* testaceous, head and elytra somewhat darker, 3.4 mm long, 3.7 times as long as wide. Until the male is known this new species might be placed in the *Platypi pseudospinulosi* group, especially on account of the pronotal pores, although a similar arrangement is also evident in the *Platypi oxyuri* group, but in the latter group the elytral declivity is somewhat different.

*Front* flat, minutely punctulate and slightly shining, covered by many medium-sized punctures on the anterior third, above opaque, the punctures larger, bearing short erect setae, convex towards the vertex.

*Pronotum* longer than wide (31:26), widest at the posterior extremity of the well-developed femoral emarginations, the latter angulate behind, more gradually incurved in front, disc shining, with scattered extremely fine punctures, a few larger and setose ones along the anterior margin, median sulcus long and very fine, surrounded by a cordiform patch consisting of medium-sized pores on the anterior two-thirds, small densely placed punctures behind, an arrangement similar to that on females of *Platypus solidus* Walk.

*Elytra* just wider (27:26) and 1.8 times as long as the pronotum, the sides subparallel on the basal three-fourths, very slightly incurved behind, apical margin transverse, shallowly biconvex when viewed from above, declivity restricted to the distal fourth of the elytra, convex above, perpendicular below, disc with rows of fine rather sparsely placed punctures in faintly impressed lines, the first row more strongly so, the interstices minutely chagrined, nearly impunctate, the third interstices slightly elevated and with a short row of minute granules near the base; upper convexity of the declivity more confusedly and coarsely punctured, each puncture given rise to a short semi-erect seta, perpendicular face densely granulate punctate, the two areas separated by an angulate ridge-like structure.

*Holotype* female (Bishop 8943) and 1 paratype in the Bernice P. Bishop Museum, 1 paratype in Collection Schedl, 1 paratype in the collection of the Department of Forests, Bulolo.

*Type-locality*: Papua, Western Dist., Oriomo Gov. Station, 26-28.X.1960, Malaise trap, J. L. Gressit (holotype); 1 paratype New Guinea (NW.), W. of Sentatni, 75 m, 24-25.VI.1959, T. C. Maa.

*Platypus enormis* Schedl, fem. nov.

*Female* ferrugineous, very shiny, 3.6 mm long, 3.8 times as long as wide. The female is easily recognized by the stout oval patch of punctures surrounding the sulcus of the pronotum closely placed to the basal margin.

*Front* flat, densely granulate in the upper two-thirds, the punctures more shallow and more widely spaced below, pubescence rather long, directed upwards.

*Pronotum* distinctly longer than wide (35.0: 25.5), femoral emarginations rather short and angulate on both ends, disc shining, minutely chagrinate, with sparsely placed, very fine punctures slightly difficult to see, median sulcus long, surrounded by a stout oval patch of densely placed fine punctures, this patch being longer than wide and bordering the basal margin of the pronotum, a few fine setose punctures along the anterior margin and on the antero-lateral angles.

*Elytra* wider (28.0:25.5) and 1.5 times as long as the pronotum, sides subparallel on the basal half, thence very slightly incurved, the apical margin shallowly biconvex when viewed from above, therefore the postero-lateral angles distinct, declivity restricted to the distal fourth of the elytra, slightly convex above, perpendicular below, the two areas separated by a low, somewhat indistinct, oblique carina; disc polished, with rows of extremely fine remotely placed punctures, the first row in a finely impressed line, interstices wide, with some scattered very fine punctures, the third widened towards the base and with densely placed fine transverse rugae; on the upper part of the declivity the main rows distinctly striate, the interstices confusedly and rather coarsely punctured, the punctures bearing short semi-erect setae, the third interstices wide, slightly convex and impunctate, the perpendicular face with some fine and setose granules, the apical margin when inspected from behind shallowly arcuate, thus producing a short curved lobus on each side of the suture.

*Allotype** (Bishop 8944) in the Bernice P. Bishop Museum, 1 paratype in Collection Schedl.

*Type-locality*: New Guinea (NE.), Wau, Morobe Dist., Kunai Creek, 1,250 m, 26.VIII. 1963, Malaise trap, J. Sedlacek (allotype); New Guinea (NE.), Wau, Morobe Dist., 1,200 m, 17,20.I.1963, J. Sedlacek.

*Platypus fracticostis* nov. sp.

*Male* dark reddish brown, 3.0 mm long, 3.1 times as long as wide. A new species of the *Platypi adjuncti* group with the alternate interstices on the elytral disc as well as on the commencement of the obliquely truncate declivity, apical margin with four toothlike structures.

*Front* silky shining, slightly impressed in the centre, minutely punctulate, shallowly punctured, with short inconspicuous pubescence, a transverse row of longer and erect hairs on the vertex.

*Pronotum* longer than wide (27:26), widest at the posterior angulate extremity of the femoral emargination, the latter moderately deep, disc minutely chagrinate, sparsely and very finely punctured, a few larger punctures on each side of the moderately long median sulcus and along the anterior margin, the latter bearing short setae.

*Elytra* distinctly wider (29:26) and 1.8 times as long as the pronotum, widest at the commencement of the declivity, the sides straight and slightly divergent on the basal four-fifths, declivity restricted to the distal fourth, obliquely truncate; disc silky shining, striate-sulcate, the interstices alternate, the first very narrow and slightly elevated, the third rather wide, convex and polished, the fifth, seventh and ninth of moderate height, and like the sulci between the interstices minutely chagrinate, the even interstices depressed, the strial punctures rather small and indistinct in parts, at the commencement of the declivity the alternate interstices gradually more carinate, ceasing abruptly and followed by a dense brush of short hairs, face of declivity slightly convex, of a silky texture, the alternate interstices continued as elevated ridges each bearing a row of fine punctures giving rise to short semi-erect setae, apical margin with a very narrow parallel-sided slit at the suture and

* 'Plesiotype' of some authors.

four short toothlike structures in continuation of interstices 1, 3, 5 and 7, teeth 1, 3 and 5 of similar size and triangular, that of interstice 7 much smaller.

*Holotype* male (Bishop 8945) in the collection of the Bernice P. Bishop Museum, 1 paratype in Collection Schedl.

*Type-locality*: New Guinea (NE.), Wau, Morobe Dist., Kunai Creek, 1,250 m, 26.VIII. 1963, Malaise trap, J. Sedlacek.

*Platypus praepositus* Schedl, fem. nov.

*Female* ferrugineous, 4.5 (4.2 to 4.6) mm long, 4.2 times as long as wide. Similar to the male, but larger, the pronotum with a patch of punctures surrounding the median sulcus, the elytra not cuneiform behind, the declivity more uniformly convex, the postero-lateral processes small, triangular, the apical margin between the processes transverse.

*Front* flat, silky shining, minutely punctulate, with a long longitudinal median carina in the upper half, with sparsely placed coarse and setose punctures on the sides, a weakly developed circular callosity in the lower half just within the insertion of the antennae and a few coarse setose punctures below.

*Pronotum* distinctly longer than wide (40:31), widest at the posterior angulate extremity of the moderately deep femoral emarginations, disc shining, sparsely and finely punctured, median sulcus long and fine, surrounded by a long oval patch of densely placed fine punctures, posterior extremity of this patch well apart from the basal margin of the pronotum.

*Elytra* a little wider (32:31) and twice as long as the pronotum, sides parallel on the basal half, thence gradually incurved, postero-lateral processes well-developed, triangular, apical margin between the processes transverse when viewed from above, declivity restricted to the distal third of the elytra, gradually convex, a narrow lunate impression below on the perpendicular face; disc shining, with rows of extremely fine and remotely placed punctures difficult to recognize in parts, the first row situated in a fine impressed line, interspaces only indistinctly punctured, the third widened towards the base and covered with fine tranverse rugae; upper convex part of the declivity with irregularly placed setose and coarse punctures on the interstices, the lower perpendicular lunate impression with some setose granules.

*Allotype** female (Bishop 8946) 2 paratypes in the Bernice P. Bishop Museum, 1 paratype in Collection Schedl and 1 in the collection of the Department of Forests, Bulolo.

*Type-locality*: New Guinea (NE.), Wau, Kunai Creek, 1,270 m, 22.VIII.1963, J. Sedlacek; same locality, 5.IX.1961, ex *Araucaria hunsteinii*, J. & J. H. Sedlacek.

***Platypus vesculus* nov. sp.**

*Male* ferrugineous, 3.0 to 3.2 mm long, 3.4 times as long as wide. Allied to *Platypus setaceus* Chap. but distinctly smaller, the pronotum more elongate, the elytra less strongly sulcate-striate, without granules on interstices 1 and 2, the declivity rather convex, with two very small tubercules on each side, one in continuation of the third interstices half-way down, the other above the postero-lateral angles, the entire beetle densely pubescent.

*Front* flat, fairly shining, covered by small punctures and longitudinal rugae, with short semi-erect pubescence. Antennal scape small, stout, triangular.

*Pronotum* longer than wide (28:24), widest at the posterior angulate extremity of the moderately deep fermoral emarginations; disc shining, with rather numerous small setose punctures, median sulcus long and very fine, surrounded by an elongate cordiform patch of closely placed deep punctures.

*Elytra* slightly wider (26:24) and 1.6 times as long as the pronotum, sides parallel on the basal half, thence gradually incurved, apex rather broadly rounded, declivity commencing just behind the basal half of the elytra, nearly uniformly convex, disc very strongly striate-punctate (sulcate-punctate), the sulci fairly deep, the strial punctures of moderate size and very closely placed, the interstices slightly convex, each one with a double row of extremely fine punctures bearing small semi-erect setae; on the upper part of the declivity the inter-

* 'Plesiotype' of some authors.

stices becoming more narrow, each with a row of minute setose granules, the sulci gradually fading away towards the lower more perpendicular part of the declivity which is irregularly and very densely granulate-punctate and with more erect, very short, pubescence on the line separating the two parts of the declivity with a very small tubercle in continuation of the third interstices, another one in continuation of interstices 7 near the apical border. Abdomen ascending convexly, densely punctured with erect pubescence.

*Holotype* male (Bishop 8947) in the Bernice P. Bishop Museum, 1 paratype in Collection Schedl.

*Type-locality*: New Guinea (NE.), Karimui, 1,000 m, 4.VI.1961, Malaise trap, J. L. & M. Gressitt (holotype); Papua, Western Dist., Oriomo Gov. Station, 26-28.X.1960, Malaise trap, J. L. Gressitt.

***Platypus grayi*** nov. sp.

*Male* dark reddish brown, 4.6 (to 4.8) mm long, 3.0 times as long as wide. The new species belongs to the *Platypi sulcati* group near *Platypus suffodiens* Samps., but is larger than any other species of the subgroup with a patch of densely placed punctures on the anterior half of the pronotum and remarkable by the carinate interstices 2 and 3 abruptly ceasing at the beginning of the elytral declivity.

*Front* slightly concave from eye to eye, subshining, minutely punctate, moderately coarsely punctured, the punctures giving rise to short semi-erect setae on the sides and towards the vertex, somewhat padded along the epistomal margin and with some very coarse punctures below the insertion of the antennae.

*Pronotum* as wide as long, femoral emarginations shallow, not angulate at the extremities, disc minutely chagrinate, with very sparsely placed fine punctures, median sulcus fine and long, with a small cordiform patch of densely placed deep punctures on the anterior half of the pronotum.

*Elytra* slightly wider (12:11) and 1.9 times as long as the pronotum, widest at the commencement of the declivity, sides straight and somewhat divergent on the basal three-fifths, thence rather abruptly incurved, apex narrowly rounded; disc opaque except the distal parts of the carinate interstices, sulcate-carinate, the sulci wide and flat, the strial punctures indistinct, the interstices finely carinate in the middle flattening out towards the base, especially the third interstices which also become widened; declivity restricted to the distal two-fifths of the elytra, convex, more strongly so below, the first interstices not elevated, opaque and gradually declivous behind, the others carinate and shining towards the declivity, the second and third more strongly so, smooth and abruptly ceasing, the third somewhat longer than the second, interstices 4 to 7 gradually declivous but each with a regular row of setose granules, those of the seventh interstices becoming larger, the last one produced into a short triangular tooth making a kind of postero-lateral process, a large triangular tooth half-way down the declivity, in continuation of the third interstices, the tip distinctly surpassing the apical margin of the elytra when viewed from above and connected with the postero-lateral processes by a tranverse carina. Abdomen ascending, convex, with long erect hairs.

*Female* of similar size and proportions to the male. Front silky shining, flat, an impressed median longitudinal sulcus just below the centre, with a few very scattered fine punctures bearing long fine hairs, especially along the side margins, a few others not setose, fine punctures on the padded anterior margin. Pronotum as in male but the cordiform patch of punctures somewhat larger. Elytra less opaque, the sulci narrower, the interstices wider and more evenly convex, the third triangularly widened and finely granulate towards the base, the uneven interstices with irregular rows of fine punctures; declivity restricted to the distal third, more evenly convex, all interstices with a median row of setose granules above, the dentation of the males indicated by an obliquely transverse ridge followed by a triangular space on which the setose granules are less numerous and more irregularly placed.

*Holotype* and allotype in the Australian National Insect Collection in Canberra, 1 male, 1 female paratype in Collection Schedl, 2 male paratypes in the collection of the Department of Forests, Bulolo, 1 male in the Bernice P. Bishop Museum in Honolulu.

*Type-locality*: Namarodu, New Ireland Dist., 29.IV.1969, in freshly fallen log, B. Gray.

*Platypus grayi* subsp. *immersus* nov. subsp.

Of the same size, proportions, general structure and sculpture as *Platypus grayi* nov. sp. but the carinate third interstices at the commencement of the elytral declivity a little longer than the second interstices and the tooth in prolongation of the seventh interstices replaced by a small pointed tubercle preceded by two small setose granules.

*Holotype* (*male*) in the Australian National Insect Collection in Canberra; 1 paratype in Collection Schedl.

*Type-locality*: Tonolei, Bougainville Dist., 9.V.1969, in freshly fallen log "white wood", B. Gray.

(Accepted for publication October, 1971.)

# SCOLYTIDAE AND PLATYPODIDAE FROM THE PAPUAN SUBREGION AND AUSTRALIA. 279. CONTRIBUTION TO THE MORPHOLOGY AND TAXONOMY OF THE SCOLYTIDAE

KARL E. SCHEDL*


## ABSTRACT

*In this paper two new genera,* Xylogopinus *in the Scolytidae and* Spathicranuloides *in the Platypodidae, are described. Descriptions are given of six new species of Scolytidae*: Cryphalus mekeoi, Poecilips sparserugosus, Webbia quadricinctus, Xyleborus ipidia, *pyleborus tectus and Xylopopinus araucariae, and nine new species of Platypodidae*: Crossotarsus chalcographus, Crossotarsus vafer, Crossotarsus ventricornis, Platypus incostatus, Platypus juvencus, Platypus lineellus, Platypus obliquetruncatus, Platypus pseudoselysi *and* Spathicranuloides moikui. *Two new subspecies,* Crossotarsus terminatus *Chapuis* sedulus *nov.* subsp. *and* Platypus shoreanus *Schedl* tersus *nov. subsp. of Platypodidae are described. Finally, descriptions are given of the females of three Platypodidae for the first time*: Crossotarsus longicornis, Platypus hirtus *and* Platypus porcellus.


## INTRODUCTION

This paper is a continuation of a series published on Scolytidae and Platypodidae largely collected by personnel of the Entomology Section, Department of Forests, Bulolo, Papua New Guinea. Descriptions are also given of two new species of Platypodidae from New South Wales.

In the paper the following abbreviations are used: Dist. (District), E.H. (Eastern Highlands), M. (Morobe), M. Bay (Milne Bay) and S.H. (Southern Highlands).

## A. SCOLYTIDAE

***Cryphalus mekeoi*** nov. sp.

*Pronotum* dark brown, elytra yellowish-brown, 1.36 to 1.50 mm long, 2.15 times as long as wide. This new species is placed near *Cryphalus brimblecombi* Schedl, but is distinctly smaller, stouter, the basal area of the pronotum densely punctured, the elytra stouter, the pubescence consisting of very short hairs and a few longer setae on the elytral declivity.

*Front* shining, convex, densely, rather coarsely punctured, a band of short setae along the anterior margin, eyes oval.

*Lienz, Osttirol, Austria.

*Pronotum* wider than long (18:17), postero-lateral angles a little more than rectangular and slightly rounded, sides somewhat divergent on basal fifth, thence gradually incurved, apex broadly rounded, apical margin with six subequal low asperities, subapical constriction distinct; summit behind centre, at the beginning of basal third, anterior area obliquely convex, covered with numerous not very closely spaced medium-sized asperities, basal area and towards the postero-lateral angles moderate, finely and rather densely punctured, pubescence short, more dense on anterior area and along the sides. Scutellum not visible, submerged.

*Elytra* a little wider (19:18) and 1.4 times as long as pronotum, sides parallel on basal two-fifths, apex broadly rounded, declivity commencing after basal half, obliquely convex; disc shining, with not very clearly defined rows of fine closely placed punctures, the interstices with slightly smaller punctures, bearing short erect setae; declivity with punctation still more dense so that the two series, main striae and interstices, are difficult to distinguish, pubescence very short, originating from the interstitial punctures.

*Holotype* in the Australian National Collection in Canberra, 6 paratypes in Collection Schedl and 10 paratypes in collection of the Department of Forests, Bulolo.

*Type-locality*: Laviama Village, M. Bay Dist., 27.VI.1970, in freshly fallen log *Dysoxylum* sp., B. Gray and J. Dobunaba (589).

***Poecilips sparserugosus* nov. sp.**

Piceous when mature, 2.4 to 3.4 mm long, 2.2 times as long as wide. Closely allied to *Poecilips nitidus* Egg. but smaller and stouter, the front sparsely and finely punctured and the elytra more finely sculptured.

*Front* plano-convex, brightly shining, rather finely and sparsely punctured, the punctures bearing moderately long fine setae.

*Pronotum* about as wide as long, postero-lateral angles slightly more than rectangular, but a little rounded, sides subdivergent on basal third, obliquely narrowed in front, apex moderately rounded, subapical constriction distinct; disc uniformly convex, brightly shining, with not very closely placed fine to moderately fine setose punctures, the pubescence very long and erect. Scutellum rather large, triangular, impunctate.

*Elytra* distinctly wider (40:35) and 1.5 times as long as pronotum, sides parallel on basal half, apex very broadly rounded, declivity commencing after basal half, obliquely convex; disc shining, striate-punctate, the strial punctures moderate in size and closely placed, the striae more lightly impressed, in some specimens more strongly so, interstices rather wide, each with a row of more distantly placed punctures bearing long semi-erect hairs; declivity with the first striae more strongly impressed, the strial punctures somewhat smaller than on the disc, the interstitial punctures largely replaced by setose granules.

This new species shows great variation in size and in the sculpture of the elytra.

*Holotype* and 5 paratypes in Collection Schedl.

*Type-locality*: New Guinea, Sattelberg, Huon Gulf, 1899, Biro.

***Webbia quadricinctus* nov. sp.**

*Female*: Nearly piceous, the greater part of elytra testaceous, 2.7 to 2.9 mm long, 3.4 times as long as wide. Somewhat allied to *Webbia ceylonae* Schedl but distinctly smaller, the appendages of the elytra much longer, slender and situated in line with the lateral margins.

*Front* convex, minutely punctulate, subshining, with rather coarse, dense punctation and with few short setae on anterior part.

*Pronotum* much longer than wide (30:23), subquadrate, postero-lateral angles rectangular and somewhat rounded, sides parallel on basal two-thirds, apex abruptly incurved and transverse in the middle when viewed from above; summit fairly high and situated far before centre, anterior area restricted to distal third, obliquely convex, subopaque, very densely covered with exteremly small asperities and short erect setae, the long basal area silky shining, minutely chagrinate and with scattered, extremely fine punctures. Scutellum submerged.

*Elytra* as wide and 1.6 times as long as pronotum, cylindrical, base broadly arcuate towards suture, sides subparallel throughout, terminating at the apex on each side into a long slender projection bifid at the tip, apical margin between the two projections broadly arcuate above, the lower margin produced on each side into a shorter more triangular tooth, declivity restricted to distal two-fifths, obliquely truncate; disc shining with very regular rows of fine, submerged punctures, interstices very wide, each with a few extremely fine punctures; upper margin of truncate declivity with a small pointed granule on each interstice, declivital face lightly impressed below upper margin, rather shining and with extremely coarse densely placed punctures.

*Holotype* in the Australian National Collection in Canberra, 4 paratypes in Collection Schedl, 6 paratypes in the collection of the Department of Forests, Bulolo, 2 paratypes in Bernice P. Bishop Museum, Honolulu.

*Type-locality*: Kulolo logging area, Wau, M. Dist., 29.X.1969, boring into fallen *Castanopsis accuminatissima,* H. Ivagai and Jack (415).

*Xyleborus ipidia* nov. sp.

*Female*: Dark brown, rather shining, 1.9 mm long, 3.3 times as long as wide.

*Front* convex, silky shining, minutely punctulate, punctured and setose in lower half.

*Pronotum* longer than wide (23.0:16.5), widest somewhat before centre, postero-lateral angles rectangular and rounded, sides subparallel on basal half, apex broadly rounded, without distinct subapical constriction; summit distinctly before centre, anterior area obliquely and moderately convex, densely covered by small asperities, basal area more shining, very finely punctured, the punctures varying in size, pubescence restricted to anterior area and the sides, erect and of medium length. Scutellum small, shining, impunctate.

*Elytra* as wide and nearly 1.4 times as long as pronotum, cylindrical, sides parallel on basal half, thence very slightly narrowed, apex broadly rounded, with a very shallow impression at the suture, declivity restricted to distal third, obliquely convex and aplanate; disc shining, with rather regular rows of fine punctures, interstices wide, each one with a row of extremely fine setose (as far as not abraded) punctures; declivital face aplanate to lightly impressed on a cordate space, the lateral convexities slightly developed in the upper half, rim-like and armed with some setose granules below, with a pointed tubercle on the combined second and third interstices at the beginning of the declivital convexity, a distinctly larger conical tubercle half-way down, distinctly within the lateral convexity and a third setose granule on the supposed third interstices just before the apical margin, distance between tubercles one and two about as long as that between two and three, declivital face shining, the first row of punctures somewhat indistinct but situated in an impressed line.

The new species is closely allied to *Xyleborus insitivus* Schedl but the second tubercle of the declivity is more within the lateral convexities and the declivital face is more shining and without the rather coarse punctures present in *X. insitivus*.

*Holotype* in the Australian National Collection in Canberra, paratypes in Collection Schedl and in collection of the Department of Forests, Bulolo.

*Type-localities*: 2 km N. of Ruwong Sawmill, New Ireland Dist., 30.IV.1969, in freshly fallen log, B. Gray (S327); Rabenhen, New Ireland Dist., 30.IV.1969, in freshly fallen log, B. Gray (S331).

*Xyleborus tectus* nov. sp.

*Female*: Dark reddish brown, rather shining, 3.8 mm long, 2.1 times as long as wide. Allied to *Xyleborus quadricostatus* Schedl but much larger, the pronotum trapezoid in outline, with well-marked antero-lateral angles, the declivital face oblique, with short triangular teeth on each interstice on the upper margin and two teeth on the declivital face in continuation of the third interstices, a smaller tooth further below in continuation of the second interstices and the apical margin of the declivity finely serrate.

*Front* plano-convex, minutely punctulate, coarsely but rather sparsely punctured, some of the punctures bearing long erect setae, longitudinally wrinkled at the commencement of the vertex.

*Pronotum* as wide as long, postero-lateral angles rectangular and somewhat rounded, sides parallel on basal third, thence obliquely narrowed apex transverse, antero-lateral angles well marked, anterior area steeply convex and densely covered with medium-sized small asperities, basal area minutely chagrinate and finely, but sparsely, punctured, short erect setae on anterior area and along the sides. Scutellum moderate in size, impunctate.

*Elytra* distinctly wider (54:50) and 1.3 times as long as pronotum, widest in the middle, sides slightly divergent on basal half, thence gradually incurved, apex broadly rounded, apical margin a little extended near suture, declivity commencing after basal two-fifths, obliquely convex; disc shining, strongly striate-punctate, the punctures rather coarse near base, a little smaller behind, the striae well marked, interstices wide, each with a few extremely fine punctures; at the commencement of the declivity all interstices produced into small pointed tubercles, those of the first interstices smaller than the others, the declivital face with the

strial punctures large, very closely placed and transverse, the bottom of the punctures opaque, the suture with a row of pointed granules in the distal half, the second interstice very narrow above, widened in the lower half and bearing four, not quite regularly placed, pointed tubercles, the third interstice with a small pointed tooth just after the commencement of the declivital face followed by a large curved conical tooth situated at the end of the first third of the declivity, very narrow below, the apical margin finely dentate.

*Holotype* in the Australian National Collection in Canberra, 1 paratype in Collection Schedl.

*Type-locality*: Pimaga, S.H. Dist., 26.XI. 1969, in fallen log *Ficus* sp., B. Gray (463).

### *XYLOGOPINUS* nov. gen.

Body similar to *Pteleobius minimus* Schedl. Head somewhat rostrate, front convex, eyes elongate, antennae with the scape short, club-shaped, funiculus consisting of five segments, club pear-shaped, somewhat aplanate, with two transverse rows of setae on the external face. Pronotum trapezoid in outline, subapical constriction distinct, disc slightly convex from base to apex, punctured. Scutellum not visible, submerged. Elytra longer than wide, apex rounded, declivity convex, densely sculptured, basal margin finely serrate. Anterior coxae separated as in the genus *Pteleobius*, anterior femur slender, tibia distally widened, tarsal joints cylindrical.

This new genus has to be placed in the subfamily Hylesinae, within the tribe Hylesini and is most closely allied to *Xylechinus* Chapuis.

#### *Xylogopinus araucariae* nov. sp.

Piceous, 1.5 to 1.7 mm long, 2.3 times as long as wide.

*Front* plano-convex, very densely granulate-punctate and with very short pubescence.

*Pronotum* wider than long (21:18), posterolateral angles rectangular and broadly rounded, sides subparallel on basal fourth, thence obliquely narrowed, apex broadly rounded, subapical constriction distinct; disc slightly convex from base to apex, shining, densely punctured, the punctures of moderate size in basal half, becoming larger and bearing short erect setae anteriorly. Scutellum not visible, submerged.

*Elytra* a little wider (22:21) and 1.6 times as long as pronotum, sides parallel on basal half, apex broadly rounded, declivity commencing after basal two-fifths gradually obliquely convex; disc subshining, with regular rows of moderately sized punctures, the interstices with similar punctation so that the two series are difficult to distinguish, the entire sculpture rather rough, appearing almost granulate-punctate; punctation on the declivity a little finer, the punctures of the interstices regularly placed and giving rise to short semi-erect setae.

*Holotype* in the Australian National Collection in Canberra, 6 paratypes in Collection Schedl and 15 in the collection of the Department of Forests, Bulolo.

*Type-localities*: 1 km E. of Heads Hump logging area, Bulolo, M. Dist., 2. V.1970, nest in cambium of branch, larvae and adults present in *Araucaria hunsteinii*, Tree No. 7, B. Gray (608); same locality, 4.V.1970, under bark branch *Araucaria hunsteinii*, Tree No. 9, B. Gray (609).

Although a good number of specimens have been collected there are no sexual differences evident.

## B. PLATYPODIDAE

#### *Crossotarsus chalcographus* nov. sp.

*Male*: Castaneous, the elytra largely paler, 3.1 to 3.2 mm long, 3.4 times as long as wide. This new species has to be placed into the *Crossotarsi barbati* group and seems closely allied to *Crossotarsus coxalis* Schedl, but is easily distinguished from the latter by its smaller size, the distal part of the elytra and the wide lunate perpendicular face of the declivity.

*Front* aplanate, shining, minutely chagrinate, sparsely but coarsely punctured, the punctures bearing short semi-erect setae, the punctation much finer and more irregularly placed on a transverse band above anterior margin; vertex separated from front by a distinct angle.

*Pronotum* longer than wide (30:27), widest behind the well-developed femoral emarginations, disc shining, minutely chagrinate and with

sparse fine punctation, median sulcus moderately long, a series of larger setose punctures along anterior margin.

*Elytra* slightly wider (28:27) and 1.8 times as long as pronotum, widest behind basal half, sides straight, faintly divergent from base to apex, cylindrical and with perpendicular lunate face at the apex, thus producing blunt lateral processes when viewed from behind; disc shining, with rows of very fine largely submerged punctures, those of the first row being much larger than the others, interstices wide, nearly impunctate, the main rows becoming deeply striate at the distal fourth of the elytra, the strial punctures indistinct to confluent, the interstices gradually diminishing in width, perpendicular lunate face shining, minutely punctulate. Hind coxae rather large but without extensions.

*Female*: Of the same colour as the male, but distinctly larger, 3.6 to 3.7 mm long and more slender, 3.6 times as long as wide.

*Front* aplanate, shining, broadly and lightly impressed on upper half, anterior half very finely punctured, posterior half with very coarse setose punctures on both sides of an impunctate median space; separation from vertex more prominent than in male.

*Pronotum* more slender than in the male (33:28), femoral emarginations more shallow, disc minutely chagrinate and with scattered fine punctures, larger setose punctures along anterior margin.

*Elytra* slightly wider (30:28) and 1.6 times as long as pronotum, base finely carinate, sides parallel on basal two-thirds, thence slightly incurved, apex broadly rounded, subtransverse near the suture, declivity very short, restricted to distal third of the elytra, finely rugose and with few very short setae; disc as in the male, base of third interstices slightly raised and with two to three minute transverse rugae; perpendicular lunate face of the declivity little developed.

*Holotype* and allotype in the Australian National Collection in Canberra, 3 male, 3 female paratypes in Collection Schedl, 7 male, 8 female paratypes in collection of the Department of Forests, Bulolo, and 1 male, 1 female paratypes in Bernice P. Bishop Museum in Honolulu.

*Type-localities*: Kulolo logging area, Wau, M. Dist., 29.X.1969, in freshly fallen *Pasania aspericupula,* B. Gray (409).

Yakawa logging area, Watut, M. Dist., 30.X.1969, boring in freshly fallen *Calophyllum inophyllum,* J. Dobunaba and Lei (428).

Kakawa logging area, Watut, M. Dist., 30.X.1969, boring in freshly fallen *Pasania aspericupula,* J. Dobunaba and Lei (432).

Heads Hump logging area, Bulolo, M. Dist., 6.XI.1969, in freshly fallen *Castanopsis accuminatissima,* B. Gray (442).

New Guinea: NE. of Wau, M. Dist., 1,200 m, 17.VIII.1963, M.V. light trap, J. Sedlacek.

*Crossotarsus longicornis* Schedl, fem. nov.

*Female*: piceous, antennae and legs testaceous, 3.4 mm long, 3.1 times as long as wide.

*Front* flat, fairly shining, minutely punctulate, coarsely but shallowly punctured, the punctures bearing fairly long, semi-erect setae, subimpunctate above the anterior margin.

*Pronotum* as wide as long, widest at the anterior angulate extremity of the rather shallow femoral emarginations, surface shining, minutely chagrinate, very finely and sparsely punctured, a few coarser and setose punctures along anterior margin, median sulcus very short, close to the base.

*Elytra* as wide and 1.8 times as long as pronotum, sides parallel on basal half, thence gradually incurved, apex transverse when viewed from above, slightly bisinuate, with distinct postero-lateral angles, declivity restricted to distal third, obliquely convex above, subperpendicular below; disc fairly shining, minutely chagrinate, with rows of fine regularly placed punctures, only the first rows in lightly impressed striae, interstices subimpunctate, the third triangularly widened at base but without granules or transverse rugae; the upper oblique part of the declivity with the strial punctures obscure, the interstices indicated by rows of setose very fine punctures, face perpendicular with fine irregularly placed punctures and with short erect setae.

*Allotype** in the Australian National Collection in Canberra and 1 paratype in Collection Schedl.

*Type-locality*: Gogol Base, Madang Dist., 23.I.1970, in freshly fallen log *Myristica* sp., B. Gray (S516).

***Crossotarsus terminatus sedulus*** **nov. subsp.**

*Male*: Piceous, 3.9 to 4.1 mm long, 3.0 times as long as wide. This new species is somewhat larger than *Crossotarsus terminatus* Chap., the elytral declivity is more strongly convex and the apical emargination about as deep as wide, the outer margin of the lateral projections are more coarsely serrate.

*Female*: The female measures 4.2 to 4.5 mm in length, which is much larger than *C. terminatus* but with all other details similar, as in the Chapuis species.

*Holotype* and allotype in the Australian National Collection in Canberra, 2 male, 1 female paratypes in Collection Schedl, 5 male, 2 female in collection of the Department of Forests, Bulolo, 1 male paratype in the Bernice P. Bishop Museum in Honolulu.

*Type-localities*: Kulolo logging area, Wau, M. Dist., 29.X.1969, boring into fallen *Endiandra,* sp., B. Gray and Anton (408).

Kulolo logging area, Wau, M. Dist., 29.X.1969, in freshly fallen *Pasania aspericupula,* B. Gray (409).

Kulolo logging area, Wau, M. Dist., 29.X.1969, boring into fallen *Castanopsis accuminatissima,* H. Ivagai (413).

Kunai Creek, 1,250 m, Wau, M. Dist., 26.VIII.1963, Malaise trap, J. Sedlacek.

***Crossotarsus vafer*** **nov. sp.**

*Male*: Piceous, antennae and legs ferrugineous, 4.0 mm long, 3.4 times as long as wide. Allied to *Crossotarsus siporanus* Schedl but larger, the interstices of the elytra being flat and shining at the commencement of the declivity and the sutural emargination on the apical margin of the elytra much wider than deep, the inner sides not parallel.

*Front* flat, subshining, minutely punctulate, with rather numerous coarse setose punctures and small impressed strigae in the centre convex towards the vertex.

*Pronotum* as wide as long, femoral emarginations deep and short, disc shining, with fine irregularly placed punctures, median sulcus fine and short.

*Elytra* wider (37:34) and 1.8 times as long as the pronotum, widest at the commencement of the declivity, sides straight and slightly divergent, apical margin broadly rounded, with a wide trapezoid emargination at the suture and a little notch where the ninth interstice joins the side margins of the declivity as in *C. siporanus,* declivity short, restricted to the distal third of the elytra, steeply convex; disc shining, with rows of fine sparsely placed punctures, striae indicated towards the base, interstices wide, each with a few extremely fine punctures; below the commencement of the declivity the interstices roughly sculptured, each with a row of closely placed setose granules with deeply impressed striae between these rows.

*Female*: of the same colour as the male, a little larger, 4.2 mm long, 3.5 times as long as wide. *Front* very similar to the male. *Pronotum* widest at the anterior angulate extremity of the femoral sulci. *Elytra* with the declivity less steeply convex, the apical margin broadly rounded, subtransverse near the suture when viewed from above, broadly and shallowly emarginate when inspected from behind, declivital face minutely punctulate and rather densely covered with moderately coarse punctures bearing very short semi-erect setae.

*Holotype* and allotype in the Australian National Collection in Canberra, 1 male damaged paratype in the collection of the Department of Forests, Bulolo, 1 male, 1 female paratypes in Collection Schedl.

*Type-localities*: Buin, Bougainville Dist., 7.V.1969, in freshly fallen log. B. Gray (S360). Karoola Plantation, Bougainville District, 7.VI.1963, borers in 6-year-old *Theobroma cacao* tree, Coll. M. Babbage and L. Green.

Okasa pineforest, E.H. Dist., 2.VI.1967, ex *Heritera trifolia,* B. Gray (15).

* 'Plesiotype' of some authors.

*Crossotarsus ventricornis* nov. sp.

*Male*: Dark brown, brightly shining, 2.7 mm long, 3.5 times as long as wide. The new species is allied to *Crossotarsus ventrispinis* Schedl but decidedly smaller, the carinate interstices towards the elytral declivity much finer and the lateral processes of the apical margin of the elytra reduced to a tiny pointed tubercle.

*Front* flat, very lightly impressed below, the impression shining and with some very fine punctures, the space above subshining, minutely punctulate and rather coarsely punctured and with very short setae, in the centre with a short impressed sulcus, convex towards the vertex, on the latter a transverse row of coarser punctures bearing long erect setae.

*Pronotum* slightly longer than wide (25:22), femoral emarginations deep and angulate on both ends, disc shining, minutely chagrinate, with fine, sparse punctation displaced in varying densities, median sulcus short but well impressed.

*Elytra* a little wider than (23:22) and 1.8 times as long as pronotum, sides parallel on basal three-fifths, thence obliquely narrowed, apex transverse, postero-lateral angles in shape of fine pointed tubercles, the side margin behind serrate, declivity short, restricted to distal two-fifths and rather strongly convex; disc with regular rows of fine sparsely placed punctures, these rows in subimpressed striae near the base, interstices wide, nearly impunctate, towards the declivity the striae become strongly impressed, the interstices carinate, further down the carinae are finer and lower, each with a median row of punctures bearing short semi-erect setae, the striae wide and dull, minutely punctulate. Abdomen with the second interstice bearing a long slender spine in the middle.

*Female*: of the same colour and size as the male, very little wider, the front more finely punctured, the pronotum about as long as wide, the elytra with the interstices towards the declivity but slightly elevated, the carinae further from the declivity less high, the apex transverse and the postero-lateral angles merely marked by a minute granule, the spine of the second abdominal sternite distinctly smaller.

*Holotype* and allotype in the Australian National Collection in Canberra, 4 paratypes in Collection Schedl, 13 paratypes in the collection of the Department of Forests, Bulolo.

*Type-localities*: Warangoi, East New Britain Dist., 3.V.1969, in freshly fallen log *Canarium indicum*, B. Gray (S351).

Kaviak, Karkar I., Madang Dist., 20.I.1970, in freshly fallen log *Canarium sp.*, B. Gray (S474).

Kassam, M. Dist., 13.III.1970, on fallen log (1), B. Peters and F. R. Wylie (S543); same locality and date, on fallen log (2), B. Peters and F. R. Wylie (S544).

*Platypus hirtus* Schedl, fem. nov.

*Female*: Piceous, 4.1 to 4.2 mm long, 3.5 times as long as wide. Although the males of *Platypus hirtus* and *P. solidus* Walker are rather closely allied, the females are quite different in sculpture, in *P. hirtus* there is no patch of closely placed punctures surrounding the median sulcus of the pronotum.

*Front* plano-convex, opaque, very densely reticulate- punctate, in the centre with a low elevation on which a few coarser and deeper punctures are situated.

*Pronotum* longer than wide (36:32), femoral emarginations very shallow, hardly noticeable when viewed from above, surface subopaque, minutely chagrinate and very finely punctured, median sulcus short and shallow, a few setose punctures along the anterior margin.

*Elytra* a little wider, and 1.6 times as long as pronotum, sides parallel on basal two-thirds, thence obliquely incurved, apex transverse up to the continuation of the fifth interstices thus producing well-marked postero-lateral angles, declivity restricted to distal third and obliquely convex; disc striate-punctate, the striae not very well defined, the strial punctures confluent in parts, the striae more strongly impressed towards the base, interstices moderately wide, very densely and finely punctured, therefore subshining, base of the third very broadly widened, somewhat elevated and with transverse carina; on the declivity the striae and strial

punctures become obscure, the interstices covered with confusedly placed shallow but larger punctures bearing very short semi-erect setae.

*Allotype** in the Australian National Collection in Canberra, 3 paratypes in the Collection of the Department of Forests, Bulolo, 2 paratypes in Collection Schedl.

*Type-localities*: Gogol Base, Madang Dist., 23.I.1970, in freshly fallen log *Diospyros* sp., B. Gray (S513, S523).

***Platypus incostatus*** **nov. sp.**

Ferrugineous, 5.2 mm long, 3.8 times as long as wide. Allied to *Platypus incompertus* Schedl, but distinctly smaller, the pronotum without a patch of punctures surrounding the median sulcus, elytra with the third interstice near the base, without transverse rugae and the elytral declivity with much less carinate interstices.

*Front* flat, shining, very densely reticulate-punctate, the punctures bearing erect setae towards and on the vertex, those on anterior half much larger in the middle.

*Pronotum* longer than wide (42:35), femoral emarginations rather shallow, angulate behind, disc shining, very densely covered with very coarse punctures, the punctures bearing (as far as not abraded), short semi-erect fuscous setae, median sulcus long, extending to the middle.

*Elytra* distinctly wider (40:35) and 2.3 times as long as pronotum, widest at the commencement of the declivity, the sides straight and slightly divergent on basal two-thirds, obliquely narrowed behind, apical margin slightly arcuate, postero-lateral angles well marked, declivity restricted to apical third, obliquely convex, disc shining, striate-punctate, the striae strongly impressed, the strial punctures closely placed, much smaller and confused towards the base, the interstices flat, each with a row of setose punctures, setae semi-erect; towards the declivity the striae are more strongly impressed, the interstices somewhat carinate and the interstitial punctures coarser and partly replaced by setose granules, carinate interstices and striae becoming obsolete towards apical margin, the postero-lateral angles marked with a small triangular tooth each elytron slightly arcuate when viewed from behind.

*Holotype* in British Museum of Natural History.

*Type-locality*: Dorrigo, N.S.W., 23.III.1954, ex *Eucalyptus laevopinea*, J. Cartwright. It is dificult to determine the sex.

***Platypus juvencus*** **nov. sp.**

*Male*: Brightly shining, prothorax and head ferrugineous, antennae and legs paler, elytra dark brown, 4.6 mm long, 3.1 times as long as wide. Allied to *Platypus selysi* Chap. but much smaller, general structure of the elytral declivity similar but with the first interstice at the beginning of the declivity carinate to form a slender small tooth surpassing to some extent the commencement of the declivity, the fourth interstice similar to the first but a little longer and the third interstice much longer, more broadly triangular; the apical margin in the new species is narrowly rounded, without the tooth below the wing-like extensions.

*Front* flat, subopaque, minutely punctulate and very densely longitudinally wrinkled, towards the vertex the wrinkles to some extent replaced by very shallow setose punctures.

*Pronotum* longer than wide (45:42), widest at the posterior angulate extremities of the well-developed femoral emarginations, surface brightly shining, rather regularly finely punctured, a few larger setose punctures along anterior margin, median sulcus moderately long.

*Elytra* distinctly wider (45:42) and 1.7 times as long as pronotum, widest at the commencement of the declivity, sides straight, distinctly divergent on basal two-thirds, apex broadly somewhat angulately rounded, declivity short, restricted to the distal fourth of the elytra, obliquely convex; disc horizontal, strongly striate-punctate, the striae well impressed, more strongly so towards the declivity, the strial punctures indistinct, largely confluent; at the commencement of the declivity the first interstice forming a slender small tooth surpassing the declivital face, the fourth interstice similar but a little longer, the second interstice short, not extending to the declivital face, the third

* 'Plesiotype' of some authors.

interstice wider than the others forming a long flat extension subtriangular at the tip, the fifth interstice still larger and longer than the third, the seventh interstice surpassing the lateral margin of the elytra in the shape of a short triangular tooth, being about as long as the third interstice; declivital face with irregularly placed, very flat but large punctures, on each side with a large wing-like structure as in *Platypus selysi*.

*Holotype* in the Australian National Collection in Canberra, 1 paratype in Collection Schedl.

*Type-locality*: Gogol Base, Madang Dist., 23.I.1970, on freshly fallen log *Evodia* sp., B. Gray (S498).

***Platypus lineellus* nov. sp.**

*Male*: Ferrugineous, 3.2 mm long, 4.0 times as long as wide. A rather peculiar species and to be placed in the *Platypi lunati* group, easy to recognize by the lack of a patch of punctures on the pronotum in both sexes and the dentate second sternite of the abdomen.

*Front* aplanate, very densely reticulate-punctate, with short erect hairs becoming longer towards the vertex.

*Pronotum* longer than wide (26:21), widest at the posterior angulate femoral emarginations, disc shining, irregularly covered with punctures of varying size, these more dense towards the anterior margin, median sulcus very fine and rather short.

*Elytra* distinctly wider than (23:21) and twice as long as the pronotum, widest just behind basal half, sides straight, slightly divergent up to the middle, gradually incurved behind, apical margin broadly emarginate, with blunt lateral processes, declivity dull, restricted to the distal third; disc shining, striate-punctate the striae hardly noticeable on anterior fourth of the elytra, thence gradually more impressed and the strial punctures less distinct, interstices fairly wide, flat towards the base, distinctly elevated behind, with scattered very fine punctures; declivity with silky pubescence, the striae fading out on the upper part of the convexity, the interstices marked by regular rows of minute punctures bearing rather long suberect hairs, a longitudinal depression in the middle above the lateral processes. Abdomen with two pointed tubercles near posterior margin.

*Female*: Of the same colour, size and similar proportions as the male, but the elytra uniformly rather finely striate-punctate, the striae not deepened towards the declivity, the latter shorter, the lateral processes smaller and more triangular, with a lunate transverse depression below, a pointed tubercle on the third interstice above this depression, the interstices of the declivity similar to those in the male, with setose punctures but with somewhat shorter hairs.

*Holotype* male and allotype female in Collection Schedl.

*Type-locality*: Sydney, N.S.W., 1914.

***Platypus obliquetruncatus* nov. sp.**

*Male*: Dark reddish brown, 3.8 mm long, 3.2 times as long as wide. A new species of the *Platypi oxyuri* group with the appendages of the elytra very stout and obliquely truncate at the tip, also with a patch of punctures on the pronotum in both sexes.

*Front* aplanate, shining and indistinctly coarsely punctured on a small transverse band above anterior margin, the rest of the front very lightly depressed, opaque, minutely granulate-punctate and with sparse short pubescence.

*Pronotum* somewhat longer than wide (35:32), widest at the anterior-lateral angles, femoral emarginations shallow and angulate at posterior extremity, disc shining, with scattered punctation of varying size, larger setose punctures along anterior margin, moderately sized punctures on both sides of the median line in the anterior two-thirds, median sulcus fine, moderate in length, surrounded by subcircular patch of rather coarse and deep punctures.

*Elytra* distinctly wider (35:32) and 1.9 times as long as pronotum, widest at the commencement of the declivity, sides straight and slightly divergent on basal three-fifths, thence strongly incurved, apex of elytra obliquely truncate below, convex above, entire declivity restricted to

distal third of elytra; disc brightly shining, with rows of very fine and sparsely placed punctures, the first row more strongly impressed and the punctures larger and confluent in parts, interstices wide, with very scattered fine punctures, base of the third and fifth interstices each with a row of transverse rugae; declivity subshining, pubescence of a silky texture, the interstices with shallowly impressed lines bearing small setose punctures on the convexity above, the truncate portion of the declivity densely granulate-punctate, the margin subcircular in outline, with a small pointed granule on the upper margin in continuation of the fifth interstices, a similar more pointed tubercle following the same line on the apical margin, a smaller tubercle on each side of the former.

*Female*: Of the same colour, 4.2 mm long, 3.3 times as long as wide.

*Front* with a wide transverse impression in lower third, this impression minutely punctulate, finely punctured and with short erect setae, the rest of the front separated from the anterior impression by an angulate carina, opaque, minutely punctulate, shallowly punctured and with short semi-erect setae, a fine short median carina just above the separation of the two distinct frontal parts.

*Pronotum* similar to that of the male and with the same patch of coarse punctures surrounding the median sulcus.

*Elytra* somewhat wider (37:33) and nearly twice as long as pronotum, sides parallel on basal half, thence gradually incurved, apex broadly, somewhat angulately convex when viewed from above, declivity short, restricted to distal third of elytra, convex above, with the usual perpendicular trapezoid plate below; disc brightly shining, with rows of small remotely placed punctures in slightly impressed lines, the first row strongly impressed, the punctures largely confluent, interstices very wide, minutely chagrinate and nearly impunctate, base of the third and fifth distinctly irregularly rugosely punctured and with very short setae, perpendicular plate well marked, slightly impressed on each elytron, very densely and finely punctured and the suture finely raised towards the apex.

*Holotype* and allotype in the Australian National Collection in Canberra, 2 female, 1 male paratypes in Collection Schedl and 4 male paratypes in the collection of the Department of Forests, Bulolo.

*Type-localities*: Nauwata Banda logging area, Rd 14, Bulolo, M. Dist., 5.IX.1969, boring in fallen stem of *Anthocephalus cadamba*, J. Dobunaba (S395).

Yakawa logging area, Watut, M. Dist., 30.X.1969, in freshly fallen *Pterygota* sp., B. Gray (S440).

*Platypus porcellus* Schedl, fem. nov.

*Female*: Piceous, antennae and legs testaceous, 4.2 mm long, 3.4 times as long as wide.

*Front* plano-convex, minutely punctulate, very coarsely punctured, the punctures bearing long erect setae and becoming much smaller and more densely placed towards the anterior margin, with a short median longitudinal carina just below the centre, vertex with a transverse row of four very large punctures and a median longitudinal carina.

*Pronotum* about as wide as long, femoral emargination shallow, disc shining in the centre, minutely chagrinate towards the anterior margin, with very scattered but large setose punctures, these more numerous along the anterior margin, median sulcus long, with a cordiform patch of very densely placed small punctures on anterior half of the pronotum.

*Elytra* slightly wider and 1.8 times as long as pronotum, sides straight and parallel on basal three-fifths, thence incurved, apex broadly rounded, declivity short, restricted to the distal two-fifths of the elytra and obliquely convex; disc sulcate-carinate, the sulci rather wide, the punctures in them small and confluent in parts, interstices slightly convex, with scattered fine punctation, third interstices widened towards the base and finely granulate; declivity with the interstices 1 and 2 evenly convex up to the apical margin, third to fifth interstices somewhat elevated, forming a blunt short subtransverse ridge, under which the declivital face is more steeply convex, upper convexity with the sulci becoming narrower, the interstices more

densely punctured and with short semi-erect setae, declivital face below the transverse ridges irregularly finely punctured.

*Allotype** in the Australian National Collection in Canberra and 1 paratype in Collection Schedl.

*Type-locality*: Yakawa logging area, Watut, M. Dist., 30.X.1969, boring into fallen *Myristica buchneriana*, H. Ivagai and Jack (S435).

***Platypus pseudoselysi*** nov. sp.

*Male* ferrugineous, 7.4 mm long, 3.8 times as long as wide. Allied to *Platypus selysi* but the interstices 1, 3, 5 and 7 of the elytral disc at the beginning of the declivity not flat and blunt at their tips, but drawn out to form rather long slender teeth.

*Front* flat, very coarsely longitudinally wrinkled in the median third, the wrinkles replaced by very coarse punctures in the middle just above anterior margin, the upper third of the front opaque, minutely punctulate and with a few fine punctures, the vertex separated from the front by an indistinct angle.

*Pronotum* longer than wide (16:14), femoral emarginations moderately deep when viewed from above, posterior extremity angulate, disc shining, minutely chagrinate and with rather small irregularly placed punctures, median sulcus short.

*Elytra* slightly wider and exactly twice as long as pronotum, widest at the commencement of the declivity, sides straight, apex rather abruptly incurved and broadly rounded, declivity short, restricted to distal third, rather steeply obliquely convex; disc shining, with rows of very small rather remotely placed punctures situated in fine striae becoming more distinct towards the base and the declivity, interstices wide, flat, with a few scattered fine punctures, interstices 2, 4 and 6 very short, not extending to the declivity, interstices 1, 3 and 5 horizontal, terminating as slender triangular teeth distinctly surpassing the declivital face on its upper margin, the third interstice longest, the fifth a little shorter, the first and seventh of equal length and somewhat shorter than the fifth, the ninth interstice still shorter than the first, terminating in a triangular small extension, oblique declivital face opaque with a large triangular tooth somewhat directed to the suture in continuation of the third interstice just before the apical margin.

*Holotype* in Collection Schedl.

*Type-locality*: New Guinea. This single specimen was found among a large number of males so far named as *Platypus selysi*.

***Platypus shoreanus tersus*** nov. subsp.

*Male*: Dark reddish brown, 4.1 mm long, 3.5 times as long as wide. Of the same general appearance as *Platypus shoreanus* Beeson but much larger, more closely sculptured. The pronotum along the base has rather coarse punctures and the carinate interstices at the beginning of the declivity are much more strongly impressed. The female of similar size but the punctation somewhat coarser.

*Holotype* and 1 paratype in the Australian National Collection in Canberra, allotype and 2 male paratypes in Collection Schedl, 4 male paratypes also in the collection of the Department of Forests, Bulolo.

*Type-localities*: Wara Sweet logging area, Kui, M. Dist., 10.II.1970, in freshly fallen log *Anisoptera polyandra*, J. Dobunaba (S525, S527, S531, S532); same locality and date, in freshly fallen log *Terminalia brassii*, J. Dobunaba (S536).

Naura, M. Bay Dist., 29.VI.1970, in freshly fallen log of *Anisoptera* sp., B. Gray and J. Dobunaba (590).

It is remarkable that *Platypus shoreanus* Beeson is now known in a number of subspecies, based mainly on size class differences.

## *SPATHICRANULOIDES* NOV. GEN.

Body cylindrical, front slightly concave and with scattered hairs in the male, deeply excavate and with very long dense pubescence in the female, maxillae with galea and lacinea separated, galea elongate with short pubescence on distal edge, lacinea small, triangular, with a seam of moderately long hairs, maxillary palpus cylindrical, consisting of three segments, labium elongate, labial palpus three-segmented, cylindrical, eyes circular in outline, situated on the sides of front and strongly convex, antennal scape asymmetrical, about twice as long as wide

* 'Plesiotype' of some authors.

and coarsely punctured in male, in female about four times as wide as long and with a seam of very long setae on anterior edge. Pronotum longer than wide, femoral emarginations very shallow, median sulcus moderately long. Elytra cylindrical, distad horizontal above as in the *Crossotarsi genuini* group with a transverse lunate groove-like structure below, the horizontal extension of the elytra dentate in the male, less so in the female. Abdomen ascending, second and third visible sternites with a tooth near the lateral border in male, these largely reduced in female.

Anterior coxae contiguous, anterior tibiae transversely carinate in both sexes.

*Genotype*: *Spathicranuloides moikui* nov. sp.

***Spathicranuloides moikui* nov. sp.**

*Male*: Castaneous, 5.4 mm long, 3.3 times as long as wide.

*Front* opaque, flat above, slightly concave in the anterior two-thirds, minutely punctate, with scattered fine punctures bearing long erect setae in upper third, lateral margin somewhat rim-like, elevated below insertion of the antennae, convex towards vertex. Antennal scape subshining, asymmetrical, about twice as wide as long, diminishing in breadth towards the tip, minutely punctate and rather coarsely shallowly punctured, a few moderately long hairs on anterior edge.

*Pronotum* slightly longer than wide (48:43), femoral emarginations very shallow, disc of a silky texture, minutely punctate, hardly noticeably punctured, a set of setose punctures along the anterior margin, median sulcus fine and moderately long.

*Elytra* wider (50:43) and 1.9 times as long as the pronotum, sides parallel on basal half, gradually incurved behind, apical margin broadly rounded in outline, with a trapezoid emargination at the suture, a semi-circular notch in continuation of the combined second and third interstices, between these two emarginations the elytra with a trapezoid extension bearing two to three setose granules on the outer edge, side margin beyond the semi-circular emargination finely dentate and setose; disc with rows of fairly regularly placed fine punctures, the first row in distinctly impressed striae, interstices very wide, minutely punctulate, the strial punctures becoming more confused near the apex; beneath the horizontal apical margin a transverse groove-like structure broadly rounded at its outer margin, which is minutely punctulate and bearing a small conical tooth in continuation of the third interstices of the elytral disc. Abdomen ascending, convex, visible sternites two and three with a conical tooth near the lateral borders, the pair on the second sternite more narrowly placed than those on the third sternite.

*Female*: of the same colour and general structure as in the male, but a little larger, 5.6 mm long, and somewhat more slender, 3.4 times as long as wide.

*Front* deeply excavate between the very prominent semispherical eyes, the cavity divided in half by a longitudinal grooved ridge increasing in width from the epistomal margin towards the centre (usually concealed by the long pubescence, arising from the dense punctation at the sides of cavity), frontal cavity separated from vertex by a ridge-like elevation interrupted in the middle by a semicircular emargination (this is rather common in the *Crossotarsi genuini* group), antennal scape flat, about three times as wide as long, gradually widened towards the angulately rounded tip of the lateral extension, with a seam of very long hairs increasing in length from the base to the tip, the longest hairs forming a kind of pointed brush, crossing each other over the anterior part of the front. *Pronotum* as in male. *Elytra* also very similar but distal border of the horizontal plane transverse, thus forming distinct posterolateral angles measuring distinctly more than 90 deg, the triangular teeth in continuation of the third interstices on the lower border of the transverse groove visible when inspected from above (concealed in the male). The lateral teeth of the second and third abdominal sternites reduced to blunt angulate low extensions.

*Holotype* and allotype in the Australian National Insect Collection, paratypes in Collection Schedl and in the collection of the Department of Forests, Bulolo.

*Type-locality*: Tonolei, Bougainville Dist., 9.V.1969, in freshly fallen "white wood", B. Gray.

(Accepted for publication October, 1971.)

# USE OF FERTILIZER IN COCONUT SEEDLING ESTABLISHMENT IN A GRASSLAND AREA OF NEW BRITAIN

J. H. SUMBAK*


## ABSTRACT

*Regular applications of nitrogen + sulphur resulted in good coconut seedling growth and initial inflorescence production 4 years after transplanting of replants on a very old and sparse coconut stand in a grassland area. Additions of trace elements failed to produce any additional improvements in growth. Sole nitrogen applications were deleterious and caused the deaths of a quarter of the seedlings within 9 months of transplanting. Applications of sulphur alone had little beneficial effect initially, presumably due to low soil nitrogen levels. There were indications that after about 3 years, nitrogen applications may have become superfluous, as legume cover-crop became established at the trial site.*

*Foliar analyses showed gross nitrogen and sulphur deficiencies and nutrient uptake from fertilizer was clearly indicated.*

*A comparison of seedlings from two sources was inconclusive.*

*It is recommended that 4 oz of ammonium sulphate be applied about 6 weeks after transplanting with follow-up applications at the same rate 3, 9 and 12 months later. Rates should then be doubled and applied at 3-monthly intervals until palms are about 3 years old.*

*Recommendations for treatment after 3 years have yet to be established.*


## INTRODUCTION

Many coconut stands in New Guinea, especially those established before or soon after the turn of the century, are in need of replanting. Signs of senility are common and often stands are uneven and sparse. Some stands have been intercropped (often with cacao) but typically kunai (*Imperata cylindrica*) or other grasses form the ground cover.

Difficulties have arisen in replanting in such situations and also in establishing seedlings in grassland areas previously not planted with coconuts, especially in the Gazelle Peninsula of New Britain.

Fires are common in grassland areas and these, combined with heavy rainfall and leaching, are likely to lead to low nitrogen levels especially as the legume component of such areas is usually negligible. Additionally, investigations by the Department of Agriculture, Stock and Fisheries have revealed a widespread sulphur deficiency in the Gazelle Peninsula and other widely separated parts of Papua New Guinea.

Southern (1967) indicated that the sulphur deficiency is more likely to be ecological than pedological as it has been noted on a variety of soil types varying from deep mature tropical latosols to immature volcanic and alluvial soils. High rainfall and heavy leaching, often combined with periodical grassfires and sometimes prolonged cropping, are likely to lead to low soil sulphur levels. Furthermore severe competition from grasses on soils low in sulphur is likely to decrease sulphur availability to seedlings.

It is noted that sulphur deficiency is not confined to grassland areas but has also occurred in coconuts interplanted with cacao. Prolonged cropping under such conditions is a likely cause of sulphur deficiency.

* Agronomist, Agriculture Research Centre, Bubia.

If seedlings are to be established successfully there is an obvious need for a suitable fertilizer programme where nitrogen and sulphur deficiencies are expected. A fertilizer trial was therefore established on a commercial plantation near Kokopo in conjunction with a programme of replanting by the owners.

## EXPERIMENTAL METHODS

### *Site*

The trial was located on an area of grassland, which supported a very sparse stand of coconuts reputedly over 80 years old. Less than 10 per cent of the original stand remained and palms were very tall with few nuts and showed typical sulphur deficiency symptoms (as described by Southern 1967). The cover was mainly *Imperata cylindrica*, and *Sorghum propinquum* with patches of *Pueraria phaseoloides* which the management was attempting to establish. The soil was a deep volcanic ash, well supplied with bases and phosphorus. The locality has one of the lowest rainfalls in the Gazelle Peninsula with an annual average of 71 in recorded over the 9 years from 1961-62 to 1969-70. A definite dry season occurs from May to November and during this period grassfires can be quite devastating.

### *Treatments*

Treatments were as follows:—

T1—control (unfertilized);

T2—nitrogen (4 oz urea at transplanting);

T3—sulphur (4 oz elemental sulphur at transplanting);

T4—nitrogen + sulphur (rates as for T2 and T3);

T5—nitrogen + sulphur + trace element mixture (same rates as for nitrogen + sulphur and 2 oz trace mixture); and

T6—same as T5 but using an alternative seed source.

Fertilizer was initially applied to Treatments 1 to 5 within a week of field-planting and subsequently at the same rate 3 and 6 months later. Thereafter fertilizer was applied at double the initial rates at 6-monthly intervals. Treatment 6 was first fertilized 6 weeks after transplanting and thereafter in conjunction with the other treatments.

Selected seednuts from a source in the Gazelle Peninsula customarily used by the plantation owners were used for the first five treatments, while seed from the plantation itself was used in the last treatment. Seednuts from the local source could be expected to be low in sulphur and this feature was considered worth studying.

Nurseries were established in October, 1965 and seedlings were field-planted in May, 1966 into holes averaging 2½ ft x 2½ ft x 2½ ft according to the owner's policy. Fertilizer was sprinkled evenly over and around the planting holes.

A randomized block design with three replicates was used. Each plot consisted of 25 seedlings planted on a 27 ft triangular spacing with a single untreated guard row between plots.

By November, 1969 (some 3½ years after transplanting) there were indications that further additions of nitrogen might be superfluous. Plots of Treatments 3, 4, 5 and 6 were split to enable a nitrogen + sulphur and sulphur alone comparison to be made. The 12 paired plots so formed should allow fairly high precision with covariance on pre-treatment records. Plots were split, with the short diagonal as guard, to give triangular plots of ten palms. Poaching was not expected to be a problem for a couple of years. In May, 1970 nitrogen rates were increased to 2 lb of urea a year comprising 3-monthly applications of ½ lb each.

### *Recordings*

The following records were taken:—

1. Heights at regular intervals until November, 1968, when measurements became impractical;
2. Frond production at regular intervals;
3. Colour—scored, using the scale below, 6 and 9 months after transplanting—
   5 = green;
   4 = yellow-green;
   3 = green-yellow;
   2 = yellow;
   1 = very yellow to orange;

4. Frond samples for chemical analysis were collected 6, 10, 24 and 36 months after transplanting. On the first occasion the youngest fully opened fronds (designated the first) were sampled; on the second occasion the first and fourth fronds were sampled while on the last two occasions the fourth and ninth fronds were used.

Analyses were conducted by the Chemistry Branch of DASF at Port Moresby.

## RESULTS

### *General Observations*

Marked differences in seedling growth were noted within 6 months of transplanting. Seedlings treated with nitrogen only were stunted, very chlorotic and frequently displayed deformed fronds. Nine months after transplanting 24 per cent had died and the rest were doing very poorly. This treatment was discontinued and thereafter seedlings were supplemented with sulphur. Most of the seedlings recovered and grew quite well.

Seedlings fertilized solely with sulphur were initially quite inferior to those treated with nitrogen + sulphur but appeared to improve later (about 3 years after transplanting). It was postulated that nitrogen additions were no longer necessary after 3 years and alterations to the trial were made to examine this. It is possible that increased nitrogen availability may have occurred as a result of the Pueraria covercrop spreading over about two-thirds of the trial.

Applications of sulphur + nitrogen produced good seedling growth while additions of trace elements failed to show any additional response. A small number of seedlings treated with sulphur + nitrogen flowered within 4 years of transplanting.

Seedlings derived from the plantation itself, although consistently behind those from the customary source, were not significantly inferior. The poor performance as a result of poorer maintenance of one of the three plots planted with local seed may have caused this lag.

It is too early yet to ascertain whether the change to sulphur alone after 3 years will show any difference from the continued use of sulphur + nitrogen.

### *Heights*

Seedling heights to 30 months after field-planting are illustrated in the Figure.

Seedlings fertilized with nitrogen + sulphur were significantly ahead of the others within 9 months of transplanting. This trend continued and sulphur-treated seedlings also made better growth than unfertilized ones or those fertilized with nitrogen only. It is noted that from November, 1967 onwards, height increment of sulphur-treated palms equalled that of palms treated with both sulphur and nitrogen.

### *Frond Production*

Cumulative frond numbers are shown in *Table* 1.

*Table* 1.—Average cumulative frond numbers to 3½ years after transplanting

| Treatment | Time from Transplanting (Months) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 6 | 9 | 12 | 15 | 18 | 24 | 30 | 36 | 42 |
| T1 | 5.3 | 7.2 | 9.2 | 10.9 | 12.4 | 14.0 | 17.3 | 20.5 | 23.6 | 27.8 |
| T2 | 5.3 | 7.3 | 9.2 | 10.6 | 12.3 | | | | | |
| T3 | 5.3 | 7.2 | 9.2 | 11.0 | 12.7 | 14.4 | 18.4 | 22.1 | 26.3 | 32.0 |
| T4 | 5.5 | 7.7 | 10.5 | 12.2 | 14.7 | 16.6 | 21.5 | 25.9 | 30.4 | 36.6 |
| T5 | 5.2 | 7.7 | 10.3 | 12.3 | 14.3 | 17.0 | 21.7 | 25.9 | 31.4 | 38.3 |
| T6 | 5.4 | 7.2 | 9.9 | 11.9 | 13.9 | 15.9 | 20.8 | 24.9 | 29.7 | 35.7 |
| Least significant difference | 5 per cent | | 0.7 | 0.9 | 1.1 | 1.6 | 1.9 | 2.5 | 3.2 | 4.7 |
| | 1 per cent | | 1.0 | 1.3 | 1.6 | 2.4 | 2.8 | 3.6 | 4.7 | 6.8 |

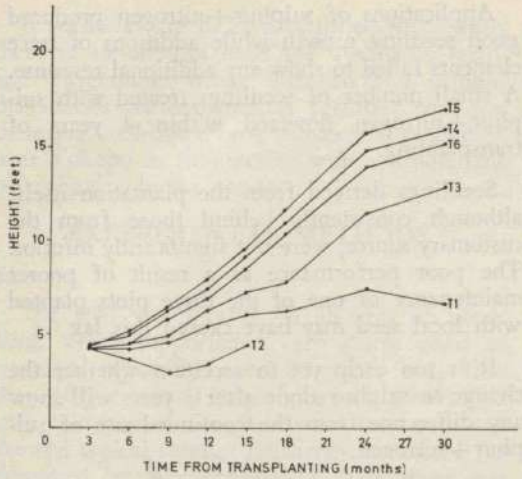



*Figure.*—Seedling heights to 30 months after transplanting

Seedlings treated with nitrogen and sulphur had produced significantly more fronds within 9 months of transplanting. Palms treated with sulphur alone produced more fronds than unfertilized palms, but up to November, 1969 the difference was not statistically significant. As the trial progressed, differences in frond production, between palms treated with sulphur and those treated with nitrogen + sulphur, diminished.

### *Colour*

An assessment of seedling colour is shown in *Table* 2.

*Table* 2.—Colour assessments*

| Treatment | | Time from Transplanting (Months) | |
|---|---|---|---|
| | | 6 | 9 |
| T1 | | 3.53 | 3.65 |
| T2 | | 2.08 | 2.13 |
| T3 | | 4.32 | 3.81 |
| T4 | | 4.65 | 4.99 |
| T5 | | 4.71 | 4.99 |
| T6 | | 4.69 | 4.87 |
| Least significant difference | 5 per cent | 0.45 | 0.36 |
| | 1 per cent | 0.63 | 0.51 |

* See text for details of scoring for colour.

On both occasions seedlings treated with nitrogen + sulphur were a good colour while untreated seedlings and those receiving sulphur alone varied in colour from green-yellow to yellow-green. A yellow or orange appearance was typical of palms treated with nitrogen only.

### *Chemical Analysis*

Analyses for various elements are shown in *Tables* 3 and 4. The N, P, K, Ca and Mg determinations are on a percentage of dry matter basis while S, Mn, Fe, Cu and B are in parts per million.

At 6 and 9 months after transplanting, foliar analyses correlated well with treatments. Nitrogen levels in both the first and fourth fronds were low in unfertilized seedlings and consistently higher where nitrogen + sulphur had been added. In seedlings fertilized only with nitrogen, excessively high nitrogen levels reflected inadequate sulphur nutrition. Samplings

*Table* 4.—Analyses for nitrogen and sulphur 24 and 36 months after transplanting

| Time from Transplanting | Frond | Treatment | N | S |
|---|---|---|---|---|
| 24 months | 4 | 1 | 2.03 | 93 |
| | 4 | 3 | 1.64 | 495 |
| | 4 | 4* | 1.49 | 463 |
| | 4 | 5 | 1.71 | 313 |
| | 4 | 6 | 1.59 | 487 |
| 24 months | 9 | 1 | 1.71 | 133 |
| | 9 | 3 | 1.38 | 348 |
| | 9 | 4 | 1.49 | 407 |
| | 9 | 5 | 1.54 | 267 |
| | 9 | 6 | 1.42 | 322 |
| 36 months | 4 | 1 | 1.90 | 185 |
| | 4 | 3 | 1.72 | 422 |
| | 4 | 4 | 1.81 | 613 |
| | 4 | 5 | 1.92 | 617 |
| | 4 | 6 | 1.87 | 622 |
| 36 months | 9† | 1 | | |
| | 9 | 3 | 1.47 | 372 |
| | 9 | 4 | 1.40 | 378 |
| | 9 | 5 | 1.61 | 527 |
| | 9 | 6 | 1.54 | 430 |

* Average of two replicates.
† Insufficient 9th fronds available for sampling.

24 and 36 months after transplanting did not indicate directly nitrogen uptake from fertilizer. Nitrogen levels tended to be lower in the sulphur + nitrogen treatments than in unfertilized seedlings but this possibly is a reflection of the superior growth of the former.

Sulphur levels correlated well with treatments over all the samplings.

*Table* 3.—Analyses 6 and 10 months after transplanting

| Time from Transplanting | Frond | Treatment | N | P | K | Ca | Mg | S | Mn | Fe | Zn | Cu | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 months | 1 | 1 | 1.67 | 0.183 | 2.11 | 0.33 | 0.33 | 93 | 39 | 24 | 16.3 | 4.0 | 15.2 |
| | 1 | 2 | 2.71 | 0.223 | 2.34 | 0.34 | 0.37 | 113 | 32 | 22 | 21.2 | 6.0 | 13.1 |
| | 1 | 3* | 1.63 | 0.170 | 2.02 | 0.37 | 0.33 | 560 | 41 | 19 | 15.3 | 3.5 | 15.2 |
| | 1 | 4 | 2.08 | 0.179 | 1.91 | 0.33 | 0.31 | 223 | 38 | 22 | 16.1 | 4.7 | 12.4 |
| | 1 | 5 | 2.11 | 0.176 | 2.07 | 0.33 | 0.32 | 353 | 38 | 21 | 15.4 | 4.9 | 21.1 |
| | 1 | 6 | 2.08 | 0.175 | 2.02 | 0.33 | 0.33 | 260 | 36 | 23 | 16.4 | 5.0 | 18.4 |
| 10 months | 1 | 1 | 1.58 | 0.232 | 1.78 | 0.29 | 0.51 | | 20 | | | | |
| | 1 | 2 | 3.08 | 0.267 | 1.99 | 0.31 | 0.50 | | 36 | | | | |
| | 1 | 3 | 1.59 | 0.221 | 2.32 | 0.31 | 0.50 | | 26 | | | | |
| | 1 | 4 | 1.77 | 0.212 | 2.08 | 0.28 | 0.44 | | 35 | | | | |
| | 1 | 5 | 1.74 | 0.212 | 2.34 | 0.26 | 0.43 | | 31 | | | | |
| | 1 | 6 | 1.74 | 0.208 | 2.31 | 0.29 | 0.46 | | 32 | | | | |
| 10 months | 4 | 1 | 1.43 | 0.173 | 1.63 | 0.45 | 0.42 | | 40 | | | | |
| | 4 | 2 | 2.19 | 0.172 | 1.48 | 0.48 | 0.39 | | 29 | | | | |
| | 4 | 3 | 1.40 | 0.155 | 1.51 | 0.56 | 0.45 | | 57 | | | | |
| | 4 | 4 | 1.73 | 0.175 | 1.40 | 0.58 | 0.46 | | 66 | | | | |
| | 4 | 5 | 1.84 | 0.169 | 1.43 | 0.58 | 0.48 | | 76 | | | | |
| | 4 | 6 | 1.72 | 0.168 | 1.41 | 0.56 | 0.45 | | 59 | | | | |

* Average of two replicates.

## DISCUSSION

Clearly, additions of nitrogen and sulphur are needed for successful seedling establishment in situations such as those described.

Frond nutrient studies indicated that sulphur and nitrogen were the only nutrients that required attention.

The gross nitrogen-sulphur imbalance caused by sole nitrogen applications is of considerable practical importance. The practice of fertilizing with urea or an NPK fertilizer (often low in sulphur) is by no means uncommon and where soils are deficient in sulphur, this would obviously be harmful. Instances of nitrogenous fertilizer causing nitrogen-sulphur imbalances have been reported with coconut seedlings on the Papuan coast (DASF 1969) as well as with tea and coffee in the New Guinea highlands.

The situation with seedlings fertilized with sulphur only is interesting. For the first 2 years or so sulphur alone appeared to have limited beneficial effect as responses were presumably limited by low soil nitrogen levels. Subsequently growth improved but due to the initial lag, overall development was still inferior to that of seedlings receiving both sulphur and nitrogen.

It is postulated that by virtue of their more extensive root system, 3-year-old seedlings are able to forage sufficient nitrogen from the soil. The spread of the Pueraria cover-crop over about two-thirds of the trial would have increased nitrogen availability both by reducing competition and through fixing nitrogen. Any future comparisons of sulphur+nitrogen and sulphur alone would be invalidated for typical grassland situations due to the spread of the legume.

Trace element applications failed to improve growth any further and chemical analyses 6 months after transplanting indicated satisfactory trace element nutrition. Futher analyses were not considered necessary. It is noted, however, that Southern and Dick (1967) pointed out that analyses of young fronds would not necessarily detect deficiencies of manganese, iron or zinc. Even so the appearance of untreated palms and the lack of a significant growth response in treated palms suggested that additions of trace elements were unnecessary.

Seedlings from the local seed source tended to be a little behind the others, but as differences were not statistically significant, definite conclusions cannot be drawn. Perhaps the slight lag in the former can be attributed to the initial delay in applying fertilizer (especially if, in fact, the seednuts from the local source were inherently low in sulphur) or to inferior maintenance of one of the three plots planted with local seed.

Obviously, additions of nitrogen and sulphur effectively promoted seedling growth but the proximity of the rates used to the optimum level is not precisely known. Possibly, lower rates could have sufficed and more frequent applications may have been desirable.

Nitrogen and sulphur are usually supplied as ammonium sulphate in Papua New Guinea and on a cost basis this is slightly cheaper as well as more convenient. As a rough approximation, ammonium sulphate contains half the nitrogen and a quarter the sulphur found in the same weights of urea and elemental sulphur. With ammonium sulphate at $70 a ton and urea and sulphur at $100 and $150 a ton respectively, it would cost approximately 25 per cent more to supply nitrogen and sulphur as urea and elemental sulphur than as ammonium sulphate. Availability and effectiveness of equivalent rates of ammonium sulphate or urea as sources of nitrogen would probably be similar under normal conditions; although initial availability of the sulphate anion from ammonium sulphate would be greater, losses through leaching from elemental sulphur may be less.

A previous experiment by the author (Sumbak 1970) with coconut seedlings up to 12 months from transplanting indicated that the effects of 4 oz doses of ammonium sulphate began to wear off within 3 months of application. Foliar analyses indicated that a drop in nitrogen levels rather than in sulphur caused this. More frequent applications of nitrogen, perhaps at lower rates, may be desirable but would be difficult to implement under present plantation conditions. The indication that high nitrogen levels increase susceptibility to Helminthosporium leaf spot disease (Sumbak 1971) rules out any recommendation for higher fertilizer rates for the first 12 months or so after transplanting.

A fertilizing programme aimed at providing seedlings with 8 oz of ammonium sulphate every 6 months was laid down by the owners of the plantation soon after the trial reported here was commenced. These palms grew reasonably well but not as well as those in the trial. Although the programme as laid down was not always adhered to exactly, it is likely that lower rates of nitrogen and sulphur limited growth.

## RECOMMENDATIONS

It is suggested that under conditions similar to those in the trial area, 4 oz ammonium sulphate be applied about 6 weeks after transplanting followed by the same doses 3, 6 and 9 months later. Thereafter 8 oz every 3 months should be added until the palms are at least 3 years old. Under conditions such as those encountered in the trial, doses of elemental sulphur may be sufficient thereafter.

The materials cost of 2 lb of ammonium sulphate per palm amounts to approximately $4.30 an acre every year. This is roughly equivalent to the same amount of nitrogen and half as much sulphur as used in the trial reported and should be adequate for vigorous palm growth.

## ACKNOWLEDGEMENTS

The Chief Agronomist, Mr A. E. Charles, read the manuscript and offered much helpful criticism. The Chemistry Branch, DASF, Port Moresby, carried out the necessary foliar analyses and this help is gratefully acknowledged.

## REFERENCES

DASF (1969). *Rep. Dep. Agric. Stk Fish., Papua New Guinea*, 1966-67: 59.

SOUTHERN, P. J. (1967). Sulphur deficiency in cocounts, a widespread field condition in Papua and New Guinea. *Papua New Guin. agric. J.*, 19(1): 18-37.

SOUTHERN, P. J. AND DICK, KAY (1967). The distribution of trace elements in the leaves of the coconut palm, and the effect of trace element injections. *Papua New Guin. agric. J.*, 19(3):125-137.

SUMBAK, J. H. (1970). Effects of time of ammonium sulphate applications on the growth of newly transplanted coconut seedlings. *Papua New Guin. agric. J.*, 21(3 & 4):93-101.

SUMBAK, J. H. (1971). Further studies in coconut seedling establishment. *Papua New Guin. agric. J.*, 22(3):167-173.

(Accepted for publication January, 1972.)

# THE SWEET POTATO IN SUBSISTENCE AGRICULTURE

A. J. KIMBER*


## ABSTRACT

*It is generally accepted that the sweet potato* (Ipomoea batatas (*L.*) *Lam.*) *originated in the Americas and was transported westwards across the Pacific, but there is as yet no firm evidence as to when or how it was introduced into Papua New Guinea.*

*The significance of sweet potato varies according to an ecological partitioning of Papua New Guinea into six natural regions, but taking the country as a whole, it is quantitatively the most important crop in subsistence agriculture.*

*A very wide range of morphological variation has been found to exist. Propagation, maintenance of gardens and harvesting are, with some exceptions, similar in all regions, but there are notable differences in mixed cropping practices and methods of land preparation, especially in the broad intermontane valleys of the main cordillera.*

*Storage practices are not well developed, as there has generally been no necessity for this, and aspects of cooking and eating quality are fairly uniform throughout the country. As a subsistence crop, the sweet potato is relatively free of pests and diseases, though there are some exceptions.*

*Sweet potato plays a major role in maintaining the domestic pig population and because of this it is important in the accumulation of wealth and in the establishment of prestige in subsistence social systems.*


## INTRODUCTION

This article is based upon a survey by mailed questionnaire and of relevant literature, together with information from the author's field studies, of sweet potato (*Ipomoea batatas* (L.) Lam.) cultivation in subsistence agriculture in Papua New Guinea. The survey was carried out in order to obtain background material from as many localities as possible, to assist in agronomic research into the crop. In the mailed survey details were obtained from almost 60 localities, and these are listed and mapped in Appendix 1. The localities cover all the main climatic variations in the country.

Some of the information is only incidental to agronomic research, but it provides material which is essential to the understanding of a plant which is of major importance in subsistence agricultural systems and which has wider potential as a cash crop. Other staple foods, such as bananas (*Musa* spp), yams (*Dioscorea* spp.), taro (*Colocasia esculenta*), *Xanthosoma* spp. and cassava (*Manihot utilissima*) may be almost as widespread as sweet potato in subsistence agriculture, but none of them has assumed the role of a main staple for as many people as has sweet potato and none of them has reached the altitudinal limit of sweet potato. There are other crops, notably some cereals and other root crops, which could extend the limits of subsistence farming, especially when one considers altitude, but these have been unknown to the people until relatively recent times. So far they have had comparatively little impact on subsistence agricultural patterns.

The following table gives some idea of the quantitative importance of the various staples in subsistence agriculture in Papua New Guinea

* Agronomist, Highlands Agricultural Experiment Station, Aiyura.

(*Table* 1). It is extracted from the "Survey of Indigenous Agriculture and Ancillary Surveys, 1961-62", carried out by the Bureau of Statistics (1963). This contains the only comprehensive information which is at present available, and although not very recent, the situation has probably changed very little since the survey was made.

| Crop | Papua New Guinea | | Papua New Guinea |
|---|---|---|---|
| Bananas (*Musa paradisiaca* and *M. sapientum* | 160 | 460 | 620 |
| Taro (*Colocasia esculenta* and *C. antiquorum* | 93 | 224 | 317 |
| *Xanthosoma* spp. .... | 10 | 138 | 148 |
| Yams (*Dioscorea* spp.) .... | 92 | 144 | 236 |
| Cassava (*Manihot utilissima*) | 16 | 37 | 53 |
| Sweet potato (*Ipomoea batatas* (L.) Lam.) | 241 | 979 | 1220 |

Evidence from the questionnaire shows that subsistence gardening is changing in many areas. The most widespread changes are, of course, caused by the introduction of cash crops, but there are other changes, caused by more widespread and more frequent communications, resulting in an exchange of knowledge and planting material. Allied with this is the adaptability of the sweet potato. Massal and Barrau (1956) say that throughout the South Sea Islands generally, sweet potato is becoming more important in indigenous agriculture because it is easy to grow and it grows rapidly, compared to most other traditional staple food crops. In addition it is a comparatively high yielder and can be progressively harvested, thus eliminating the need for lengthy storage. All of these factors allow more time to be devoted to cash cropping or to outside employment.

The survey has shown that as a general rule, there is no ritual associated with the cultivation or consumption of sweet potato, a feature which contrasts with other subsistence crops such as yams or taro.

## ORIGIN AND VARIETIES OF SWEET POTATO IN PAPUA NEW GUINEA

The introduction of all parts of the sweet potato plant into Papua New Guinea is prohibited (Plant Quarantine Regulations). Some years ago, a number of varieties were officially introduced from the United States of America, for testing and crossing with local types. The well-known American varieties 'Nancy Hall' and 'Puerto Rico' were reported to have been introduced into the Zenag area in 1945 (Massal and Barrau 1956).

Most evidence supports an east-west movement of sweet potato from the Americas, where it is thought to have originated, into the Pacific (Dixon 1932; Brass 1941; Barrau 1958; Conklin 1963; Nishyama 1963; Yen 1963). In those studies historical, lexical, botanical and cytological evidence is presented.

There are various ideas regarding the mode of introduction into Papua New Guinea and in discussing this it is often necessary to discuss also the time of introduction. Massal and Barrau (1956) say the most plausible theory is that the sweet potato was introduced recently from Indonesia whence the Portuguese had brought it. Yen (1963) concludes from botanical evidence that it is unlikely that the sweet potato was introduced from Polynesia. The mode of introduction into the Highlands*, where it is the most important subsistence crop, is unknown, but suggestions would be along trading routes known to have been kept free of internecine warfare, or even through the migrations of people. Such migrations have been suggested, largely on botanical evidence (Robbins 1963).

The question of the time of introduction of sweet potato into Papua New Guinea is of major ethnological importance in view of the theory of what might be termed a quite recent social and cultural revolution in the Highlands, following the suggested appearance of sweet potato between two hundred and three hundred years ago (Bulmer, S. and R. 1964; Watson 1965a, 1965b). The subject is somewhat controversial and is beyond the purpose of this article to examine in detail, except for recording the need for further evidence from other fields of study. For example, a study of the linguistic evidence on the origin and varieties of sweet potato would be of value, especially if done in conjunction with an investigation on morphological variation.

* Highlands in this article refers to the valleys and mountains of the main cordillera of Papua New Guinea.

It would appear from the present survey that people in Papua New Guinea often think of sweet potato as being native to their area. In other cases, however, people remember where sweet potato came from, and when, its appearance in these cases usually being associated with Christian missions, or with German, Japanese or Angau administrations. Unfortunately the evidence is not always clear, however, whether informants are talking of sweet potato in general, or of particular varieties.

On the basis of the limited collection of sweet potato varieties at Aiyura (about 300 in all) it is evident that many areas in former times had varieties distinct from those in neighbouring areas. Many of these varieties are now being replaced by a more limited number which are finding more popular acceptance over larger areas.

The ability of sweet potato to set seed under local conditions was first reported by Yen (1963). The germination of seed in the field has been found by the author to occur frequently, indicating that the vegetative propagation of chance seedlings in subsistence agriculture could lead to the appearance of new varieties in a relatively short period of time, even allowing for discriminatory selection by the propagators. It is also possible that bud mutation, common in the sweet potato plant, has been a source of varieties in the many isolated valleys of Papua New Guinea.

Some examples of the existence of a number of sweet potato varieties in various areas are worth mentioning. The people of the Lake Ipea area recognize 13 distinct types, 11 of which they knew before European contact (Walker 1966). The Enga people of the Western Highlands District recognize at least 31 different kinds, 25 of which they believe are indigenous to the region (Meggit 1960). Brookfield and Brown (1963) record the people of the Chimbu as growing at least 30 varieties.

In the Aiyura collection the most noticeable variations are in the leaf shape (*Plate* I) hairiness of stems, pigmentation of leaf veins and of stems and pigmentation of skin and flesh

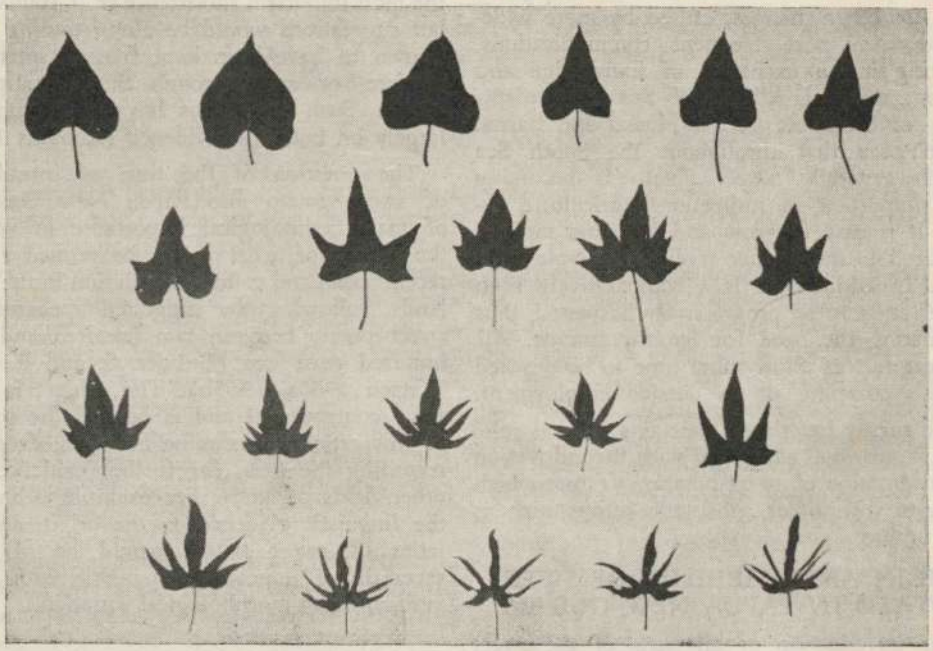


*Plate* I.—A representative range of leaf shapes of sweet potato in Papua New Guinea

*Plate* II.—Some variations in tuber shape and size and of pigmentation of skin and flesh. The varieties are, left to right, beginning from the top: Yakat, Baromba, Nama; Bonangen, Hagesafa, Ngulugu; Domambo, Pora, Markham; Wanmun, Conmayam, Kia

(*Plate* II). Most of this variation is not very significant from an agricultural point of view, but in initial observation plots the variation in tuber shape and size and especially also in yield, have been found to require further investigation.

## SUBSISTENCE AGRICULTURAL ENVIRONMENTS

Subsistence agriculture in Papua New Guinea is based upon the production and consumption of the starchy staples sweet potato, yams, bananas, sago, taro and cassava. Depending on the environment and with the exception of cassava, one of these becomes the main staple, with the others assuming varying degrees of secondary importance. The diet is otherwise supplemented by sugar-cane and by various greens and pulses (Conroy and Bridgland 1947; Massal and Barrau 1956; Barrau 1958).

The natural regions, as given by Barrau (1958) are used as a basis in this study and they are given in Appendix II, slightly modified, together with examples and along with other details relevant to this study. Barrau's scheme is very broad so as to accommodate conditions in Melanesia as a whole and in the present modifications, one of his regions, 'Rainforest foothills and mountain ranges', has been divided into 'Rainforest lowlands and foothills' and 'Lower montane forests'. They have been separated because the survey shows that it is at about the lower level of the lower montane forest that sweet potato becomes the most important staple in the subsistence economy. The natural regions used here are, therefore:—

1. Non-swampy coastal areas;
2. Swampy lowlands;
3. Grassland, scrub, savanna and savanna woodland;
4. Rainforest lowlands and foothills
5. Lower montane forest; and
6. Inter-montane valleys of the main cordillera.

In environments 1 to 4 it is unusual to find any one staple comprising as much as 50 per cent of the bulk of the diet and in many areas two staple root crops, or even three, may assume equal quantitative importance. In environment 5 sweet potato is the main staple. In environment 6, sweet potato never provides less than 50 per cent of the bulk of the diet and can provide over 90 per cent. The proportions mentioned are estimates only, but their magnitude serves to emphasize the role of sweet potato in subsistence agriculture in Papua New Guinea.

In environments 1, 2, 4 and 5 all subsistence gardening is characterized by a slash and burn technique, short cropping periods and a long bush fallow. A particular subsistence technique can therefore be used to advantage in a number of environments, but it is the environment, including population pressure, which will determine which crops are grown from those available. The scheme as presented here is intended only as a means of establishing the importance of sweet potato in relation to the environment and for this reason the environment has been considered more important as a basis to the study than the type of subsistence agriculture. As in all such schemes, there will always be buffer areas between sharply contrasting natural environments, but this does not detract from the importance of the main divisions.

## CULTIVATION OF THE SWEET POTATO

Grown in each of the natural environments, sweet potato can also be found grown over a wide range of soil types (Haantjens *et al* 1967). Soil type is not a limiting factor to growth, as provided sufficient free-draining top-soil is available, the sweet potato plant will usually produce a reasonable crop. Where the top-soil layer is shallow, sufficient is usually provided by the practice of mounding, which also assists drainage requirements.

As with other subsistence crops, sweet potato can be grown all the year round in Papua New Guinea. In all environments there is only a minor seasonal temperature variation throughout the year, and with certain exceptions, rainfall is not limiting. The exceptions are environment 3 and the Bena-Korofeigu area of environment 6, where rainfall is very limited for a certain period each year.

Irrigation of sweet potato has not been documented and if it occurs must be very rare. Mulching also is rare, though weeds may be left lying on top of the ground once they have been pulled.

The remainder of this section on cultivation of the sweet potato has been divided into separate subheadings dealing with the various aspects of propagation, preparation of land, maintenance, harvesting and yields and finally, relationships with other crops.

*Propagation*

Propagation is universally from vine cuttings because, it is said, of the ease with which they strike and the rapidity of their development. Tubers may be used for propagation when new varieties are brought into an area, or when cuttings are in short supply. They are first sprouted and the sprouts either broken off when they are long enough for planting, or a piece of tuber may be cut off with the sprout still attached, and then planted. The only case of propagation from seed was in environment 4 in the Gazelle Peninsula, New Britain, where seed may apparently be the medium of bringing in new varieties. It is not certain, however, whether it is known by the people that the sweet potato is a cross-pollinating plant and that an established variety cannot therefore be propagated from seed. The use of seed in this case could well be an innovation since European contact. Apart from variability of seedlings, the reasons for seed not being used as a means of propagation include low germination, difficulty of collection and time needed for establishment.

Cuttings are almost always taken from the apical portions of the vines, but lengths of ordinary stem may be used if apical portions are in short supply. When this occurs, cuttings which have a new shoot in a leaf axil are preferred. Apical portions are generally recognized as giving quicker establishment and an earlier yield. In environment 2 this is not often recognized and preference is not always made. Cuttings vary in lengths, but the usual is around 30 cm.

There is widespread recognition of the desirability of taking cuttings from mature plants only. The reasons are that cuttings from immature plants are liable to die or strike more slowly after planting. Taking cuttings from immature plants is also thought to lower the yield of the plants from which they were taken. The truth of this would depend on the stage of growth of the plant and severity of pruning for removal of cuttings. There are usually no objections to taking cuttings from plants which are in the process of being harvested and this is often done, as one can see the crop, and cuttings can then be selected from individual plants according to their yield of tubers.

Cuttings are mostly planted straight away, but if convenience dictates, they may be left for up to a week. If pre-treatment of cuttings is carried out, it is always to promote the initiation of adventitious roots. This may be done by leaving the cuttings in a heap in the shade and covered with grass and banana leaves. At Yanyi village in the Lae Highlands and in places in the Wonennara Subdistrict of the Eastern Highlands, one practice is to place cuttings in a shallow pool of water for a few days to initiate roots, but this practice is not widespread. As a rule, such pre-treatment practices are not regarded as essential.

There is widespread variation in the depth of planting, from about 6 cm to as deep as 30 cm or more in some cases. The most widespread is about 6 to 15 cm. There are various reasons for the planting depths adhered to, as no doubt they are best thought to suit local conditions of climate, soil and drainage. However, there is widespread recognition in most environments that planting too deep reduces yield and makes tubers hard to harvest, while planting too shallow exposes cuttings to drying out, reduces successful establishment and results in smaller tubers and reduced yield. There is a tendency to plant at shallower depth in heavier soils than in lighter soils, no doubt because the latter dry out more quickly.

All angles of planting are employed, from horizontal to vertical. The usual is between 30 and 60 degrees from the horizontal. Proponents of planting at 60 degrees and below are usually quite firm in their belief that these angles promote a more even spread of tubers and increase yields. Followers of vertical planting, however, though not so numerous, also believe their method to increase yields.

In all environments, cuttings may or may not be bent underground. Bending, if practised, is usually carried out by simply placing the

underground portion of the stem in an horizontal position and curving it at an angle as it protrudes from the soil. Where cuttings are bent underground like this, the reason is always said to be to promote greater tuber growth from a greater number of nodes. Where bending of cuttings is not practised, the usual reason given is to avoid their rotting.

The usual number of cuttings per planting point lies in the range two to five. In environment 1 it is sometimes only one cutting, but in other environments it can be as many as eight to ten. The reasons given for planting a number of cuttings are to obtain a greater number of tubers per planting position and as an insurance against some not striking. This is often evidenced by more being used in the dry season than in the wet season. In many cases, however, it is an obvious overinsurance and its value in increasing yields is very doubtful, yet it is often believed in all environments that more than one cutting per hole will increase yields. An additional reason, however, is to obtain a quick ground cover. Only in environment 6 is one cutting per planting point more widely used, a practice which no doubt is followed because of the ability of sweet potato to maintain fairly constant yields over a wide range of plant density.

### *Preparation of Land*

The ability of sweet potato to yield good crops in a range of environments has been assisted by the use of horticultural methods developed by subsistence gardeners. This mainly involves earth-moving to assist drainage and tuber development, usually by forming mounds, and where so-called 'hot-beds' are used, at higher altitude, to create a soil temperature more suitable to growth.

In environments 1 to 5, mounds may or may not be used, but where they are used there is almost always an appreciation of their value in increasing yields. In each of these environments, the range in size of mounds appears to be fairly constant. They may vary from about 25 to 90 cm in diameter and from between 15 to 40 cm high (*Plate* III). Wherever mounds are used in environments 1 to 5 the main recognition of their function is in providing good drainage for the crop, but they are also useful in making harvesting easier. In many cases in environment 2, the use of mounds is a recent innovation. Where mounds are not used, the soil is merely loosened before the cuttings are inserted into the ground, a typical slash and burn subsistence practice. However, it is also often recognized that one can vary

*Plate* III.—Shown in the foreground are sweet potato cuttings planted in mounds of a size common in environments 1, 2, 3, 4, and 5 (see Appendix II)

practice according to soil type. If the soil is loose and friable, a reasonable production can be obtained without going to the trouble of forming mounds. In isolated instances where mounds would obviously give an improvement in yields, their value is not recognized. For example, at Yoliapi village in the Telefomin Subdistrict, where soil profiles are dominated by a very shallow top-soil and by a heavy clay subsoil, mounds are not used and although a soil loosening technique may be employed, it is no different to that of growing other food crops. At Ketskets in the Buka Passage Subdistrict on Bougainville, where sweet potato is planted both on flat ground and in mounds, the former is said to produce a quicker crop than the latter. At Timini village, in the Mumeng Subdistrict of the Morobe District, there are initially no mounds, but during growth soil is heaped up to about 15 cm high to cover developing tubers. This practice is probably also followed elsewhere.

Digging sticks are still widely used in all environments, mainly to break the soil down to a finer tilth than is possible with a spade, should this be needed. The spade is, however, universally used, and it is the main implement in ground preparation. It has been instrumental in environment 6 in encouraging the drainage and cultivation of fertile areas which previously could not be used for cultivation because of excess moisture.

One often finds that where sweet potato is the dominant staple, planting may be carried out in established gardens throughout the whole year and new gardens are prepared just before the beginning of the wet season. In most areas of environment 6, therefore, there is a tendency to seasonal activity, with clearing, burning and land preparation reaching a peak late in the dry season and with wet seasons marked by lower activity, mainly harvesting, maintenance and replanting.

The preparation of land in environment 6 is distinct from that in all other environments, except that it shares the features of tillage and orderly garden lay-out with environment 3. Within environment 6, the methods of providing a medium for sweet potato growth vary. Leahy (1936) provided the first general account of some of the techniques and the areas where they are practised. Other observers have given both general and more detailed accounts of practices in particular localities (Schindler 1954; Barrie 1956; Reay 1959; Kingston 1960; Meggit 1960; Montgomery 1960; Brookfield and Brown 1963; Walker 1966; Watson 1967). These authors also usually provide details of cropping procedures, fallow periods and subsidiary crops. Brookfield (1962) in a valuable study, developed a systematic approach and defined the areas of 'distinctive agricultural methods' within the Highlands and gave explanations in terms of rainfall distribution and temperature, at the same time emphasizing that all variations could not be explained by physical factors alone. Appendix III outlines these agricultural methods used in the Highlands and gives examples of their use. The methods are illustrated in *Plates* IV to VIII.

*Plate* IV.—Technique of growing sweet potato on very steep slopes, common in the inter-montane valleys of environment 6. Of particular interest are the small terraces, which are slightly oblique to the contour, and the small mounds made by accumulating soil uphill of the spot to be planted

*Plate* V.—Typical cultivation method of the Upper Ramu Valley and the Asaro and Bena Valleys. For description see Appendix III

Attributing the widespread grasslands of the Highlands region solely to the cultivation of the sweet potato cannot be categorically accepted. Even though cultivation has obviously contributed to the reversion of forest to grassland in some areas, this is not so for most of the Eastern Highlands, for example, where large uncontrolled fires each dry season are probably the main reason for preventing a reversion to montane forest.

*Maintenance*

Weeding practices vary—some people only weed until the vines cover the ground, but others carry on periodical weeding up until harvest, because it is said to improve yields. Once the ground is covered, weeding is easily and quickly done and depending on climatic conditions, two to five weedings are required before this stage is reached. In the Lake Ipea area of the Western Highlands District, where large composted mounds are used, for the first 5 or 6 months after planting, mounds and spaces between them are carefully hand-weeded and any earth that has fallen down is replaced on the mound. After vines have covered the ground, the spaces between the mounds are allowed to become overgrown (Walker 1966).

Vine pruning may or may not be carried out, irrespective of the environment. When it is carried out, the reasons for doing so may differ. Vine pruning to encourage tuber development instead of top-growth is seen, for example, at Wabunum (Woodlark Island) and at Tauta (Madang District). At Mendamen (East Sepik District) on the other hand, vine tips are removed to encourage spreading. Vine pruning in these lower altitude gardens may also be carried out to prevent encroachment upon a neighbour's garden. In environment 6 vine pruning is more common and again is usually done to encourage tuber development. In this environment also, tuber pruning is common, and this is done by discarding smaller tubers during progressive harvesting, together with the removal of any excess roots which are not developing tubers.

*Harvesting and Yields*

Ideal climatic growing conditions are considered to be adequate rain in between periods of sunny weather. It is generally agreed that excessively wet or dry periods will produce a poor crop.

In all environments, the most common method of determining a garden's readiness for harvesting is by inspection of tubers in the ground. Additional signs are appearance of flowers, hardening and thickening of vines, discolouring and abscission of leaves, length of time the crop has been in the ground and by the protrusion of developing tubers above ground level. Tubers are almost always harvested with digging sticks and hands to keep damage to a minimum. Knives may be used occasionally, but never a spade.

There is a wide range of periods to maturity between environments and a lesser range within. Aside from local variations in temperature and cloud cover, caused mainly by surrounding terrain, time to maturity increases with altitude. In environments 1, 2 and 3 the usual time to the first harvest is between 2 and 4 months, while in environment 4, which extends up to about 900 m, it can be up to 6 months. In some instances there is an acknowledged variety effect. In environment 5 the period to first harvest ranges from as little as 3 months to as long as 8 or 9 months, the usual being around 6 months. In environment 6 the period to first harvest is usually no less than 5 months and can be longer than 9 or 10, depending on the elevation and season. At 2,000 to 2,200 m for example, it is usually 7 to 8 months, compared to 5 months at 1,500 m. In some Chimbu areas, for example at Kone village at 1,590 m, first harvest is at 3 to 4 months, but this is probably a reflection of favourable climate and soil, together with a high level of technical ability resulting from the necessity to maintain a high level of production from a limited area of land.

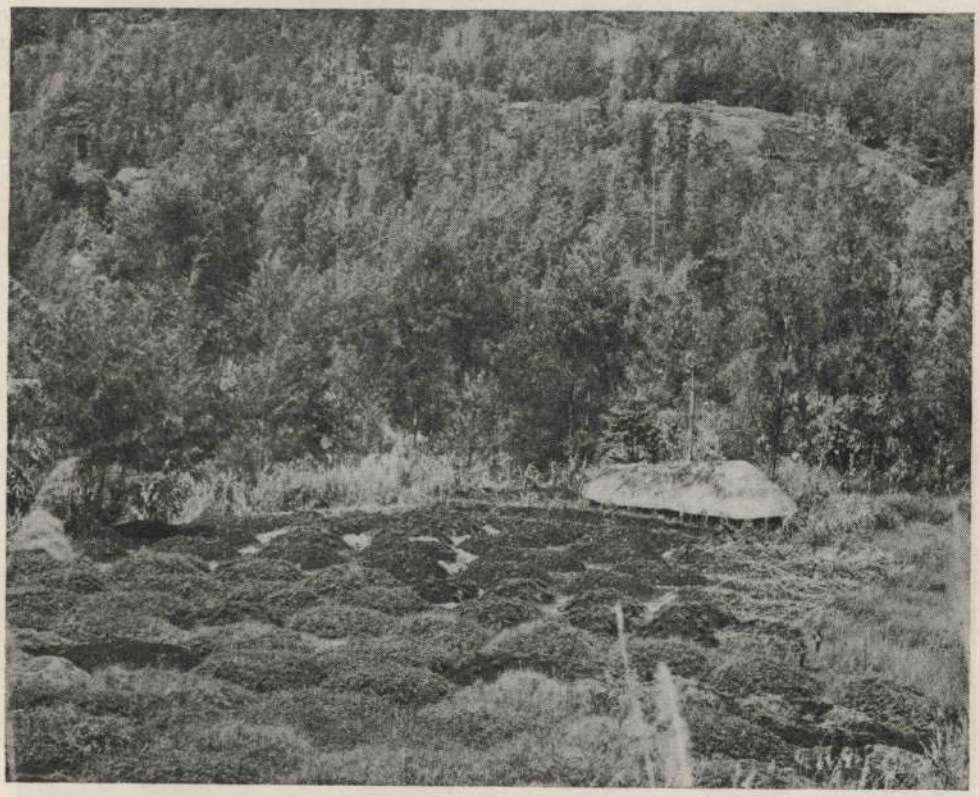
*Plate* VI.—Method of cultivation found most commonly in the lower Chimbu Valley and the Wahgi Valley. For description see Appendix III

Progressive harvesting is carried out in all environments, irrespective of variety, but it is not always found, especially in environment 2. Progressive harvesting involves exposing individual tubers to view to determine if they are large enough or mature enough for harvesting. If a tuber is considered not to be ready, it is re-covered, with inspection at a later date. In environments 5 and 6 it is a universal practice and is of course facilitated by mounding. In

these two environments, the crop can last for up to 6 months from the first harvest, but normally it is harvested over a period of 2 to 3 months before replanting is carried out, or a new garden made.

Being a somewhat specialized method of growing, the so-called 'hotbed' mounds found in parts of the Western Highlands are often harvested so as to facilitate their rebuilding for the next planting (Walker 1966). At the final harvest, the ground is worked down and out, a shallow hole being left beneath the centre of the position of the old mound. Old sweet potato vines and weeds are then put back into the hollow. Meggit (1960) reports a similar procedure, but he says that the second crop is not a large one, unless the ground is of good quality, and it is usually fed to pigs or kept for emergencies.

Although reliable yield figures for subsistence production are not available, it is believed that yields from the Soil Exhaustion and Crop Rotation Trials at Aiyura are a fair reflection of what subsistence gardeners achieve in the Highlands (DASF Annual Reports, 1959-60 to 1965-66). These have been around 20,000 kg per hectare, although the Soil Exhaustion Trial yields have dropped well below this in recent years. Allowing for an approximate 31 per cent loss as inedible tubers (unpublished results) for the variety 'Akaio', which is at present being used in the Exhaustion Trial, an estimate of



*Plates* VII and VIII.—Cultivation of sweet potato in the Lai Valley of the Western Highlands District. This method is found also in other areas of the Western Highlands and in the Southern Highlands. The Casuarina trees in the background are planted as part of the fallow rotation. Refer to Appendix III for a description

average yields of edible tubers for Highlands subsistence sweet potato growers would be about 14,000 kg per hectare. However, one proviso is that in subsistence production, if there is a temporary shortage of food, tubers which would normally be fed to pigs are quite acceptable for human consumption. A Soil Exhaustion Trial at Keravat (DASF Annual Report, 1959-60) initially gave a yield of approximately 29,000 kg per hectare, and this would probably be a good estimate of subsistence yields in environments 1 to 4. This yield includes all grades, however, and the yield of tubers acceptable for human consumption would probably be 18,000 to 20,000 kg per hactare.

*Relations with Other Crops*

Mixed gardening is the usual practice in subsistence agriculture and one finds that in all environments sweet potato is grown intercropped with other food crops such as maize, taro, yams, bananas, sugar-cane, cassava, beans, peas and cucumbers, the emphasis on other crops depending upon the environment (*Plate* IX). At the same time, however, sole plantings of sweet potato are common in all environments and not infrequently people have reservations of growing sweet potato mixed with other crops. Some believe that the intercropping of sweet potato with yams or taro reduces the yield of the latter two, especially that of taro. Examples are at Nunamai and Tatupiti villages in the Central District. In the Highlands some people prefer not to mix taro and sugar-cane with sweet potato.

In the lower altitude environments gardening cycles are quite short and the land is usually cropped only once. In environments 5 and 6, gardening may be continued on the one site for 3 or 4 years, especially if sweet potato is the crop concerned. In environment 6 in partic-

*Plate* VIII

ular, where population densities are higher and land availability on the whole lower, some land may be cropped almost continuously, depending on its quality; some may be cropped for 3 or 4 years, with short fallows of varying length of time between croppings and then the land abandoned to long fallow, and some may be cropped only once or twice before long fallow, which may be up to and over 20 years. Examples of land classification, cropping systems and land enclosure have been described for the Chimbu (Brookfield and Brown 1963) and for other areas in the Highlands (Barrie 1956; Montgomery 1960; Meggit 1960; Walker 1966; Schindler 1954).

There is ample evidence from the survey and from published literature that in environments 5 and 6 the ability of sweet potato to yield worthwhile crops from relatively depleted land is well known. For example, the Wain people of the Lae Highlands (Morobe District) grow sweet potato on poor land near the village and yams on less frequently cropped land some distance away. The yam areas may also be used for sweet potato, but only as a second crop (Jackson 1965). The North Fore people of the Okapa area (Eastern Highlands) may crop a mixed garden of taro, yams and winged beans, then sweet potato and maize and then sweet potato only, before the land is fallowed (Loh,

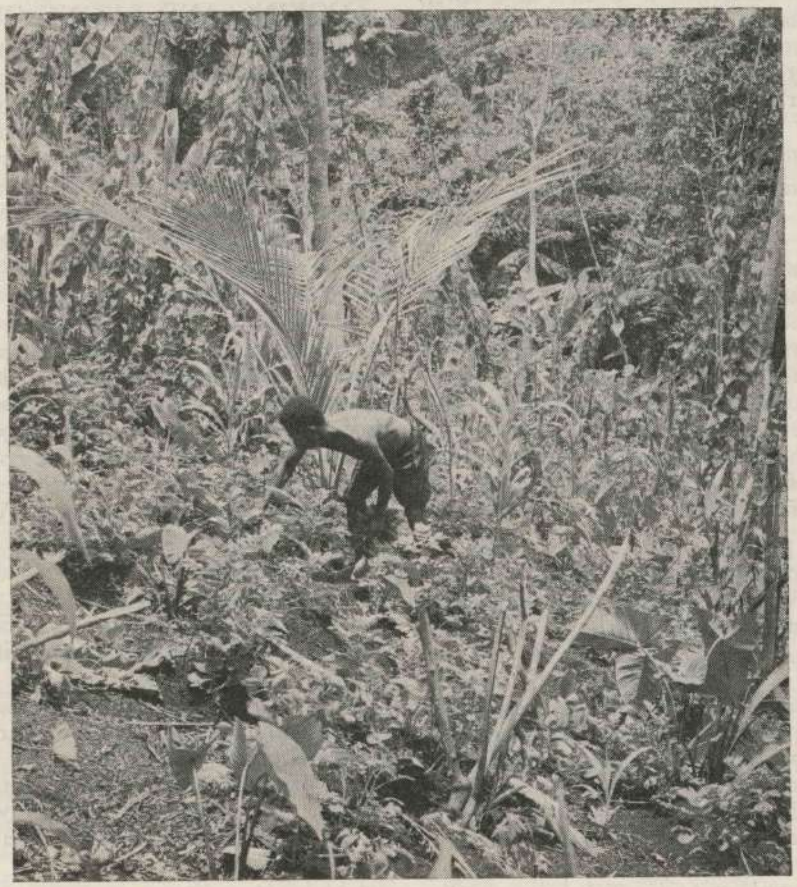


*Plate* IX.—A typical mixed cropping garden in a Lowlands environment. Some of the food plants which can be seen are sweet potato, taro (Colocasia), maize, banana, yam and coconut

pers. comm.). Various gardens would be in different stages of such a cycle and there would be variations according to the quality of the land. At Usa village, in the Southern Highlands, sweet potato may be grown up to six times in succession before the land is fallowed.

The relationships of sweet potato with cash cropping are also worth noting. In environments 1 and 4 it is common for an area of ground to be used as a subsistence garden before planting to coconuts, cocoa or rubber. After that, the use of sweet potato as a cover-drop in young coconuts is a widespread practice up until palms are 5 or 6 years old. Sweet potato may also be planted as a subsistence crop concurrently with coconuts to make double use of the land. When it is used as a cover-crop in coconuts, cocoa or rubber, it is not likely that much effort is made to maintain it, but rather it is allowed to fend for itself, perhaps after initial care. The actual value or otherwise of sweet potato as a cover-crop is not yet known.

In those areas of environment 5 where coffee is grown, it is not uncommon to find coffee planted into old sweet potato gardens and it is not unusual to find also sweet potato being planted into and harvested from well-established coffee groves. Much the same situation applies in environment 6, with the exception that it is rare to find sweet potato being cropped in established coffee. However, sweet potato and coffee in environment 6 may be planted in a garden at the same time, so that after the harvesting of the sweet potato the garden becomes a coffee grove.

When it precedes coffee, sweet potato is thought by some to assist the coffee by breaking up the ground, or in some other way which the people cannot define.

## STORAGE

There are no elaborate storage techniques. These have probably not been developed because sweet potato can be grown at all times of the year, and it can therefore be harvested as required. In all environments it is unusual for sweet potato to be stored for more than 2 or 3 weeks. The normal pattern is to harvest 2 or 3 days' supply at a time. Tubers are usually kept on a table, or on the floor, in a bilum hanging in the house, or even under the house, but in environment 3 may be stored in a yam food house. In one instance, storage of tubers in holes in the ground was reported, but this would be similar to leaving plants unharvested in the ground. Storage in holes filled with sand is also found in some cases. Leaving edible tubers unharvested in the ground is a good storage method, provided moisture is not excessive. If this is done, tubers which are known to be ready for harvest become more satisfying when eaten, mainly because of the lower moisture content which develops.

There is a general recognition of the desirability of retaining the skin intact and preventing bruising, so that rotting of tubers is avoided.

## COOKING AND EATING QUALITY

Although it would seem that little attention is paid to it, storage for a few days is often recognized by the people as improving eating quality. This is due to loss of moisture from the tuber, given a greater energy value per unit weight and also to the hydrolysis of starch to sugars. Only on the desirable aspects of lowered moisture content, sweetness and lack of fibre is there any agreement on eating quality. There is no expressed preference for dry or moist types.

Preferences for size vary, although in subsistence horticulture there is a definite bias towards growing large tubers. Despite this, large size is regarded as of little practical importance, and provided tubers are not too small, they are readily consumed, particularly if there is a danger of a food shortage. Where preference for flesh colour is expressed, it is usually for white or cream.

Sweet potatoes are prepared for consumption in a number of ways. They may be baked in ashes, steamed in a mumu, or boiled. In the Lowlands environments they are sometimes mashed with coconut milk. Although in all environments it is not hard to find examples of sweet potato leaves and vine tips being used as an item of diet, it is not a general practice. The more usual habit, when it is carried out, is to use the leaves as a flavouring with some other foods.

Evidence from the survey suggests that varieties can be supplanted in favouritism by others, but whether this is a process which has been

accelerated by improved communications in recent years is not known. Many people use sweet potato varieties of relatively recent introduction to their area. Along main roads in the Highlands, for example, three or four varieties have become widespread during the last 15 or 20 years. Older varieties are often retained, though they may not be eaten very often.

Finally, yield is not the main criterion of desirability. One variety, commonly known as 'Gonimi', is very widespread and popular though of relatively low yield.

## SWEET POTATO AND LIVESTOCK FEED

Pigs are the largest and most important domestic animal in subsistence agriculture in Papua New Guinea. Their use lies mainly in their value as a source of wealth and prestige. The date of their introduction into Papua New Guinea is not known exactly, though their first discovered remains are reported to be five to six thousand years old (White 1968).

Pigs may or may not be allowed to forage in old sweet potato gardens, depending on what the local social custom is and also upon local ideas of allowing the animals to acquire the taste of fresh garden food. In environments 5 and 6, where pigs tend to be socially more important than in other environments, only a small minority prevent pigs foraging in old gardens and occasionally, when the supply of sweet potato is plentiful, they may even be allowed to forage in unharvested gardens.

Regardless of forage practice, it is common in all environments to feed pigs sweet potato by hand. This is usually in the form of discarded tubers and peelings, from the household, but when there is an abundance available, better quality sweet potato is also fed to them.

Free foraging pigs in environments 5 and 6 are the cause of a great deal of soil loss from steep slopes, where their rooting habit in recently abandoned gardens exposes the soil to water erosion.

It would be true to say that the pig population in environment 6 would not be so high, but for the cultivation of the sweet potato. The pig population of the Highlands is not known, but there are probably as many pigs as people, if the observations of Schindler (1954) and the estimates of Brookfield and Brown (1963) can be taken as a guide. However the pig population in the Highlands is known to vary in accordance with a cycle, coinciding with a periodic spate of feasting, dancing and exchange, which activity generally lapses until the pig population builds up again. The length of the cycle, and the particular stage encountered would no doubt vary from area to area. In his study of land use at Aiyura village in the Eastern Highlands, Schindler says that about half the production of sweet potato goes to feeding the family pigs. This emphasises the relative efficiency of Highlands gardening methods and emphasises the role of the sweet potato in the accumulation of accepted standards of wealth.

## PESTS AND DISEASES

In subsistence agriculture, much reliance is placed upon natural predators in controlling insect pests. In addition, however, both disease and insect pests are usually kept in check by the practices of mixed cropping, crop rotation and garden fallowing.

There are three insect pests of some consequence in sweet potato subsistence crops, despite the practices mentioned above. The three major pests are the sweet potato weevil (*Cylas formicarius* F.), the sweet potato hawkmoth (*Herse convolvuli* (L.)) and the sweet potato leaf miner (*Bedellia somnulentella*). The life history, alternative hostplants, damage caused by and recommended control measures of these are given by Smee (1965) and O'Connor (1969).

In the field of sweet potato diseases, virus-infected sweet potato has been found on the Gazelle Peninsula of East New Britain. Movement of any part of the sweet potato plant from this area is therefore prohibited, as virus diseases could have serious implications for sweet potato in Papua New Guinea, through possible dissemination by insect vectors and vegetative propagation.

## CONCLUSIONS

The ability of sweet potato to sustain good yields in subsistence agriculture from sea level to altitudes of up to 2,600 m is reflected by the fact that quantitatively it is the most

important food crop in Papua New Fuinea. Although it achieves this position largely through its cultivation in the inter-montane valleys of the Highlands region, it has been shown to be of considerable importance in other environments as well. Of all the staple root crops available to the people, it appears to be the most adaptable to a range of environments, an attribute which is probably based upon a large degree of genetic heterozygosity. Its relative freedom from pests and diseases in subsistence agriculture is an additional factor accounting for its widespread acceptance in all environments and growing importance in some.

The significance of sweet potato in the Highlands lies in the fact that it appears to be the only crop which has, until recently, been available to the people, which will support relatively dense populations at altitudes above 1,400 m. The importance of sweet potato in supporting the pig population of the Highlands, and to a lesser extent of the Lowlands, has already been mentioned as a major factor in the establishment of wealth and prestige in subsistence economies.

The last 50 years has seen the introduction of a variety of food crop plants—legumes, roots and grains—which may become more acceptable with the passage of time and which will, if more widely accepted, be able to extend the limits of cultivation further than at present, especially in terms of altitude. Already maize and potatoes are relatively common items in the subsistence diet, the former in both coastal and elevated areas, the latter in elevated areas only.

The various agronomic and horticultural aspects studied in the survey have provided basic information on sweet potato cultivation which will be of value to research into methods of commercial production.


## ACKNOWLEDGEMENTS

The author would like to express appreciation to members of the Summer Institute of Linguistics and of the staff of the Department of Agriculture, Stock and Fisheries who so kindly participated in the mailed survey.


## REFERENCES


BARRAU, J. (1958). Subsistence agriculture in Melanesia. *Bull. Bernice P. Bishop Mus.*, 219.

BARRIE, J. W. (1956). Population-land investigation in the Chimbu Subdistrict. *Papua New Guin. agric. J.*, 11(2):45-51.

BRASS, L. J. (1941). The 1938-39 expedition to the Snow Mountains, Netherlands New Guinea. *J. Arnold Arbor.*, 22:271-295; 297-342.

BROOKFIELD, H. C. (1962). Local study and comparative method: an example from Central New Guinea. *Ann. Ass. Am. Geogr.*, 52:242-254.

BROOKFIELD, H. C. (1964). Ecology of Highland settlement; some suggestions. *Am. Anthrop.*, 66(4) Pt2, "New Guinea: the Central Highlands".

BROOKFIELD, H. C. AND BROWN, PAULA (1963). *Struggle for land: agriculture and group territories among the Chimbu of the New Guinea Highlands* (Oxford Univ. Press: Melbourne).

BULMER, S. AND R. (1964). The pre-history of the Australian New Guinea Highlands. *Am. Anthrop.*, 66(4)Pt2, "New Guinea: the Central Highlands".

BUREAU OF STATISTICS (1963). *Survey of indigenous agriculture and ancillary surveys*, 1961-62 (Bureau of Statistics: Konedobu, Papua).

CONROY, W. L. AND BRIDGLAND, L. A. (1947). *Native agriculture in Papua-New Guinea*, Report of the New Guinea Nutrition Survey Expedition, 1947 (Dept of External Territories, Canberra).

CONKLIN, H. C. (1963). The Oceanic-African hypothesis and the sweet potato. *In* J. Barrau, Ed., *Plants and migrations of Pacific peoples.* (Bishop Museum Press: Hawaii).

DASF (1961, 1963, 1965a, 1965b, 1966, 1968). *Rep. Dep. Agric. Stk Fish., Papua New Guinea*, 1959-60 to 1965-66.

DIXON, R. B. (1932). The problems of sweet potato in Polynesia. *Am. Anthrop.*, 34:40-66.

HAANTJENS, H. A., REYNDERS, J. J., MOUNTHAAN, W. L. P. J. AND VAN BAREN, F. A. (1967). Major soil groups of New Guinea and their distribution. *Communication, Royal Tropical Institute, Amsterdam*, 55.

JACKSON, GRAHAM (1965). Cattle, coffee and land among the Wain. *New Guinea Research Unit Bulletin*, 8 (Australian National University Press).

KINGSTON, D. J. (1960). The physical processes involved in subsistence agriculture and the necessity therefor. Symposium on the Influence of Man on Humid Tropics Vegetation, Goroka, 1960.

LEAHY, M. (1936). The central highlands of New Guinea. *Geogrl J.*, 87:229-267.

MASSAL, E. AND BARRAU, J. (1956). Food plants of the South Sea Islands. *Tech. Pap. S. Pacif. Commn*, 94.

MEGGIT, M. J. (1960). Notes on the horticulture of the Enga people of New Guinea. Symposium on the Impact of Man on Humid Tropic Vegetation, Goroka, 1960.

MONTGOMERY, D. E. (1960). Patrol of the Upper Chimbu census division, Eastern Highlands. *Papua New Guin. agric. J.*, 13(1):1-9.

NISHYAMA, J. (1963). The origin of the sweet potato plant. *In* J. Barrau, Ed., *Plants and migrations of Pacific peoples* (Bishop Museum Press: Hawaii).

O'CONNOR, B. A. (1969). *Exotic plant pests and diseases* (South Pacific Commission: Noumea, New Caledonia).

QUARANTINE REGULATIONS, 1963-69. (Govt Printer: Port Moresby).

REAY, MARIE (1959). Individual ownership and transfer of land among the Kuma. *Man*, 108 and 109.

ROBBINS, R. G. (1963). Correlations of plant patterns and population migration into the Australian New Guinea Highlands. *In* J. Barrau, Ed., *Plants and migrations of Pacific peoples* (Bishop Museum Press: Hawaii).

SCHINDLER, A. J. (1954). Land use by natives of Aiyura village, Central Highlands, New Guinea. *South Pacific*, 5, 7.

SMEE, LANCE (1965). Insect pests of sweet potato and taro in the Territory of Papua and New Guinea: their habits and control. *Papua New Guin. agric. J.*, 17(3):99-101.

WALKER, D. (1966). Vegetation of the Lake Ipea region, New Guinea Highlands. 1. Forest, grassland and garden. *J. Ecol.*, 54:2.

WATSON, JAMES B. (1965a). From hunting to horticulture in the New Guinea Highlands. *Ethnology*, 4:295-309.

WATSON, JAMES B. (1965b). The significance of a recent ecological change in the Central Highlands of New Guinea. *J. Polynes. Soc.*, 74.

WATSON, JAMES B. (1967). Horticultural traditions of the eastern New Guinea Highlands. *Oceania*, 38, 21.

WHITE, PETER J. (1968). Studies of pre-history in the New Guinea Highlands. *Aust. nat. Hist.*, 16, 3.

YEN, D. E. (1963). Sweet potato variation and its relation to human migration in the Pacific. *In* J. Barrau, Ed., *Plants and the migrations of Pacific peoples* (Bishop Museum Press: Hawaii).

(Accepted for publication July, 1972).

## APPENDIX I

Locality details of villages from which information was obtained during the mailed survey

| Environment | Village | Number of Village on Map | Elevation (m) | Administrative Subdistrict | Administrative District |
|---|---|---|---|---|---|
| 1. Non-swampy coastal | Merani | 5 | 15 | Abau | Central |
| | Nunamai | 6 | 30 | Abau | Central |
| | Wabununu | 10 | 15 | Samarai | Milne Bay |
| | Amele | 25 | not given but<150 | Madang | Madang |
| | Baranis | 26 | sea level | Madang | Madang |
| | Kaliku | 28 | sea level | Madang | Madang |
| | No name given | 33 | not given about 30 | Lae | Morobe |
| | Ketoketo | 56 | 61 | Buka Passage | Bougainville |
| 2. Swampy lowlands | Bibriari | 11 | 430 | Amanab | West Sepik |
| | Wagu | 17 | 60 | Ambunti | East Sepik |
| | Karanio | 22 | 15 | Angoram | East Sepik |
| 3. Grassland, scrub, savanna and savanna woodland | Gnarowein | 30 | 180 | Kaiapit | Morobe |
| 4. Rainforest lowlands and foothills | No name given | 1 | <150 | Kerema | Gulf |
| | Bakoiudu | 2 | 488 | Kairuku | Central |
| | Serove | 7 | 30 | Popondetta | Northern |
| | Kiorata | 8 | 150 | Popondetta | Northern |
| | No name given | 12 | <150 | Lumi | West Sepik |
| | Nuku | 13 | 230-300 | Lumi | West Sepik |
| | Yoliapi | 14 | 450 | Telefomin | West Sepik |
| | No name given | 18 | 150-300 | Maprik | East Sepik |
| | Mendamen | 19 | 460 | Maprik | East Sepik |
| | Kmoluik | 20 | 107 | Maprik | East Sepik |
| | Waigakam | 21 | 180 | Maprik | East Sepik |
| | Bembei | 24 | 300 | Madang | Madang |
| | Narer | 27 | 300 | Madang | Madang |
| | Timini | 31 | 610 | Mumeng | Morobe |
| | Bai | 52 | 30 | Rabaul | East New Britain |
| | Tanaka | 53 | 335 | Rabaul | East New Britain |
| | Illugi | 54 | 30 | Kokopo | East New Britain |
| | Tabuna | 55 | 46 | Kokopo | East New Britain |
| 5. Lower montane forest | Tatupiti | 3 | 1006 | Goilala | Central |
| | Efogi | 4 | 1220 | Port Moresby | Central |
| | Kakaia | 9 | 915-1220 | Baniara | Milne Bay |
| | No name given | 15 | 7915 | Telefomin | West Sepik |
| | Drelingan | 16 | 1200-1530 | Telefomin | West Sepik |
| | Bundi | 23 | 1530 | Ramu | Madang |
| | Tauta | 29 | 1280 | Saidor | Madang |
| | Mapos | 32 | 1460 | Mumeng | Morobe |
| | No name given | 34 | 1530-1830 | Lae | Morobe |
| | Konge | 35 | 1530-1830 | Finschhafen | Morobe |
| | Mobuta | 50 | 915-1070 | Wonerara | Eastern Highlands |

Appendix I—*continued*

Locality details of village from which information was obtained during the mailed survey

| Environment | Village | Number of Village on Map | Elevation (m) | Administrative Subdistrict | Administrative District |
|---|---|---|---|---|---|
| 6. Inter-montane valleys of the main cordillera | Usa | 36 | 1530 | Kagua | Southern Highlands |
| | Kone | 37 | 1585 | Gumine | Chimbu |
| | Nonambaro | 38 | 1830 | Goroka | Eastern Highlands |
| | Wanima | 39 | 1585 | Goroka | Eastern Highlands |
| | Korofeigu | 40 | 1585 | Goroka | Eastern Highlands |
| | Rana | 41 | 1830 | Henganofi | Eastern Highlands |
| | Kanampa | 42 | 1830 | Kainantu | Eastern Highlands |
| | Hena-agaru | 43 | 1830 | Okapa | Eastern Highlands |
| | Kopena | 44 | 2075 | Kainantu | Eastern Highlands |
| | Kainantu | 45 | 1585 | Kainantu | Eastern Highlands |
| | Tuempingha | 46 | 1585 | Kainantu | Eastern Highlands |
| | Ibusa-Kagu | 47 | 1980 | Okapa | Eastern Highlands |
| | Punano | 48 | 1615 | Kainantu | Eastern Highlands |
| | Omomunta | 49 | 1707 | Kainantu | Eastern Highlands |
| | Yanyi | 51 | 1646 | Wonerara | Eastern Highlands |

## APENDIX II

### Subsistence Agricultural Environments

| Environment and Examples | Characteristics | Details of Subsistence Agriculture | Details of Staples in Diet |
|---|---|---|---|
| 1. Non-swampy coastal areas. Parts of north coast of New Britain, west coast of New Ireland and parts of Bougainville. | Narrow coastal strips of herbaceous beach and strand vegetation. Mostly sandy and coral-derived soils. Coconut palms have replaced most of the natural vegetation. | Subsistence economy greatly modified by production of copra and employment on large plantations. The subsistence economy is basically slash and burn, with a fallow period which is relatively short. Fallows are often only long enough to allow regeneration to a high secondary brush. Gardens can extend into the hinterland and fishing remains an important source of protein and subsidiary income. | By and large, sweet potato assumes the place of a secondary staple behind taro, yams and sometimes bananas. Quantity of sweet potato in diet however, varies from 10 to 50 per cent and in some cases can be more than 50 per cent. Sweet potato becoming more important because of ease of cultivation and relative freedom from pests and diseases—factors important to people who have greatly modified their subsistence economy. |
| 2. Swampy lowlands. Deltas of Fly and Purari Rivers; mouths of coastal creeks and rivers; inland swamps of Sepik. | Freshwater swamp and tidal swamps mainly covered by *Rhizophora* and *Bruguiera* spp. mangrove and stands of Nipa palms. Sago palm (*Metroxylon* spp.) occupies large areas of shallow freshwater swamps. | Fishing and sago collecting are the main activities, with gardening assuming varying degrees of importance, depending on how much sago is available. When carried out, gardening is slash and burn, usually with only dibbling of vegetative cuttings. | Mextroxylon (sago palm) the main starchy staple. When gardening is practised sweet potato is of very little importance and is often only one of a number of subsidiary dietary items. In some areas only those who like it bother to plant it. Yams can achieve considerable importance. |
| 3. Grassland, scrub, savanna and savanna woodland. Extensive areas of coastal and subcoastal Papua, especially the rain shadow Moresby area, the Gona-Popondetta-Oro Bay-Tufi area and the broad rift Markham-Ramu valley. | Typical of areas receiving a marked seasonal rainfall of 1,000 mm a year or less or where rainfall may be higher, but dry season is still very pronounced. Forest can occur along river valleys. | Vegetative characteristics believed to have been formed mostly by man through destruction of original vegetation by shifting agriculture and by burning for hunting. Agricultural techniques have been developed to suit the conditions, the main feature being tillage to retain soil moisture. Gardens are usually rectangular and the soil is turned over carefully in large clods. | Yams and bananas are usually the most important crops and cassava also often rates more importantly than sweet potato. |
| 4. Rainforest lowlands and foothills. Occupies large tracts of country throughout Papua New Guinea, from sea level to about 915 m. | As well as rainforest, includes monsoon (semi-deciduous) forest where there is a marked dry season and where, through man's activity, patches of grassland tend to appear. Local variations in terrain affecting climate can extend the limits of this environment to altitudes considerably higher than 915 m. | Typical slash and burn economy with bush fallow rotation involving a long fallow period and short cropping period of 1 to 2 years, with semi-foraging of bananas and other foods as the bush regenerates. Fallow after main cropping periods varies from 10 to 20 years, depending on the availability of land. Soil preparation mainly confined to scraping and loosening patches of ground with a digging stick and spade at the sites of individual plants. | Taro is the staple food and sweet potato assumes varying importance as a supplementary staple, varying from about 10 to 20 per cent of the bulk diet. At altitudes approaching 610 m, sweet potato becomes more important and may even become the main staple. The approximate limit of 915 m to this environment is also a rough estimate of the altitude where sweet potato assumes the role of the main starchy staple. |

APPENDIX II—*continued*

| Environment and Examples | Characteristics | Details of Subsistence Agriculture | Details of Staples in Diet |
|---|---|---|---|
| 5. Lowland montane forest. Areas of Papua New Guinea mainland and islands which are not part of the inter-montane valleys of the main cordillera, e.g., Lae Highlands, many parts of the Southern Highlands and elevated valleys of the mainland and islands. | This zone is usually taken to extend from 915 to 2745 m, though there are local variations. Where grasslands have not been induced, vegetation consists mainly of forests of oaks (*Quercus* and *Castanopsis* spp.) members of the family Lauraceae, klinki pine (*Araucaria klinkii*) and southern beech (*Nothofagus* sp.). | Very similar to environment 4. | Sweet potato is the dominant staple, with few exceptions, e.g., Telefomin area of the Western Highlands District where taro supplants it. |
| 6. Inter-montane valleys of the main cordillera. Upper Ramu, upper Purari Valleys. (Lai River, Upper Yuat and Strickland Valleys) | Except for steep valley sides, these are predominantly grassland areas. Two types of grassland occur: "short grass", dominated by *Imperata cylindrica, Themeda, Arundinella* and *Ischaemum* spp.; and "long grass", dominated by *Miscanthus* spp. In swamp areas, vegetation is dominated by *Saccharum spontaneum* and *Phragmites kaka.* Theoretically a part of environment 5, these grasslands appear to have been formerly forested (Robbins 1963, and others) | Separated from environment 4 because of more advanced and more orderly garden techniques. More advanced localized aspects are composting and planting of Casuarina trees in the fallow. Land tilled, in direct contrast to all other environments except 3. Gardens extend from about 1,220 to 3,050 m for cultivated Pandanus. Upper limit of sweet potato cultivation around 2,400 to 2,600 m, depending on local conditions, especially frost and cloud occurrence. | Sweet potato is by far the most important staple. Crops typical of lower environments (yams, aroids, cassava and bananas) are still grown, but usually in spots especially favoured to suit their growth. Content of sweet potato in diet ranges from 50 per cent to over 90 per cent. Dependence upon it increases with altitude, modified by local conditions. What amount to monocultures with sweet potato occur in certain areas such as Upper Chimbu and Okapa. Different tillage techniques are used in different areas (see Appendix III). |

## APPENDIX III

### Environment and Agricultural Techniques in the Inter-Montane Valleys of the New Guinea Highlands (Environment 6)

| Conditions and Examples | Other Characteristics of Environment | Details of Agricultural Methods |
|---|---|---|
| 1. Areas of marked seasonality of rainfall. Lack of rainfall at a certain time each year imposes a limitation on plant growth. Upper Ramu Valley, Asaro and Bena Bena Valleys. | Seasonality of rainfall has encouraged the use of fire in agriculture to such an extent that fires are largely indiscriminate and uncontrolled in the dry season. Landscape now dominated by large areas of short grassland in which *Imperata cylindrica*, *Themeda*, *Arundinella* and *Ischaemum* spp. occur, their proportion depending upon local conditions of soil and climate. Use of Casuarina in fallows not as widespread as in 2 and 3, except in more locally heavily populated spots. | Gardening methods determined by seasonality of rainfall. Field layout of sweet potato gardens is one of long narrow parallel beds separated by shallow drains, 1 to 1.5 m apart, dug down to the often stiff clay subsoil. Drains run up and down hillsides, or on a lesser slope, may be at an oblique angle. Their main function is disposal of excess water and prevention of gully erosion and large-scale soil movement downhill, which occur if drains are dug across the slope. Sweet potato planted throughout the year, but the more seasonal the rainfall the more there is a peak of activity in garden preparation some weeks before the commencement of the wet season. After burning, land is given a complete tillage and fallowed until planting time. In between periods of light showers the land is tilled to prevent formation of a surface crust and to conserve moisture. When soil moisture is sufficient planting is carried out. This is usually accomplished by the beginning of the wet season, because of the difficulty of working ground once the wet season has commenced. The bare fallow is, apart from moisture conservation, recognized as improving the yields of the subsequent crop, though the technical reasons for soil aeration and mineralization are not understood by the people. Variations of preparation of beds between trenches include one or more rows of small mounds, or no mounds at all. On occasions no drains are necessary and the tilled ground is merely small-mounded. If after planting general rains do not commence, the soil is dug over at intervals to prevent a crusty surface forming. |
| 2. Areas of lower seasonality of rainfall such that growth is not limited by seasonality, or only to a relatively minor extent. Chimbu Valley, Lower Wahgi Valley. | Landscape dominated by sweet potato gardens and fallowed areas planted to Casuarina trees. Grasses also occur (*Miscanthus floridulus, Imperata cylindrica, Themeda, Ischaemum* and *Arundinella* spp. In Upper Chimbu slopes of 35 degrees commonly cultivated. | No definite planting season, but may be a peak just before commencement of less obvious wet season or even just before it ends. Complete tillage as in 1, together with bare fallow technique, but more conscious incorporation of debris (burnt grass, Casuarina leaves and twigs) into tilled soil. Layout of garden beds may be square or rectangular (2 to 3 m wide by about 3 to 5 m long) separated by shallow drains which, however, usually go to greater depth than in 1. This type of land preparation governed by need for more adequate drainage than in 1 and it is this that governs the distance between drains. Small mounds are usually constructed on the beds. In areas where large-scale steep slope cultivation is carried out, ditching is often not used and a system of semi-terracing is employed, using split Casuarina saplings pegged across the slope. These retaining walls are made permeable to prevent build-up of water and massive soil movement downhill. |

APPENDIX III—*continued*

| Conditions and Examples | Other Characteristics of Environment | Details of Agricultural Methods |
|---|---|---|
| 3. Seasonality of rainfall not marked, but climate such that these areas are exposed to lower temperatures than is usual elsewhere in the Highlands. Large areas of high altitude in the Western Highlands and Southern Highlands Districts, e.g., Lai Valley, Lagaip Valley. | Again widespread use of Casuarina. Fallowed areas, if not planted to Casuarina tend to be dominated by the long sword grass *Miscanthus floridulus*. Short grass communities composed of *Imperata cylindrica*, *Themeda*, *Ischaemum* and *Arundinella* spp., however still occur. | Complete tillage, but ground formed into very large mounds whose size appears to increase with altitude and decreasing soil temperatures. Variation is approximately as follows (Kingston 1960): at 1,680 m, 2 m diameter and 60 cm high; at 1,980 m, 3.7 m diameter and 90 cm high; at 2,286 m, 3 m diameter and 122 cm high. Mounds may also be oval to oblong in shape. Plant debris is incorporated into mounds and composted inside to raise soil temperature. Mound saucer-shaped at first (concave at top) and all weeds and old sweet potato vines are thrown into the saucer and then covered to complete the mound. Only topsoil is used in construction. A light incomplete burning of grass is often practised before mounds are constructed and the actual filling in with plant debris and tilled earth may take place over a period of 8 weeks. This constitutes a bare fallow similar in effect and purpose to those in 1 and 2. Grass may often be cut and incorporated into the mound with only stubble being burned. Any soil washed down from the mounds is returned to the top. In these areas yield and size of tubers is often reduced and shape tends to be inferior. |
| 4. Swampy areas. Parts of Wahgi. However, more developed in Wissel Lakes area of West Irian. | Peaty swamp soils built up over time from trash of tall grass which constitutes the swamp vegetation (*Phragmites kaka* and *Saccharum spontaneum*. | Fairly similar to grid-iron pattern of 2, and in a way difficult to separate from it apart from necessity for more adequate drainage in these swamp soils. However, in its usual pattern this method does not involve tilling of the original surface. Ditches are deeper and subsoil from them is thrown onto intervening beds, is broken down and then becomes the plant medium. In the Wahgi Valley ditches may be 60 cm deep, but this is shallow compared to the necessity for greater depth in the Wissel Lakes areas. |

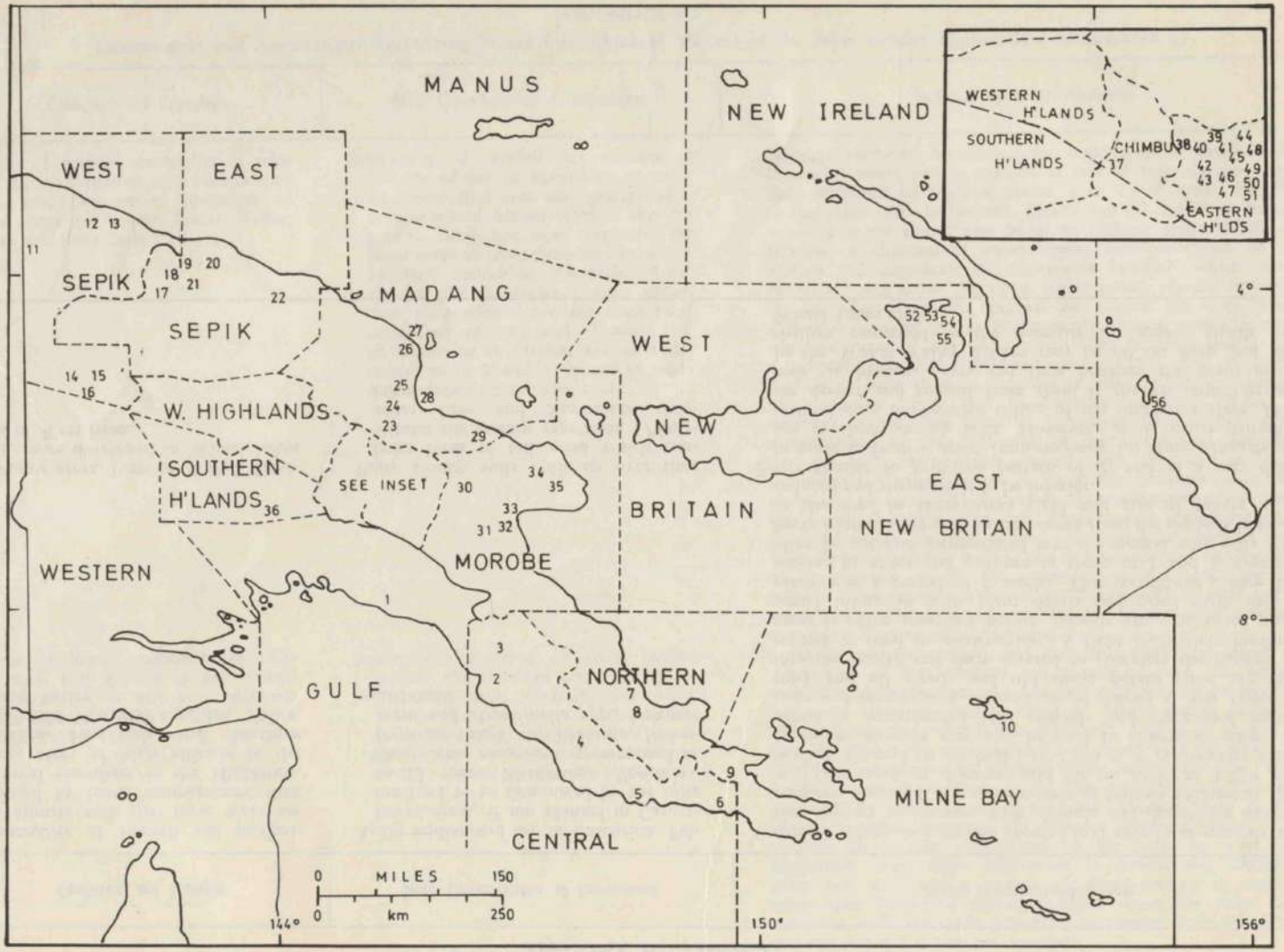



*Figure* 1.—Location of Districts and villages listed in Appendix I.

# EFFECT OF INTENSIVE v. SEMI-INTENSIVE REARING AND OF A VITAMIN-MINERAL PREMIX ON CHICKENS FED A RATION BASED ON INGREDIENTS GROWN IN PAPUA NEW GUINEA

W. J. TURNER*


## ABSTRACT

*A factorial experiment with 300 Australorp and Rhode Island Red chickens from 5 to 10 weeks old is described. There were six duplicated treatments—two management types, intensive and semi-intensive, each with one of three diets all with approximately 18 per cent crude protein. The diets were a control containing imported ingredients and two diets based on locally grown sorghum, soybean and peanut either with or without a vitamin-mineral supplement.*

*The locally grown diet without vitamins and minerals supported poor growth and efficiency under intensive management. Semi-intensive management caused a slight improvement only. The vitamin mineral supplement improved performance on this diet almost to the level obtained on the control diet.*

*It is recommended, when a ration composed of locally grown ingredients is fed, that this be supplemented with a vitamin-mineral premix and that management be of the intensive deep litter type.*


## INTRODUCTION

Village poultry in Papua New Guinea is, more often than not, run under an open range system of management, that is, there is very little food or shelter provided for chickens. However in some areas, village poultry owners have been encouraged to intensify their management by providing shelter and feed of various types. The most sophisticated level of management which could still be considered as village or subsistence production is the intensive, deep litter system in which the birds are housed in a native material shed with a deep litter floor and all feed is supplied to the birds as a mixed ration. A less sophisticated form of management is the semi-intensive system in which birds are housed and fed in much the same way as under the intensive system but the chickens have access to a grassed outside run from which they should be able to obtain some nutrients.

Poultry can be profitable in Papua New Guinea when reared under intensive management and fed a properly balanced ration which must either be imported or purchased from one of the few feed mills operating in this country. For a small-scale village farmer in a remote area the cost of purchasing and transporting this feed is generally prohibitive. There is therefore a need for a cheaper and simpler but probably less productive management system to be developed which will be suitable in this case.

A system of semi-intensive rearing and feeding a ration which can be almost completely home grown may be suitable for this purpose but there is no reliable experimental evidence of the effectiveness or otherwise of such a system. It is probable that a vitamin and/or mineral deficiency could result in poor performance on a simple home grown diet. An imported premix can be fed to overcome any expected adverse effects but the economics of such a practice need examination. It may well be that the provision of an adequate outside

* Animal Production Officer (Poultry), Three-Mile Station, Department of Agriculture, Stock and Fisheries, Lae.

area for the chickens as would be the case under semi-intensive management is sufficient to allow the birds to meet their requirements for minerals and vitamins. If such were the case then the feeding of a premix under this system of management would not be necessary.

The experiment described here was aimed at determining the relative importance of semi-intensive rearing and supplementation with a vitamin-mineral premix for chickens fed a simple ration composed of home grown ingredients.

It was anticipated that from the results of the trial it would be possible to design a simple, low cost management-feeding system which could be applied for small-scale village farmers.

## MATERIALS AND METHODS

Three hundred unsexed Rhode Island Red and Australorp chickens were fed from day-old to 5 weeks of age on a commercial 21 per cent protein starter ration. At 5 weeks of age the chickens were distributed at random to 12 pens, each about 100 sq ft in area, so that each pen contained 25 chickens. Of these 12 pens, 6 had an outside run attached which was approximately four times the area of the pen, constituting a semi-intensive management system. The other 6 enclosed pens constituted an intensive management system. Within the two management systems, three different experimental diets were fed to separate pens, with two replications (design was 2 x 3 fractorial).

*Table* 1.—The composition and analysis of the experimental diets

| Ingredients | % Composition | | |
|---|---|---|---|
| | Diets | | |
| | 1 | 2 | 3 |
| Sorghum .... .... .... .... .... | 61.5 | 68.0 | 66.6 |
| Wheat .... .... .... .... .... | 20.0 | | |
| Soybean meal .... .... .... .... | 7.5 | | |
| Fish meal .... .... .... .... .... | 5.0 | | |
| Meat meal .... .... .... .... | 5.0 | | |
| Soybean (unextracted) .... .... .... | | 22.0 | 22.4 |
| Peanut (unextracted) .... .... .... | | 10.0 | 10.0 |
| Premix* .... .... .... .... .... | 1.0 | | 1.0 |
| Crude protein (N x 6.25) .... .... | 18.0 | 18.7 | 19.5 |

* Premix comprises the following per kg of feed:— 11,000 I. U. vitamin A; 1,250 I.U. vitamin $D_3$; 4mg vitamin E; 4 mg menadione $NaHSO_3$; 4 mg riboflavin; 10 mg pantothenic acid; 1 mg pyridoxine; 2 mg folic acid; 0.02 mg vitamin $B_{12}$; 300 mg choline chloride; 1 mg copper; 0.4 mg iodine; 30 mg iron; 45 mg manganese; 30 mg zinc; 0.5 g DL-methionine; 2.0 g NaCl; 125 mg antioxidant; made up to1.0 per cent with pollard.

Composition of the experimental diets is shown in *Table* 1. Diet 1 was used as the control diet and all the ingredients were imported with the exception of the sorghum which was grown in the Markham Valley. Diets 2 and 3 were the experimental diets composed of ingredients grown in Papua New Guinea. Diet 2 did not contain a vitamin-mineral premix while diet 3 was supplemented with the premix. A coccidiostat, Pancoxin, was added to all diets at the rate of 1 lb per ton.

Both soybeans and peanuts were heated prior to mixing into the diets. This was carried out by roasting the seed over an open fire in a 44-gallon drum cut lengthwise. Roasting continued for 30 minutes during which time the seeds were mixed with a shovel to ensure that all seeds were equally well cooked. After roasting, the soybeans and peanuts were mixed with milled sorghum in the required proportions and the mixture was then hammer-milled. It was necessary to mix the ration before milling as the soybeans and peanuts contain too much oil to be milled individually. After milling, the Pancoxin in the case of diet 2, and the Pancoxin and premix for diet 3 were mixed into the ration. Sufficient feed for about 10 days was mixed at a time.

The experiment continued until the chickens were 10 weeks of age. The chickens were weighed at weekly intervals and the feed intake

*Table* 2.—Liveweight gain, feed intake and feed conversion efficiency from 5 to 10 weeks of age

| Treatment | Mean Liveweight Gain per Chick (g) | Mean Feed Intake per Chick per Day (g) | Mean Feed Conversion Efficiency (Feed/Gain) |
|---|---|---|---|
| Intensive | | | |
| Diet 1 .... .... .... | 656.5 a* | 70.2 a | 3.85 a |
| Diet 2 .... .... .... | 135.4. b | 52.3 a | 13.94 b |
| Diet 3 .... .... .... | 467.7 c | 55.4 a | 4.26 a |
| Semi-intensive | | | |
| Diet 1 .... .... .... | 684.2 a | 67.4 a | 3.56 a |
| Diet 2 .... .... .... | 180.0 b | 54.5 a | 10.86 c |
| Diet 3 .... .... .... | 451.0 c | 58.2 a | 4.71 a |
| Mean intensive .... .... | 419.8 d | 59.3 b | 7.35 d |
| Mean semi-intensive .... | 438.4 d | 60.1 b | 6.38 e |
| Mean diet 1 .... .... | 670.3 e | 68.9 c | 3.70 f |
| Mean diet 2 .... .... | 157.7 f | 53.4 d | 12.40 g |
| Mean diet 3 .... .... | 459.3 g | 56.8 cd | 4.49 f |

*Within groups, means not followed by a common postscript are significantly different ($P < 0.05$).

was also recorded on a weekly basis. Calculations were made of the weight gain per chick, feed intake per chick and the feed conversion efficiency calculated as g of feed consumed per g of body weight gain.

Mortalities were recorded and post mortems carried out on all birds which died.

## RESULTS

The results of the experiment are summarized in *Table* 2. The analysis of variance technique was used in conjunction with Duncan's Multiple Range Test to detect significance.

There was no significant effect on growth rate of type of management, but type of diet had a large and significant effect on growth. The control diet promoted faster growth than either diets 2 or 3 and the addition of vitamin-mineral premix (diet 3) produced a significant improvement in growth compared with diet 2 (*Figure* 1).

Feed conversion efficiency follows a similar trend to that of liveweight gain but due to the high variability of the feed intake figures the only significant effects on F.C.E. are those arising from the very poor efficiency on diet 2 and the general improvement in efficiency with semi-intensive management. The only significant difference in feed intake was between the higher intake of diet 1 compared with diet 2.

Only five birds died during the course of the trial. Four of these deaths were due to trauma not associated with any treatment. The fifth death was from a suspected case of coryza and was likewise not attributable to any experimental treatment.

## DISCUSSION

The chickens fed the locally grown ration without premix (diet 2) under intensive management exhibited a very poor growth rate and efficiency. This was improved by semi-intensive management, the response only being significant for efficiency which improved from 13.94 to 10.86.

However this is well below the response in both growth and efficiency caused by the addition of the vitamin-mineral premix to diet 2.

Growth on the supplemented diet was still inferior to that on the control diet. In terms of efficiency, the apparent 18 per cent greater efficiency of feed conversion on diet 1 over diet 3, although not statistically significant, was probably genuine.

It may be that the lower level of production with diet 3 is more economic than that obtained with diet 1 since the former ration is probably cheaper to produce. This experiment does not lend itself to any economic analysis

primarily because the premix used was not commercially available and could not be reliably costed. Further experiments are planned using similar diets with intensive management and commercially available premixes which will provide valuable economic data relevant to this level of poultry management.

## CONCLUSION

With chickens fed a locally grown ration it is not possible to provide the vitamin and mineral requirements from a grassed outside run as under semi-intensive management. From a technical point of view it is therefore recommended that intensive deep litter systems be used that the locally grown ration be supplemented with a vitamin-mineral premix. The economics of such a practice will be tested in future experiments.

## ACKNOWLEDGEMENTS

Thanks are due to Mr L. Vaiba, Livestock Officer, who was responsible for most of the recording of the results and Mr N. Clark for his assistance in providing the facilities of the Tropical Pig Breeding and Research Centre, Goroka, where the trial was carried out.

(Accepted for publication August, 1972.)

Printed and published by G. W. Reid, Government Printer, Port Moresby.—3345/5.73.