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PIPER (PIPERACEAE) IN NEW GUINEA: THE NON-CLIMBING SPECIES

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SUMMARY

A taxonomic account is given of six *Piper* species of New Guinea: *P. bolanicum* spec. nov., *P. gibbilimbum*, *P. recessum* spec. nov., *P. subbullatum*, *P. triangulare* and *P. wabagense*. These small shrubby trees are best represented in secondary growth and forest at 1300–2500 m altitude, with *P. gibbilimbum* reaching c. 3000 m and *P. bolanicum* (and rarely *P. triangulare*) c. 3500 m. *Piper subbullatum*, the most widespread of the six in New Guinea, sometimes descends to sea-level there and is also found in the Philippines and from the Bismarck Archipelago to Vanuatu.

The New World species *P. aduncum* and *P. subpeltatum*, adventive to New Guinea, are treated briefly.

Piper recessum spec. nov. has been confused with *P. gibbilimbum* and *P. subbullatum* but is a completely glabrous plant. Its inflorescences have fleshy, asymmetrically peltate, strongly overlapping bracts. At anthesis the bracts move apart slightly; in the male the anthers dehisce underneath the bract-heads, while in the female the stigmas become (only just) visible between the sides of the bract-heads. One or more species of thrips may be this plant's pollinators.

Key words: *Piper*, ethnobotany, non-climbing species, taxonomy, New Guinea.

INTRODUCTION

This account of the six shrubby species of *Piper* native to New Guinea is intended especially for those collecting or identifying plants from the island's montane zone, that is, the often well-populated regions at 1000–3000 metres above sea-level. Two of the species, *P. gibbilimbum* C.DC. and *P. subbullatum* K. Schum. & Lauterb. (until recently known as *P. wichmannii* C.DC.) occur widely in this zone in New Guinea, being abundant in the secondary scrub and fallow gardens always so plentiful near habitation. The other four species seem to have narrower distributions, with most collections coming from the Highlands parts of Papua New Guinea

A brief treatment is given of the two other shrubby species of *Piper* now present in New Guinea, *P. aduncum* L. and *P. subpeltatum* L. These pernicious weeds, adventive from the New World, are essentially lowland plants although they have been seen (cultivated!) within the montane zone in the particular place where fieldwork towards this study was carried out. Also, in the key only, mention is made of the montane species *P. wilhelmense* Chew, New Guinea's only herbaceous piper.

METHODS

The study is based on an examination of specimens from AK, B, BM, BRI, CANB, K, L, MEL and SING, and on a field acquaintance with the four species (not *P. bolanicum*

or *P. wabagense*) that grow in the upper Kaironk Valley of the Schrader and Bismarck Ranges in Madang Province, Papua New Guinea. The indigenous people there, the Kalam, distinguish the four species and group them into a folk-genus which they name *alkn* (Pawley, Bulmer & Majnep, ms. Kalam Dictionary). The various uses for these plants in the Kaironk, and some ethnobotanical information from elsewhere, are given below in the notes on each species.

CHARACTERS

Habitat & habit

In the Kaironk the two lower-altitude species, *P. recessum* and *P. subbullatum*, can be found side by side (without hybrids) in secondary growth along streamsides, on former garden sites and around the ubiquitous plantations of *Casuarina oligodon*. They reach c. 5 m in height and have erect or somewhat leaning, large-pithed trunks of up to c. 10 cm diameter. They are usually large shrubs but sometimes new orthotropic (sucker) shoots are few or lacking. Though often gregarious they do not form extensive suckering thickets and it seems likely that individuals are fairly short-lived – a fully mature plant may have only three or four major trunks and it is not generally the case that these would be clustered around older dead trunks or a hollow base.

Piper gibbilimbum in the Kaironk is a smaller plant, its trunks rarely getting to be more than c. 2 m tall and 5 cm diameter. Collectors' notes from other parts of New Guinea indicate that this plant often reaches 4 m tall (though the possibility of confusion with the above two species cannot always be discounted). Plants growing on unfavourable substrates, e.g. exposed limestone terrain, may be fertile though less than 1 m tall.

Piper triangulare, the Kaironk's highest-altitude species, is seldom greater than c. 1.5 m tall there; unlike the others it is a shade-requiring plant, rarely if ever being found in young secondary growth nor seen as gregarious in gaps in the primary forest. Its strong, flexible stems, relatively slender and almost without a pith, resemble those of a *Ripogonum* (Smilacaceae).

Piper wabagense, which grows at about the same altitude as *P. triangulare*, is generally said by collectors to be a robust shrub of c. 5 m tall though one collection (*Pullen 400*) notes a height closer to 7 m. *Piper bolanicum*, the highest-altitude species, is also said to reach c. 5 m tall. It has relatively slender stems and small leaves.

All these six species have orthotropic sterile leading shoots (trunks) that grow continuously, and plagiotropic, sympodial, fertile branches. This is Petit's Model, providing it includes the case where, as in these plants, the leading shoots in their later growth themselves become sympodial and fertile (see below).

Vegetative parts

Orthotropic shoots bear leaves only, in 2/5 spiral phyllotaxy. Once such a shoot becomes more than a metre or so tall it begins to produce sylleptic axillary branches, one at each node, which depart the main trunk at a fairly wide angle. Further growth of these principal branches, and eventually of the main trunk itself, is plagiotropic, sympodial, and fertile. The branch has its leaves, (terminal) inflorescences and (axillary) branches lying distichously in the horizontal plane. The branches have a glabrous

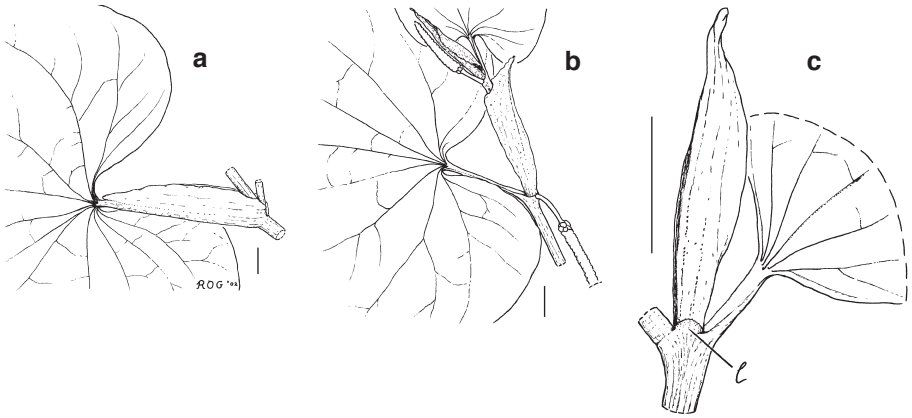


Fig. 1. Sheathing structures in *Piper*. a. Petiole with sheathing sides (*P. recessum* R.O. Gardner, *Gardner 7130*); b. stipules on apical part of plagiotropic shoot (*P. recessum* R.O. Gardner, *Gardner 10131*); c. ligule (one side of it, labelled *l*) and stipule at apex of plagiotropic shoot (*P. gibbilimbum* C.DC., *Bowers 51*). — Scale bars = 1 cm.

collar-like prophyll at their base, usually low and obscurely keeled but sometimes in plagiotropic shoots (of *P. subbullatum* at least) strongly keeled and up to 5 mm tall.

New leaves of orthotropic shoots have sheathing petioles, that is, the upper edge of each side of the petiole is expanded to form a convolutedly sheathing structure (Fig. 1a). The nascent shoot, at first enclosed, is freed by the recurving of the sheath's edges. In *P. recessum* the sheath persists until leaf-fall (the leaf being situated by then at about four nodes below the shoot apex). In the other five species the sheaths are shed very soon after leaf expansion, to leave a pair of long scars on the upper side of the petiole and sometimes (especially in *P. subbullatum*) dark adherent mucilaginous debris too.

Leaves of the plagiotropic branches contrast with those of the orthotropic shoots in not having sheathing petioles. They have instead a conical, several centimetres-long, intrapetiolar stipule, which encloses the nascent part of the shoot, including the already-formed terminal inflorescence (Fig. 1b, c). The stipule is considered homologous with the prophyll (Burger, 1972). Note that in his species' descriptions Chew (1992) called the stipule by this latter term, and referred to what is here called the petiole sheath as the stipule.

The stipules do not show the great interspecific variation seen in the *Piper* species of the New World (Burger, 1972; Tebbs, 1989), and their size varies too much to be taxonomically useful. Hairs, where present, are found only on the outer surface of the stipule's two convolutedly wrapped halves.

In the New Guinea species, on the plagiotropic branches, there is sometimes a third sheathing structure, the ligule (Burger, 1972). This comprises a pair of membranous unvascularized flaps 1–3 mm high along the inner sides of the encircling petiole base (Fig. 1c). They taper to zero in both directions, i.e. proximally (against the base of the inflorescence peduncle) and distally (against the channel along the top of the petiole); thus it is clear that the ligule is the plagiotropic shoot's reduced homologue of the petiole sheath.

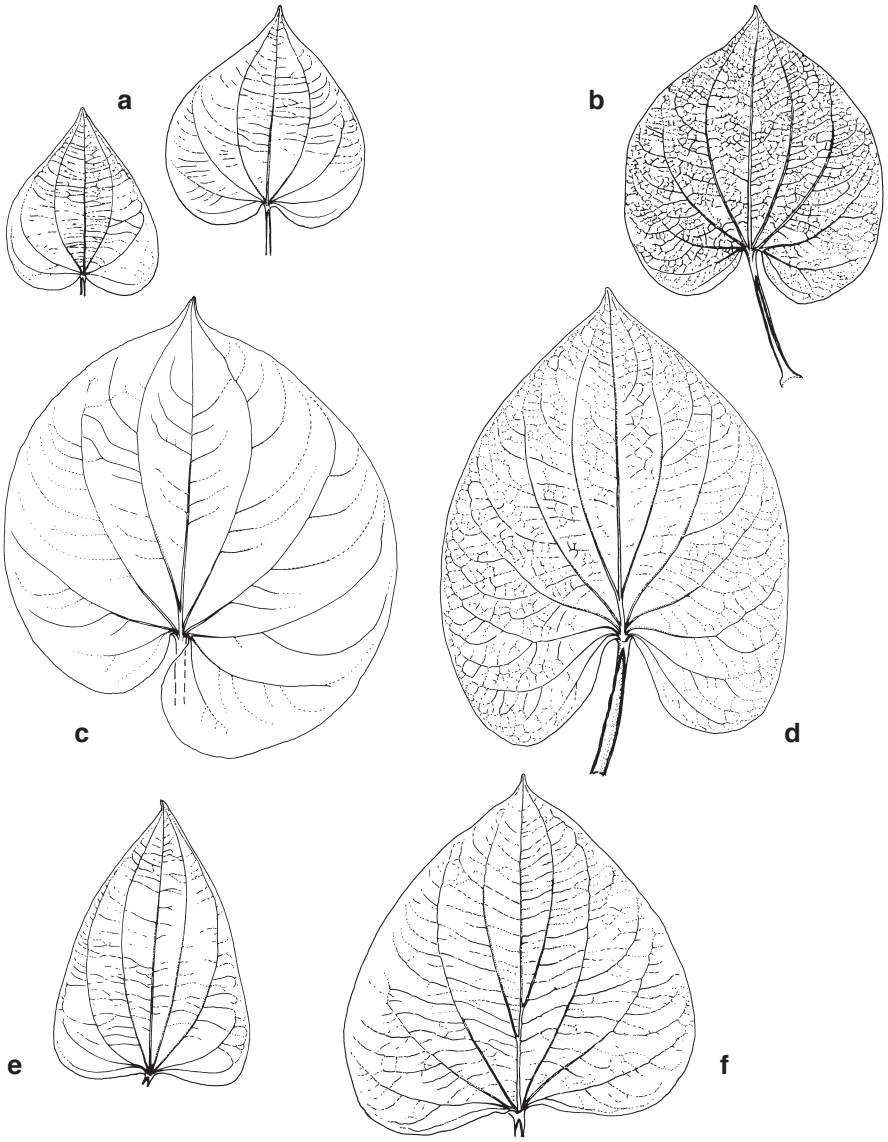


Fig. 2. Leaf shape in *Piper* species. Based on rubbings of adaxial surface of dried leaves. All leaves from orthotropic shoots except for that of *P. recessum*. a. *P. bolanicum* R.O. Gardner (*LAE 59823*); b. *P. gibbilimbum* C.DC. (*Gardner 9407*); c. *P. recessum* R.O. Gardner (*Gardner 9027*); d. *P. subbullatum* K. Schum. & Lauterb. (*Gardner 8804*); e. *P. triangulare* Chew (*Gardner 9736*); f. *P. wabagense* Chew (*Hoogland 9615*).

The leaf blades of the six species are palmately nerved and vary in size (though not much in texture) according to architectural position: leaves of plagiotropic shoots are smaller and less symmetrical in their basal lobing than those of orthotropic shoots. One of the most consistent and easily appreciated features of the blade is the degree to which

the midrib is fused near its base to one or both of the adjacent lateral (secondary) nerves (Fig. 2, 3). The number of pairs of these nerves is also characteristic but ambiguity is possible when counting them, since the lowermost ones, those that spread downwards into the basal lobes, are much weaker than the higher ones. The counts given in the species' descriptions below are as seen with the naked eye, and so omit the faint one or two lowermost pairs.

The tertiary veins leave the principal laterals at a wide angle and are usually somewhat prominent on both surfaces, particularly in the more coriaceous-leaved species (where the finer venation is prominent too). Especially in *P. wabagense*, also in *P. gibbilimbum* and to a slight degree in *P. subbullatum*, the surface of the blade can be bullate between the tertiaries.

Where present the tomentum consists of erect to spreading or appressed multicellular hairs, which can reach c. 1 mm long but are often much smaller. The petiole and proximal part of the nerves are relatively coarsely and densely tomentose, with larger hairs lying over smaller ones. In life the hairs are generally colourless to golden (brownish when dry) but in *P. triangulare* they are purplish at least on the inflorescence bracts (and when dry still notably darker than those of the other species).

Piper recessum is distinctive in being entirely glabrous, not just in the Kaironk but throughout its range. The two most widespread species, *P. gibbilimbum* and *P. subbullatum*, are tomentose in the Kaironk but elsewhere in New Guinea occasionally appear to be glabrous – almost always though they have hairs at their newest nodes, among the nerves at the base of the blade below, and, most constantly, on the inflorescence rachis and bract-stalks.

In the Kaironk, and sometimes also in the neighbouring Eastern Highlands, there is a distinctive form to the tomentum of *P. gibbilimbum* – on the stems and petioles and to a lesser degree on the blades the hairs are aggregated into tufts, a central group of long hairs standing in a corona of shorter hairs. On the new stem these tufts, c. 0.5 mm tall and 0.3 mm diam., make the stem appear scurfy.

Inflorescence

The short-peduncled spicate inflorescences of the six species are solitary and terminal though seeming to be leaf-opposed even before the shoot apex emerges from the stipule. While still enclosed the inflorescence is directed antrorsely. At least in *P. gibbilimbum* and *P. subbullatum* the spikes of both sexes are suberect at anthesis, but in *P. recessum* they are pendent below the foliage. The spikes taper slightly in diameter distally; the measurements given in species descriptions apply to the base of the spike, at anthesis.

The native species are generally dioecious but bisexual flowers occur sporadically, e.g. in *P. gibbilimbum* (*Brass 12252*, BRI; both sexes apparently well-formed), *P. recessum* (*Gardner 9485*, AK; stamens rudimentary) and *P. subbullatum* (Quisumbing, 1930: 45). The spikes of the two adventive species, *P. aduncum* and *P. subpeltatum,* are perhaps invariably bisexual.

In all the native species except *P. recessum* the spike's bracts are centrally peltate, the bract-head being nearly orbicular and membranous or somewhat firm. The margin of the head sometimes bears cilia (though not as densely as the top of the bract-stalk) and is otherwise irregularly indented ('subentire') or, especially in *P. gibbilimbum* and

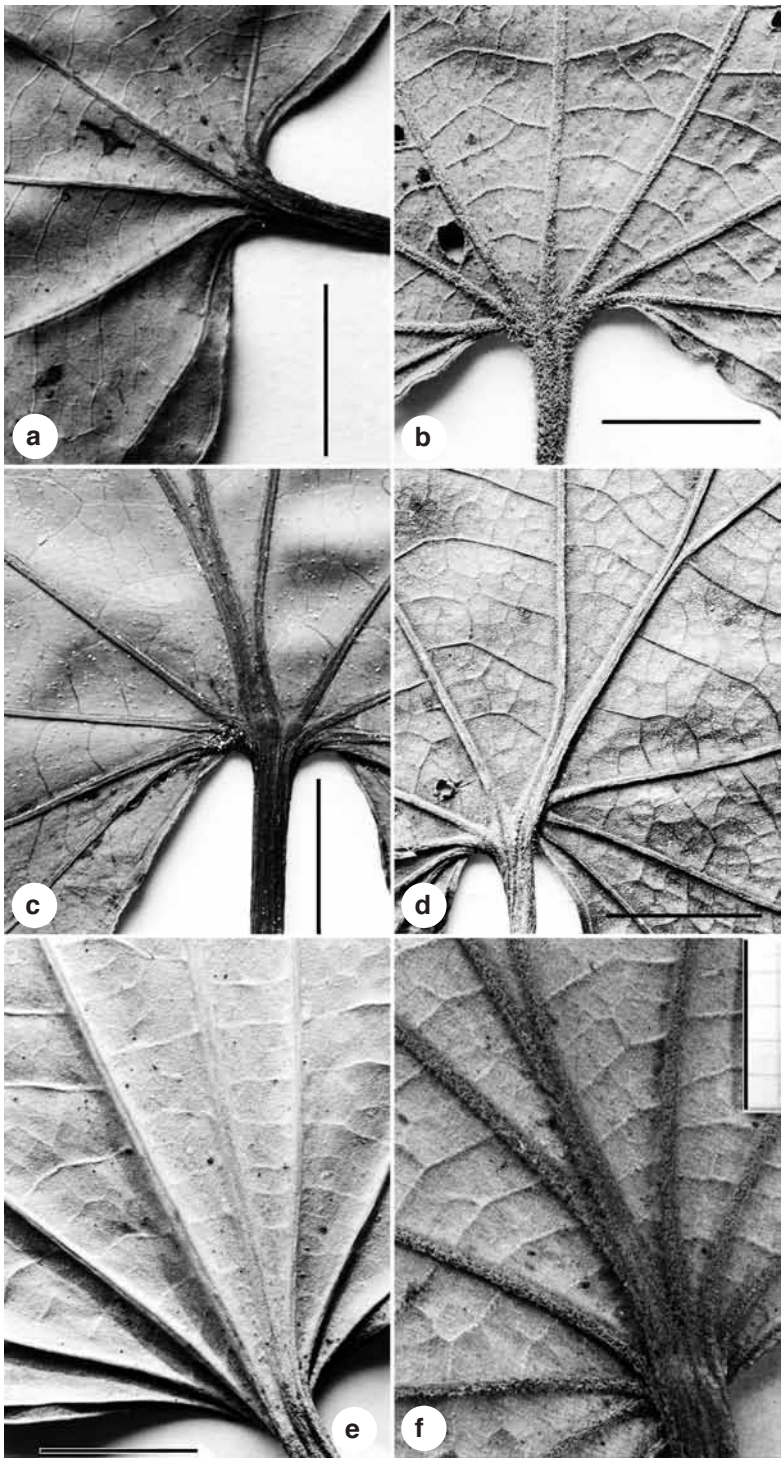

a
b
c
d
e
f

Fig. 4. Fruiting spike in *Piper recessum* R.O. Gardner (*Gardner 10138*). Intact and in l.s. — Scale bars = 1 cm.

P. subbullatum, minutely erose-fimbriate. The hairiness of the bracts is not as conspicuous as in the two adventive species, whose spikes appear minutely woolly because of their dense white bract-head cilia.

Piper recessum is distinctive in having bracts that are obliquely peltate, the fleshy and umbonate bract-head being elongate acroscopically (Fig. 4). Because in all the species the bracts overlap considerably in the developing spike, and later (in females of the other five species) become contorted between the ripening fruitlets, this difference in bract shape is clear only at or just after anthesis.

The number and position of the stamens in dried material of *Piper* is hard to ascertain (cf. Burger, 1971: 81). In *P. gibbilimbum*, *P. subbullatum* and *P. wabagense* Chew (1972, 1992) described the male flowers as having two or three stamens. Three appears to be the usual number in *P. recessum*. In a count made on a length of the spike of *P. bolanicum* (*NGF 16167*) I obtained a ratio for stamens: bracts of slightly less than three.

←

Fig. 3. Leaf base (abaxial surface) in *Piper* species. All leaves from orthotropic shoots. a. *P. bolanicum* R.O. Gardner (*Hoogland & Schodde 7218*); b. *P. gibbilimbum* C.DC. (*Gardner 9407*); c. *P. recessum* R.O. Gardner (*Gardner 7172*); d. *P. subbullatum* K. Schum. & Lauterb. (*Gardner 9401*); e. *P. triangulare* Chew (*Gardner 9524*); f. *P. wabagense* Chew (*Hoogland 9457*). — Scale bars = 1 cm.

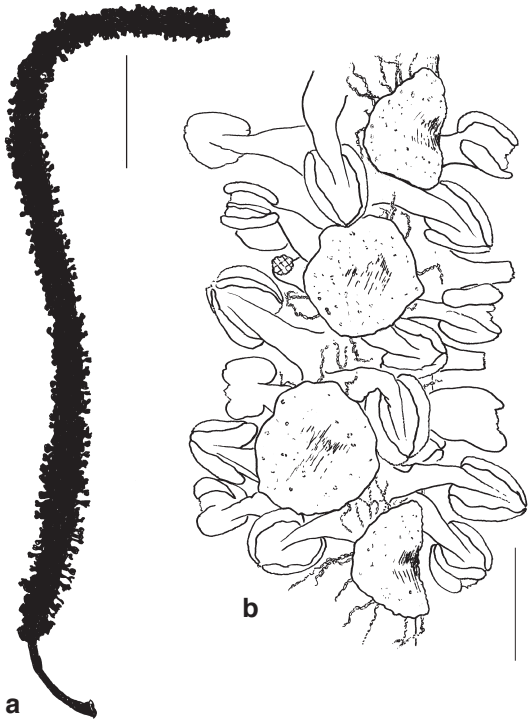


Fig. 5. Male spike in *Piper bolanicum* R.O. Gardner (*NGF 16167*), its flowers spent. a. Silhouette; b. enlargement. — Scale bars: a = 1 cm; b = 1 mm.

The staminal filaments are relatively long (to 0.8 mm) in *P. bolanicum* (Fig. 5). In the other species, perhaps because of the effect of crowding, some anthers may be sessile while others, on distinct filaments, are dehiscing. As observed by Chew (1992) the anthers dehisce either by a pair of lateral longitudinal slits (*P. wabagense*) or by a single slit continuous over the top of the anther. This latter mode, which exposes a 'dish' of pollen at or just below the level of the bract-heads, was considered by Burger (1972) to be an advancement in the genus and related to the pollen-gathering activities of insects.

A single measurement, 'diameter', is given in species descriptions for the size of the anthers – this refers to width in the plane of dehiscence, which is slightly greater than the anther's length and depth.

As the spikes of *P. gibbilimbum* approach anthesis they change from green to white; in *P. subbullatum*, at least in the Kaironk, a more yellowish colour is usual. In both these species male and female spikes have a pleasant oily odour, and in the Kaironk I have seen small meliponine bees (Kalam name *bm*) gathering the white pollen from male spikes of *P. subbullatum*. Lebot et al. (1991) also consider this species may be insect- rather than wind-pollinated.

In the pendent male spikes of *P. recessum* anthesis is marked by the bracts becoming soft and yellowish. They loosen slightly but in large part the bract-heads remain

overlapping and shed pollen accumulates underneath them. In the Kaironk, the only insects I have seen associated with these flowers are one or more kinds of thrips (*Thysanoneura*).

The ovary in *P. recessum* is embedded into and confluent with the rachis in its lower seed-bearing half, with its rounded upper half free from those adjacent (Fig. 4). This is also the case in *P. gibbilimbum*, at least in the fruiting state. In the other native species the ovaries are free and sit above the rachis. The number of stigmas per flower, the degree to which a style is present, and the size of the stigmas considered together as a rosette, provide useful taxonomic information (see species descriptions). A dif-

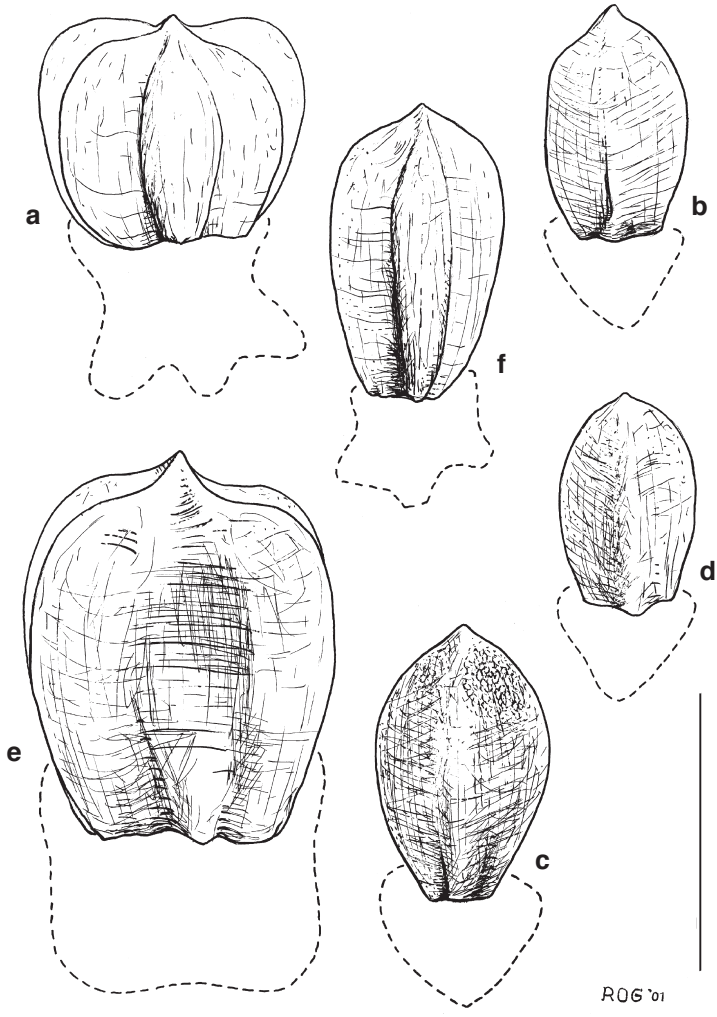


Fig. 6. Seeds of *Piper* species. Cross section at widest point outlined. a. *P. bolanicum* R.O. Gardner (*ANU 2836*); b. *P. gibbilimbum* C.DC. (*NGF 11860*); c. *P. recessum* R.O. Gardner (*Gardner 7022*); d. *P. subbullatum* K. Schum. & Lauterb. (*White* 518); e. *P. triangulare* Chew (*Gardner 8868*); f. *P. wabagense* Chew (*Robbins 446*). — Scale bar = 2 mm.

ference in these minute flowers of only fractions of a millimetre can be a significant one; unfortunately, because of damage in pressing, *Piper* specimens seldom exhibit their floral characters well. The stigmas persist on the fruitlet and are hardly if at all accrescent. The style is lacking or ill-defined (being very short, ribbed, and tapering from the ovary summit) in all the native species except *P. bolanicum*, where in both flower and fruit it is a relatively well-defined columnar structure of c. 0.5 mm tall.

Fruit & seed

The infructescences in five of the six native species are more or less pendent when ripe, with free orange-scarlet (sometimes 'yellow') fruitlets. Collectors have twice noted that *P. triangulare* has dark purplish fruit but this may be the bracts' hairs and not the fruitlets (see Note under *P. triangulare*). In the Kaironk I have collected only immature fruit of this species; it was changing from green to orange. *Piper wabagense* appears to be significantly different from the other native species (Chew, 1992) in that collectors have noted its ripe orange infructescence as being held erect.

In *P. recessum* the rachis of the ripened spike becomes soft, fleshy and orange-coloured. By contrast, in *P. bolanicum* and to a lesser degree in *P. gibbilimbum* and *P. subbullatum*, but apparently not in the other three native species as far as a limited sampling has shown, the rachis contains a substantial core of woody fibrous tissue. Another taxonomic character of the rachis may lie in the degree of development of its mucilage channels, which seem to be relatively well-developed in *P. subbullatum*.

The seeds have an outer pale, slippery covering (endocarp or exotesta?) and a hard red to brown endotesta. Their dimensions as given in the species' descriptions refer to the dried state, the covering being shrunken or lost. The endotesta's hexagonal reticulations may be obscure or (*P. recessum*) distinct to the naked eye. There also appears to be useful taxonomic variation in the size, shape and degree of lobing of the seeds (Fig. 6) but because of a low number of samples examined the data below must be regarded as tentative. Collectors could help in this regard by extracting seeds for separate packaging or at least by making sure that fully ripe infructescences are gathered.

KEY TO THE SPECIES

1a. Leaf blades pinnate-veined, c. 20 times as long as petiole. — Adventive to New Guinea . . . . . **1. P. aduncum**
b. Leaf blades palmate-veined, 1–3(–5) times as long as petiole 2
2a. Leaf blades membranous, often 15 cm or more wide; petiole sheath c. 0.5 times as long as petiole; conical intrapetiolar stipules lacking; inflorescence a stalked umbel of spikes, axillary, sometimes several per node. — Adventive to New Guinea . . . . . **2. P. subpeltatum**
b. Leaf blades submembranous to coriaceous, seldom more than 15 cm wide; petiole sheath more or less as long as petiole; conical stipule present at apex of plagiotropic (fertile) shoots; inflorescence a short-pedunculate spike, terminal but appearing leaf-opposed, solitary at each node. — Native to New Guinea 3
3a. Herb or subwoody scrambler with decumbent or erect stems. — Papua New Guinea: Mt Kerigomna, Mt Wilhelm, Bulldog Track, 2250–3500 m; not further treated . . . . . *P. wilhelmense* Chew in Van Royen
b. Shrubby small trees, trunks erect, branches spreading 4

4a. Glabrous in all parts; leaves of orthotropic (sterile) shoots retaining petiole sheaths until leaf-fall; bract-heads firm (in life subfleshy) and centrally umbonate, elongate, stalk attached basiscopically . . . . . **5. P. recessum**
b. Hairs usually present at newest nodes and on leaves, at least on margins and nerves below, and always present (sometimes sparsely) on the bract-stalks; leaves of orthotropic shoots soon shedding petiole sheaths; bract-heads membranous to rather firm, not umbonate, ± orbicular, centrally peltate 5
5a. Leaves submembranous to firmly chartaceous; bract-head margins usually minutely erose-fimbriate; stigmas together 0.3–0.6 mm diam.; seeds to c. 1 mm diam., elliptic-oblong, trigonous 6
b. Leaves coriaceous; bract-head margins subentire (sometimes coarsely papillose in *P. wabagense*); stigmas together 0.8 mm diam. or more; seeds 1 mm diam. or more, subglobose or oblong, lobed (weakly so in *P. wabagense*) 7
6a. Leaf blade usually pubescent below but not on margins, hairs mostly sparse and long (to c. 1 mm); midrib and adjacent 1 or 2 nerves free to base (rarely ± fused for up to c. 1 cm); bract-head 0.8–1.3 mm diam. . . . . **4. P. gibbilimbum**
b. Leaf blade usually pubescent below and on margin; midrib and adjacent nerves fused for 1–(2–4) cm; bract-head 0.5–0.9 mm diam. . . . . **6. P. subbullatum**
7a. Leaf blades relatively narrow, on fertile shoots 1.5–2.5 times as long as wide and more than 12 cm long; new stems glabrous or with a few dark hairs . . . . . **7. P. triangulare**
b. Leaf blades on fertile shoots usually 1–1.5 times as long as wide (if 1.5–2.5 times then less than 7 cm long) 8
8a. Glabrous except for a few long hairs on newest nodes and petioles and subpersistent very short subappressed hairs on blade margins; midrib and adjacent nerves not fused; anthers dehiscing by a slit continuous over the apex; infructescence pendent, fruitlets with stigmas raised on a style c. 0.5 mm long . . . . . **3. P. bolanicum**
b. Indument conspicuous as a mid- to grey-brown appressed cover on stipule, new stem and new blade, often persistent on blade underside; midrib and adjacent 1 or 2 nerves fused for (0.5–)2–5 cm; anthers dehiscing by a pair of lateral slits; infructescence erect, fruitlets with sessile stigmas . . . . . **8. P. wabagense**

SPECIES DESCRIPTIONS

For synonymy and typification beyond what is given below see Chew (1972, 1992). The descriptions apply to dried material unless otherwise stated. Most herbarium collections are of fertile (plagiotropic) shoots, with fruit (generally immature) represented more often than flowers.

1. Piper aduncum L.

Piper aduncum L. (1753) 29.

Shrubby treelet to 4(–8) m tall, with plagiotropic fertile branches. *Leaf blades* ± lanceolate, c. 15 by 5 cm, firmly chartaceous, pinnate-veined with 4–8 pairs of lateral nerves, scabrid above, puberulous below on nerves; petiole relatively short, mostly less than 1 cm long. *Inflorescence* a solitary leaf-opposed spike, bisexual, at anthesis the spike

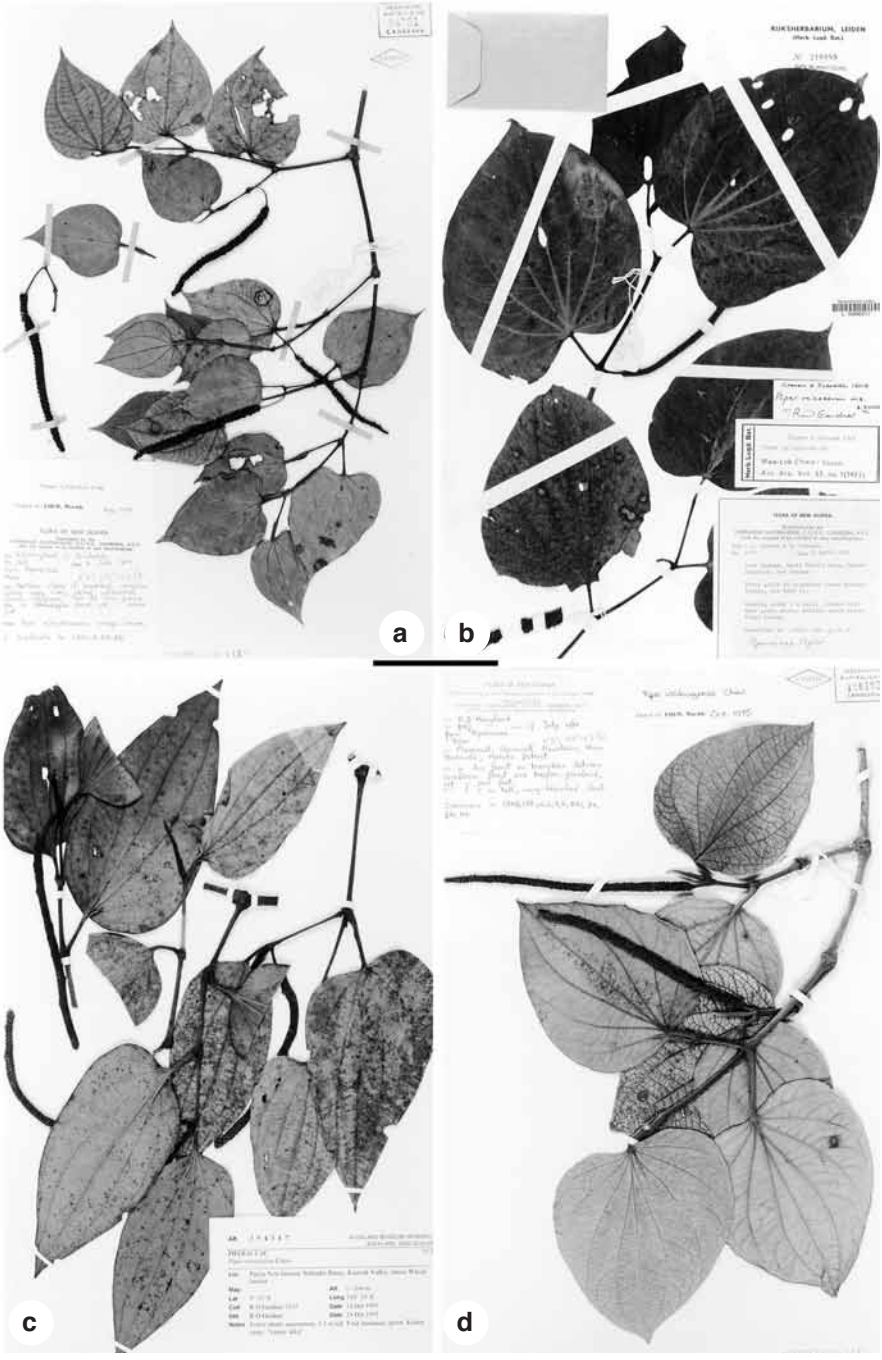


Fig. 7. Specimens of *Piper* species. a. *P. bolanicum* R.O. Gardner (*Hoogland & Schodde 7218*, CANB); b. *P. recessum* R.O. Gardner (*Craven & Schodde 1207*, L holo); c. *P. triangulare* Chew (*Gardner 7107*, AK); d. *P. wabagense* Chew (*Hoogland 9457*, CANB). — Scale bar = 10 cm.

c. 2 mm diam., arching up and forward; bracts centrally peltate, margin of bract-head with dense pale cilia; anthers subsessile, c. 0.25 mm diam.; stigmas 3, together c. 0.3 mm diam.; fruitlets free, red when ripe. *Seeds* oblong, ± 4-sided, c. 0.75 mm long.

Distribution — Native to the New World; now present in New Guinea. Chew (1972: 3) lists only four collections but it is abundant today at least in drier regions, e.g. parts of Morobe Province.

Habitat — Mostly in disturbed secondary vegetation, fallow gardens etc., altitude to c. 1500 m.

2. Piper subpeltatum Willd.

Piper subpeltatum Willd. (1797) 166. — *Pothomorphe subpeltata* (Willd.) Miq. (1840) 36.

Shrub (usually few-stemmed?) to 1(–2) m tall, branches all monopodial and ± orthotropic (thus conical shoot-encircling stipules lacking). *Leaf blades* suborbicular, deeply cordate at base (sometimes slightly peltate?), (10–)15–25 cm diam. or more, membranous, palmate-veined with c. 7 pairs of lateral nerves, the innermost pair fused to midrib for 1–3 cm; minute hairs on venation above and below and on margins; petiole 10–15 cm or more long, sheath slightly less than half as long as petiole and soon shed. *Inflorescence* bisexual, an axillary stalked umbel of spikes, sometimes with one or two similar additional inflorescences in the axil, the spikes erect, at anthesis c. 3 mm diam.; bract-heads c. 0.3 mm diam. (including the dense cilia); anthers subsessile, minute (c. 0.2 mm diam.); stigmas 3, minute (together c. 0.15 mm diam.). Fruitlets free. *Seeds* obovoid, trigonous, c. 0.5 mm diam.

Distribution — Native to the New World; now apparently widespread in New Guinea.

Habitat — Mostly in disturbed secondary vegetation, fallow gardens etc. The highest-altitude wild specimen I know of comes from c. 1450 m (*Hoogland & Pullen 5277*, near Goroka).

Note — I have followed herbarium annotations by W.-L. Chew and others in providing a name for this taxon, without attempting to assess how it might differ from *P. peltatum* L. and *P. umbellatum* L. s.s. – see the descriptions of Backer & Bakhuizen van den Brink (1964) and Burger (1971). I believe there is only one taxon of this affinity in New Guinea.

3. Piper bolanicum Schltr. ex R.O. Gardner, *spec. nov.* — Fig. 2a, 3a, 5, 6a, 7a, Map 1

> Ex aliis Piperibus fruticosis novoguineensibus differt foliis parvis 3-plinervatis spicis fructis stylis distinctis seminibusque sulcatis. — Typus: *Hoogland & Schodde 7218* (holo CANB 84251; iso A, BM, BRI, LAE, L), Papua New Guinea, Enga Province, northern slopes of Sugarloaf complex (along Wapu River), 10,000 feet [3050 m], 21 July 1960, ripe fruit.

Piper interruptum auct. non Opiz: P. Royen (1979) 1276.

To c. 5 m tall, new stems with a few coarse hairs to c. 0.5 mm long at the nodes, glabrescent. *Orthotropic shoots*: leaf blades mostly less than 12 by 11 cm, relatively thin but coriaceous, drying midbrown, broadly ovate, base truncate (cordate only on largest leaves); lateral nerves 3 (or 4) pairs, innermost pair not fused to midrib; tertiaries and finer venation prominent above and below; a few patent long hairs below on nerve bases;

margins with minute antrorse-appressed subpersistent hairs to 0.3 mm long; petiole to c. 3 cm long, c. 0.33 times as long as blade, glabrous or with a few hairs, the sheath almost as long as petiole, soon lost. *Plagiotropic (fertile) shoots*: leaf blades often as small as 5 cm long; stipule to 3 cm long, almost glabrous. *Female inflorescence* a spike to c. 7 cm long, 3.5 mm diam., bracts centrally peltate, stalk usually very short, hairy, the bract-head orbicular, firm-textured, c. 1.3 mm diam. not including the sometimes copious cilia, margin subentire; style usually distinct, ± columnar, 0.5 mm long; stigmas 3 (or 4), together 1 mm diam. *Male inflorescence* a spike to c. 5.5 cm long, 3 cm diam.; stamens 2 or 3 per flower, filaments 0.5(–0.8) mm long, anthers c. 0.75 mm diam., dehiscence slit continuous over apex. *Infructescence* ± pendent, to c. 15 by 0.6 cm; ripe fruitlets c. 2 mm diam., ± lobed (subglobose in outline), quite free from the non-swollen and rather woody rachis. *Seed* depressed-globose, with 4 or 5 rounded lobes and longitudinal furrows, 1.3 mm tall by 1.75 mm diam., obscurely reticulate.

Distribution — West Irian: Lake Habbema. Papua New Guinea: Highlands regions, Huon Peninsula (Finisterre and Sarawaket Ranges), Owen Stanley Range.

Habitat & Ecology — Montane forest and shrubberies mostly at (1980–)2700–3320 m altitude.

Notes — The name *P. bolanicum* has been adopted from annotations (B, BM) made by Schlechter on collections (B, BM) of Keysser from a 'Mt Bolan' in the Sarawaket Range (W.-L. Chew, pers. comm.). The locality is, correctly, Mt Bangeta (Van Royen, 1979: 259). *Piper bolanicum* seems not to have been rediscovered on Mt Bangeta but there are several collections from elsewhere on the Huon Peninsula mountains.

Piper interruptum, which Van Royen (1979) mistook the present species for, is only superficially similar. It is a climbing species, found at low altitude in New Guinea and West Malesia.

Several specimens cited below and in the identification list have been included on authority of W.-L. Chew (pers. comm., 2001). In particular, the record for Lake Habbema is based on his identification of *Brass 9308* (A), collected at 3225 m. I have not been able to re-examine this specimen. Another Lake Habbema collection, *Brass*

Map 1. Distribution of *Piper bolanicum* Chew ex R.O. Gardner.

10847 (K), from 2800 m, differs from the Papua New Guinea plants at least by the considerably larger size of its leaves and fruiting spikes (to 15 by 8.5 cm, and 19 by 0.8 cm respectively). Possibly it belongs to a distinct taxon; its dimensions have been omitted from the description above.

Collections studied: 33.

Representative specimens:

WEST IRIAN: *Brass 9308*, A (n.v.), Lake Habbema, 3225 m, Aug. 1938.

ENGA & WESTERN HIGHLANDS: *ANU 2836* (*Flenley*) CANB, L, highest pt of Laiagam-Kandep Rd, 2900 m, 11 June 1965, *tormbolya* (Enga lang.); *ANU 6415* (*Wheeler*), CANB, E side of Mt Hagen, 3290 m, 2 July 1967, *kuki* (Melpa lang.); *Hoogland & Pullen 6078*, L, nr Tomba village, S slope Mt Hagen Ra., 2600 m, 29 Aug. 1956.

EASTERN HIGHLANDS: *Brass 30186*, CANB, E slopes Mt Wilhelm, 3320 m, 29 June 1959; *LAE 54555* (*Stevens*), CANB, Mt Kerigomna, 3200 m, 21 June 1971.

SOUTHERN HIGHLANDS: *Bowers 797*, CANB, Upper Kaugel Valley, 2620 m, 13 July 1969, vern. *kokole*; *LAE 60743* (*Croft et al.*), CANB, Mt Giluwe, 2550 m, 25 Dec. 1973; *Vink 17506*, CANB, E foot of Mt Ambua, 2670 m, 24 Aug. 1966.

MOROBE: *Keysser s.n.*, B, BM (n.v.), Mt Bangeta, [1912]; *NGF 16167* (*Van Royen*), L, SW slope Mt Enggom, Sarawaket Ra., 3080 m, 24 Feb. 1963; *Pullen 6038*, CANB, Lake Naho, Finisterre Ra., 2670 m, 5 Nov. 1964, *papa kinga* (Naho lang.), "crushed leaves used to give fragrance to cooked pandanus … the roots are cooked with various vegetables at feast times".

ORO, CENTRAL: *Brass 22729*, LAE (n.v.), Mt Dayman, 2150 m, June 1953; *Van Royen 10953*, CANB, Iswan Swamp, 2670 m, 22 May 1976.

4. **Piper gibbilimbum** C.DC. — Fig. 1c, 2b, 3b, 4b

Piper gibbilimbum C.DC. (1910) 416. — Type: *Versteeg 1515* (holo BO n.v.), Irian Jaya, Noordrivier, near Alkmaar, 24 July 1907.

To 2(–4) m tall; new stems often with conspicuous crisped or patent, sometimes clustered, coarse hairs to 1 mm long. *Orthotropic shoots*: leaf blades to c. 17 by 15 cm, firmly chartaceous to slightly fleshy, drying brown or greenish brown, broadly ovate, base cordate, upper surface somewhat bullate above (especially in life), lateral nerves 3 or 4 pairs, the innermost pair usually distinct from midrib even at blade base but sometimes in larger leaves one of this pair fused with midrib for up to c. 1 cm, tertiaries and some finer venation prominent below, lower surface pubescent (rarely glabrous, usually with at least a few hairs on and between the nerve bases), margins glabrous; petiole to c. 7 cm long, pubescent, the sheath usually not quite reaching petiole apex, yellowish, subfleshy, soon shed. *Plagiotropic (fertile) shoots*: leaf blades sometimes as small as 10 cm long, stipule to 5 cm long, usually glabrous. *Female inflorescence* a spike to 10 cm long, c. 0.6 mm diam.; bracts centrally peltate, stalk hairy, bract-head orbicular, membranous, 0.8–1.3 mm diam., margin usually minutely erose-fimbriate, weakly ciliate or glabrous; style usually short and ill-defined (sometimes in fruit ± distinct and c. 0.3 mm long), stigmas 3, together 0.35–0.6 mm diam. *Male inflorescence* a spike to 10 cm long, 3–5 mm diam.; staminal filaments rather fleshy and often swollen-headed, to 0.4 mm long, anthers 0.5 mm diam., dehiscence slit continuous over apex. *Infructescence* ± pendent; ripe fruitlets orange, 1.5 mm diam., ± embedded in rachis in lower (seed-bearing) part, shortly conical above, central part of rachis somewhat woody-fibrous. *Seed* oblong, c. 1.3 by 1 mm, weakly trigonous with rounded angles, usually (?) obscurely reticulate.

Distribution — Widespread in the mountains of New Guinea east to the Finisterre Range and Eastern Highlands.

Habitat & Ecology — In young secondary growth, streamside scrub etc., at (200–) 1300–2000(–3000) m altitude.

Notes — Three collections lack hairs on the stems and leaves (*Bowers 51*, Kaugel Valley; *NGF 8109*, Lake Kutubu; *Pulle 932*, Mt Hellwig) but hairs are present on their bract-stalks.

In the Kaironk the leaves of *P. gibbilimbum* are used to line earth-ovens, once the stones are heated, prior to the cooking of the food. Leaves and broken pieces of branch are also put among caches of uncooked taro that are being hoarded for community feasting. Crushed leaves are occasionally used as a soap-substitute.

Schmid (1991: 160) stated that the Nokopo people of the Huon Peninsula commonly use the young leaves of *P. gibbilimbum* as a masticatory with betel-nut. Unfortunately, her vouchers are now inaccessible at the defunct Christensen Institute at Madang, Papua New Guinea. I have seen only one collection of *P. gibbilimbum* where it is said that the inflorescence is chewed with betel-nut (*Fallen & Endress 645*, Mt Kaindi).

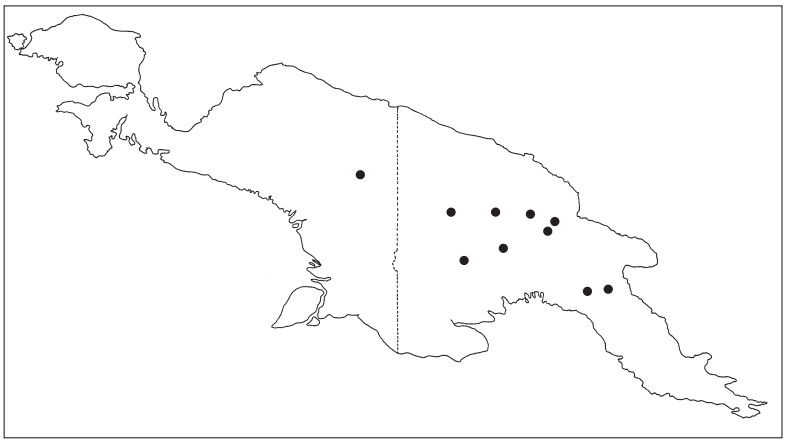
An upper altitudinal limit of 3000 m is given by Van Royen (1979), who had the advantage of having seen the material in LAE. The highest-altitude specimen I know of comes from 2800 m (*Van Royen 11448*, Victor Emanuel Ra.). The collection *Darbyshire & Hoogland 8254* (Torricelli Mts, Bliri River, 200 m) is an anomalously low record.

Collections studied: c. 80.

5. Piper recessum R.O. Gardner, *spec. nov.* — Fig. 1a, 1b, 2c, 3c, 4, 6c, 7b, Map 2

> Inter Piperibus fruticosis novoguineensibus singulare est vaginis petiolorum non caducis et capitibus bracteis spicarum robustarum elongatis succulentisque, praeterea pilis perfecte absentibus. — Typus: *Craven & Schodde 1207* (holo L; iso A, CANB, K, LAE), Papua New Guinea, Morobe Province, Aseki Patrol Area, near Haumga, 4600 ft [1400 m], 6 April 1966, female flowers.

To c. 6 m tall, trunks to 10(–15) cm dbh, new shoots sometimes wine-coloured near nodes. Glabrous in all parts. Crushed tissues with rather rank odour of citrus, pepper and cheese. *Orthotropic shoots*: leaf blades broadly ovate to almost suborbicular, to 25 by 22 cm, chartaceous to slightly fleshy, drying reddish brown, base cordate, lateral nerves 4 or 5 (or 6) pairs, the innermost pair almost free from midrib or fused with it for up to c. 1.5 cm, tertiaries and finer venation prominulous above, lower surface somewhat whitish and shining in life but dull when dry and with only the tertiaries prominulous; petiole to 15 cm long, c. 0.6 times as long as blade, the petiole sheath firm, yellowish and often with wine-coloured stripes, almost as long as petiole, persistent. *Plagiotropic (fertile) shoots*: leaf blade sometimes as small as 15 cm long; stipule to 8 cm long. *Female inflorescence* a spike to 20(–25) cm long, c. 5 mm diam. (8 mm in life); bracts obliquely peltate, stalk c. 0.8 mm long, bract-head ovate (elongate in the direction of apex), c. 2.5 by 1.8 mm, firm-textured (fleshy and umbonate in life), margin entire; stigmas sessile, 3, together c. 0.7 mm diam.; rudimentary stamens sometimes present. *Male inflorescence* a spike to 10(–21) cm long, c. 4 mm diam., stamens 3 per flower, staminal filaments fleshy, c. 0.3 mm long; anthers 0.8 mm diam., dehiscence slit continuous over apex. *Infructescence* pendent, 1 cm diam., fruitlets maturing through orange to dull red-brown, their lower seed-bearing part sunken into the soft fleshy



Map 2. Distribution of *Piper recessum* R.O. Gardner.

rachis and completely confluent with it, upper free part of fruitlet subglobose, 2 mm diam. *Seed* elliptic-oblong, 2.2 by 1.3 mm, subtrigonous with rounded angles, usually (?) with distinct hexagonal reticulations of c. 0.05 mm diam.

Distribution — Irian Jaya (eastern Snow Mts) east to Highlands regions of Papua New Guinea, also Bismarck-Schrader Ranges, Mt Bosavi, and Aseki-Upper Watut region.

Habitat & Ecology — Secondary growth, streamside scrub etc., at 1340–1900 m altitude.

Notes — In the Kaironk *P. recessum* is abundant only in a narrow zone, at 1600–1900 m. Its stems are not sufficiently large or durable as to have any use as timber but like those of *P. subbullatum* and *P. gibbilimbum* they do provide good fire-starting material. Crushed leaves are used to treat eye infections.

The principal Kalam name for *P. recessum* is *alkn yb*, which can be glossed as 'the common alkn', that is, common at the altitude where the principal settlements and gardens are. The other Kalam name, *alkn dak*, is presumably a more recent one, as it refers to the fact that the fruits and new shoots can be chewed with betel-nut, which is a recent import to the Kaironk. The other shrubby pipers of the Kaironk are not used in this way, supposedly because they induce nausea (but see Note under *P. gibbilimbum*). Other collectors have noted such a use for *P. recessum* elsewhere, e.g. Sterly (1997), and cf. Blackwood (1940: 112).

Collections studied: 26.

Representative specimens:

IRIAN JAYA: *Hiepko & Schultze-Motel 1039*, L, Eipomek, c. 1600 m, 13 Feb. 1976, vern. *kolum*; *Schiefenhövel 384*, CANB, Eipomek-Tal, 1800 m, 27 Sept. 1975.

SANDAUN (formerly West Sepik): *NGF 38991* (*Henty et al.*), L, Oksapmin, 1520 m, 13 Oct. 1968.

ENGA & WESTERN HIGHLANDS: *ANU 2318* (*Flenley*), CANB, L, Yaibos nr Wabag, 2130 m, 4 Jan. 1965, [a kind of] *kengali* (Enga name); *ANU 9538* (*Clarke*), CANB, Kompia, Jimi District, 1650 m, 14 March 1970, vern. *yikun*, "unfurled young leaf chewed together with fruit with betel"; *NGF 4322* (*Womersley et al.*), BRI, CANB, Nondugl, W Highlands, alt. not given, April 1951; *NGF*

42049 (*Vandenberg et al.*), CANB, Kopiago, 1340 m, 6 Nov. 1968; *UPNG 1541* (*Powell*), CANB, Upper Waghi Valley, 1710 m, 5 July 1971, *kuki* (Medlpa name).

SIMBU & EASTERN HIGHLANDS: *ANU 10605* (*Hope*), CANB, Bundi Patrol Post, 1500 m, 1970, *buawa* (Chimbu name); *Sterly 1734*, L, Konbromé, Gembogl, 1990 m, 10 Feb. 1985, *kiglawa* (Kuman name), "infls consumed with betelnut"; *Vink 16419*, CANB, L, Uinba, Nona-Minj Divide, 1970 m, 28 June 1963, *koggan* (Yoowi dialect, Hagen-Chimbu lang.).

SOUTHERN HIGHLANDS: *LAE 58858* (*Damas*), CANB, Mt Bosavi, 1500 m, 25 Aug. 1986, "leaves used as mustard for chewing betelnut"; *Pullen 2778*, CANB, L, nr Kagua Patrol Post, c. 1710 m, 20 July 1961.

MADANG: *Bulmer 103*, AK, North Kaironk V., c. 1900 m, 13 Aug. 1964, vern. *alkn yib*.

MOROBE: *Blackwood 40*, K, near Manki village [Watut-Bulolo watershed], c. 1220 m, 6 Dec. 1936, vern. *angganda*, "planted in native gardens … young leaves chewed as substitute for betel-pepper".

6. **Piper subbullatum** K. Schum. & Lauterb. — Fig. 2d, 3d, 6d

Piper subbullatum K. Schum. & Lauterb. (1900) 262. — Type: *Lauterbach 2343* (holo B; iso K), Ssiganu Wodsa, 1896.

Piper wichmannii C.DC. (1910) 418; Chew (1992) 161. — Type: *Atasrip 39* (holo L n.v.), Côte du Nord.

Piper plagiophyllum K. Schum. & Lauterb. (1900) 260. — Type: *Lauterbach 2143* (holo B n.v.), NE New Guinea, Oertzen Gebirge, 300 m.

To c. 7 m tall, trunks to c. 10 cm diam., new stems glabrous or sparsely pubescent with slender hairs to c. 0.8 mm long. *Orthotropic shoots*: leaf blades membranous to chartaceous, to c. 30 by 24 cm, base cordate or occasionally subtruncate, lateral nerves 4–6 pairs, the innermost pair fused ± unequally to midrib for 1–2(–4) cm, tertiaries and finer venation prominent above and below, upper surface in life sometimes obscurely bullate, lower surface with minute hairs especially on veins, margin usually densely ciliate with hairs c. 0.25 mm long; petiole to 10 cm long, usually a little more than 0.3 times as long as blade, sparsely hirsute, the sheath almost as long as petiole, soon shed. *Plagiotropic (fertile) shoots*: leaf blades sometimes as small as 15 cm long; stipule 5(–8) cm long, glabrous or with a few hairs. *Female inflorescence* a spike to 12(–25) cm long, 5 mm diam.; bracts centrally peltate, stalk hirsute, bract-head orbicular, membranous, 0.5–0.9 mm diam., margins usually minutely erose-fimbriate, sometimes ciliate; style short and obscure (in fruit sometimes to c. 0.3 mm long), stigmas 3, together 0.3–0.5 mm diam. *Male inflorescence* a spike to 12(–40) cm long, 3 mm diam.; staminal filaments 0.4 mm long; anthers 0.5 mm diam., becoming exserted fully above the bract-heads, dehiscence slit continuous over apex. *Infructescence* ± pendent, to c. 25 by 0.8 cm, ripe fruitlets orange (sometimes only yellowish?), free from rachis, 1.5 mm diam., oblong below, conical above for c. 0.5 mm; axis of rachis (usually?) only slightly woody. *Seed* subglobose to broadly elliptic, c. 1 mm diam., trigonous, (usually?) obscurely reticulate.

Distribution — Widespread in New Guinea, also in the Philippines, New Ireland and New Britain, Bougainville, Solomon Islands and Vanuatu.

Habitat & Ecology — Secondary growth, streamside scrub etc., at (0–)1300–1700 (–1900) m altitude.

Notes — The type of *P. subbullatum* is from 'Hochland Ssigaun' (Schumann & Lauterbach 1900: 262), that is, hill country at the western end of the Finisterre Range, towards the Nuru River.

The variant known as *Piper plagiophyllum* seems to differ only in having truncate-based leaves. Most such plants come from Morobe Province at lower altitude, but some are from much higher, e.g. Edie Creek at c. 1500 m or more. Chew (1972) listed specimens from the northern side of New Guinea, e.g. Arfak Mts, Mt Torricelli, Goodenough Is., and also from the Milne Bay region.

When crushed the live leaves of *P. subbullatum* give an oily, spicy, peppery odour, which becomes 'grassy'. The Kalam name *alkn kwy-sek* refers to this quite pleasant scent, and in the Kaironk the leaves are sometimes used to line earth-ovens.

Collections studied: c. 90.

7. Piper triangulare Chew — Fig. 2e, 3e, 6e, 7c

Piper triangulare Chew in Van Royen (1979) 1285 — Type: *NGF 20360 (Van Royen)* (holo L n.v.), Papua New Guinea, Central Province, Mt Amorwange E of Woitape, 7800 ft [2380 m], 14 Jan. 1965.

To 2(–3) m tall; most parts eventually glabrous but sometimes at first hirsute on new stems, blades and petioles with rather dark hairs to 1 mm long; tissues when crushed with a pleasant odour of citrus. *Orthotropic shoots*: leaf blades subtriangular to ovate, to c. 22 by 10 cm, coriaceous, often drying pale yellowish green or yellowish brown, base truncate to rounded (rarely cordate), lateral nerves 4 or 5 pairs, free from midrib right to base, tertiaries narrowly prominulous above and below, margins at first with dark rather coarse patent hairs c. 0.3 mm long; petiole to 5 cm long, c. 0.3 times as long as blade, the sheath ± as long as petiole, soon shed. *Plagiotropic (fertile) shoots*: leaf blades sometimes as small as 15 cm long; stipule to 3(–4) cm long, glabrous or with dark hairs. *Female inflorescence* a spike 4–6.5 cm long, 3.5 mm diam.; bracts centrally peltate, stalk with dense dark brown hairs (purplish in life), bract-head orbicular, rather firm, 0.7–1 mm diam., margin subentire, glabrous or sparsely ciliate; stigmas sessile, 3, together 0.8–1 mm diam. *Male inflorescence* a spike 3–5 cm long, c. 4 mm diam., staminal filaments c. 0.4 mm long; anthers c. 0.5 mm diam., dehiscence slit continuous over apex. *Infructescence* pendent, to c. 12 by 0.6 cm; fruitlets 2 cm diam., quite free from rachis, globose, orange or yellowish. *Seed* subglobose, with 4 or 5 obscure faces, ± truncate at apex, 1.8 mm diam., (usually?) obscurely reticulate.

Distribution — Papua New Guinea: Highlands and nearby regions, and also Owen Stanley Range (Mur Mur Pass, Mt Amorwange, Myola, Mt Albert Edward).

Habitat & Ecology — Montane forest and lower subalpine shrubberies, at 2135–3550 m altitude.

Notes — The 'purplish' (very dark crimson?) hairs are conspicuous on the rachis and bract-stalks of the female spike. Two collections (*NGF 9443*, Mt Kum near Mt Hagen; *NGF 30062*, Mt Albert Edward) refer to purple fruit as well, but they are hardly beyond flowering stage and the reference might just be to the hairs.

One Kalam name for *P. triangulare* is *alkn aydk*, the 'wild *Piper*'. The other is *kamay alkn*, '*Piper* of the *Nothofagus* forest', this plant being found in the Kaironk only in such forest, above c. 2200 m. The strong stems may be used, in an emergency, as hunting-bows.

Collections studied: 12.

8. Piper wabagense Chew — Fig. 2f, 3f, 6f, 7d

Piper wabagense Chew (1992) 163. — Type: *ANU 2793 (Flenley)*, (holo CANB; iso BRI, LAE, NSW), Papua New Guinea, Enga Province, near Lake Inim, c. 2800 m, May 1965, ripe fruit.

To 5(–7) m tall, new stems densely appressed-villous with rather slender mid- to grey-brown hairs to c. 0.5 mm long. *Orthotropic shoots*: leaf blades to 22 by 19 cm, broadly ovate, coriaceous, drying somewhat yellowish brown, cordate at base; lateral nerves 4 (or 5) pairs, one or sometimes both of the innermost pair fused to midrib for (0.5–)2–5 cm, never free right to base of midrib even on smallest leaves, the tertiaries and some finer venation prominent above (within the channels between bullate sections) and prominent below, appressed-villous below on nerves at least, margins finely villous; petiole to 4 cm long, c. 0.33 times as long as blade, appressed-villous, the sheath almost as long as petiole, soon shed. *Plagiotropic (fertile) shoots*: leaf blades sometimes as small as 10(–15) cm long; stipule to 4 cm long, appressed-villous. *Female inflorescence* a spike to 13 cm long, c. 4 mm diam., bracts centrally peltate, stalk hairy, the bract-head orbicular, membranous to rather firm, c. 1 mm diam., margin subentire or closely papillose, sometimes ciliate (and occasionally some cilia on surface of head); stigmas sessile, 3 or 4 (or 5), together 1 mm diam. *Male inflorescence* a spike to 12 cm long (fide Chew), c. 3 mm diam.; staminal filaments 0.6 mm long (or to 1.5 mm, fide Chew); anthers 0.5 mm diam., dehiscing by a pair of lateral slits. *Infructescence* erect, to 16(–25) by 0.9 cm; fruitlets orange, 2–2.5 mm diam., subglobose, quite free from rachis, axis of rachis (usually?) not fibrous. *Seed* oblong, with 4 or 5 rounded ridges and longitudinal furrows, 2.3 by 1.5 mm, (usually?) obscurely reticulate.

Distribution — Papua New Guinea: Highlands regions, also Cromwell Range and Owen Stanley Range (Kerau Mission, near Goilala; Mt Tofa).

Habitat & Ecology — Forest, secondary growth and upper montane shrubberies, at 2100–2600 m altitude.

Notes — The description above differs in some places from that of Chew (1992). I have seen only one male specimen (*ANU 2271*, Dec. 1964, CANB) and, in addition to the type, only one with ripe fruit (*Robbins 446*, July 1957, CANB).

The collections lie in a narrow altitudinal range. Chew (1992) comments that the species is particularly abundant in clearings in *Nothofagus* forest at c. 2500 m altitude.

Collections studied: 9.

INCERTAE SEDIS

See note under *P. bolanicum* on *Brass 10847* from Lake Habbema.

I cannot place the specimen *LAE 54351* (*Stevens & Veldkamp*), Milne Bay district, [near] Mayu 2, 1835 m, 2 July 1972, K. Its leaves and fruiting parts are intermediate between those of *P. bolanicum* and *P. subbullatum*; perhaps it is a hybrid.

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LIST OF COLLECTIONS

bol	=	*P. bolanicum*	sub	=	*P. subbullatum*
gib	=	*P. gibbilimbum*	tri	=	*P. triangulare*
rec	=	*P. recessum*	wab	=	*P. wabagense*

ANU 419: gib; 2040: gib; 2271: wab; 2318: rec; 2793: wab; 2836: bol; 5517: sub; 6217 :sub; 6415: bol; 9509: gib; 9538: rec; 10605: rec.

Baltisberger et al. (leg. 14 Sept. 1988): gib — Blackwood 40: rec; 105: gib — Borgmann 250: bol — Bowers 51: gib; 53: gib; 402: gib; 426: gib; 797: bol— Brass 1449: sub; 5396: sub: 9308: bol; 11054: gib; 11671: gib; 12252: gib; 13243: sub; 13276: sub; 22729: bol; 23235: gib; 23684: sub; 27128: sub; 29542: sub; 30186: bol; 30918: gib; 30924: wab; 31517: gib; 32099: sub; 32112: sub — Briggs 3822: gib; 3823: sub — Bulmer: 103: rec; 168: tri; 224 : gib; 85/242: rec; 85/253: sub; 85/264: gib — BW 8593: gib; 8924: gib;12506: sub; 12577: sub; 12665: sub.

Carr 13199: sub; 15700: sub — Clemens 140: sub; 148: sub; 331: sub; 7780: bol; 9892A: bol — Conn et al. 73: sub — Craven & Schodde 512: sub; 1207: rec; 1370: sub.

Darbyshire & Hoogland 8254: gib — Docters van Leeuwen 9745: sub; 10746: sub.

Fallen & Endress 645: gib — Frodin 665: wab — Frodin, Morin & Gabir 2398: sub.

Gardner 7022: rec; 7023: sub; 7031: gib; 7033: sub; 7040: gib; 7107: tri; 7130: rec; 7150: gib; 7172: rec; 8804: sub; 8805: sub; 8856: rec; 8868: tri; 8874: tri; 8924: gib; 9027: rec; 9401: sub; 9407: gib; 9408: rec; 9436: rec; 9459: rec; 9485: rec; 9486: sub; 9507: gib; 9508 gib; 9511: sub; 9524: tri; 9654: tri; 9736: tri; 9836: tri; 10052: tri; 10131: rec; 10138: rec.

Hartley 9620: sub; 10355: sub; 10938: sub; 11170: bol; 11796: gib; 12197: sub — Hide 575: sub — Hiepko & Schultze-Motel 1039: rec; 1413: rec — Hoogland 3976: sub; 4445: sub; 5202: sub; 8895: sub; 9099: sub; 9457: wab; 9615: wab; 9756: bol; 9992: bol — Hoogland & Pullen 5253: gib; 5301: gib; 6078: bol — Hoogland & Schodde 6922: wab; 7218: bol; 7536: bol.

Jackson 69: sub.

Kalkman 4739: bol.

LAE 53188: bol; 54395: bol; 54555: bol; 55273: bol; 56536: sub; 56710: sub; 58858: rec; 59823: bol; 59879: sub; 60734: bol; 60884: gib; 61547: bol; 61585: bol; 74454: sub.

Manner & Street 396: sub; 535: sub — Mayar 354: sub — McKee 1196A: gib.

NGF 1192: sub; 3525: sub; 4322: rec; 4349: gib; 5378: sub; 6082: gib; 6097: gib; 6601: sub; 8105: gib; 8109: gib; 9443: tri; 10453: sub; 10626: gib; 11554: sub; 11860: gib; 11912: sub; 13676: sub; 13847: gib; 15824: gib; 16167: bol; 18260: gib; 19746: sub; 22724: gib; 23391: sub; 26434: sub; 26993: bol; 27794: sub; 28260: bol; 28407: gib; 30062: tri; 32052: gib; 32926: bol; 33063: sub; 37014: bol; 37647: sub; 37730: sub; 38972: gib; 38991: rec; 39520: bol; 40353: gib; 42049: rec; 42071: gib; 43192: gib.

Paijmans 1275: bol — Pulle 172: gib; 517: gib; 932: gib — Pullen 400: wab; 454: gib; 2778 : rec; 6038: bol; 5961: sub.

Quisumbing 65838: wab.

Robbins 446: wab; 679: bol.

Sands 6336: sub — Saveur & Sinke 2701: sub — Schiefenhövel 127: gib; 384: rec — Schlechter 14389: sub; 14604: sub — Schodde 1414: sub; 2355: gib; 14155: sub — Sosrodihardjo 54: gib — Sterly 1595: gib; 1596: gib; 1604: sub; 1626: gib; 1734: rec; 80-376: sub — Stone 9771: sub — Streimann 8577: gib.

UPNG 1514: rec; 13481: tri.

Van Balgooy 979: tri — Van Royen 10953: bol; 11448: gib — Verdcourt 5156: gib — Versteeg 1515: gib; 1581: sub — Vink 16341: gib; 16419: rec; 16564A: gib; 17506: bol — Von Römer 1268: gib.

Webster & Hildreth 15192: sub — White 454: sub; 518: sub — Widjaja & Hamzah 3000: gib.