

CRUCIFERAE (B. Jonsell, Stockholm)

Herbs, sometimes subshrubs. *Leaves* spirally arranged, basal ones often in a rosette, exstipulate, petiolate to sessile and amplexicaul, entire to variously divided. *Inflorescences* terminal or sometimes axillary racemes, in flower mostly condensed and often corymbose, in fruit elongate, usually ebracteate. *Flowers* bisexual, actinomorphic or slightly zygomorphic, hypogynous, cyclic, tetramerous, heterochlamydous. *Sepals* 4, free, usually equal, spatulate to clawed, imbricate or contorted. *Stamens* 6, tetradynamous (rarely 4 or 2), episepalous usually free; anthers usually 2-theous opening lengthwise. *Nectarial glands* variously arranged at the filament bases. *Ovary* superior, sessile or stipitate, of seemingly two united carpels, secondarily divided into two locules by a thin membranous septum (sometimes transversely locular by intrusions from the fruit wall); placentation parietal, ovules usually many, anatropous or campylotropous; stigma bifid or connate. *Fruit* a bivalved dehiscent siliqua or silicula (see key), sometimes a nutlet, lomentaceous or otherwise constricted. *Seeds* virtually devoid of endosperm, with cotyledons incumbent, accumbent or variously folded.

Distribution. A cosmopolitan family with about 380 genera and more than 3000 species, especially diversified in the Mediterranean and the Irano-Turanian regions as well as in parts of Southern Africa, North America and montane South America. The family is comparatively sparse in the tropics, mainly confined to montane and arid areas.

The family includes a number of important crops and spices, notably in the genera *Brassica*, *Sinapis*, *Raphanus*, *Crambe*, *Lepidium*, *Rorippa*, some now cultivated in montane parts of the tropics.

Several cosmopolitan weeds belong to the family (within *Lepidium*, *Coronopus*, *Capsella*, *Thlaspi*, *Arabis*, *Sisymbrium*, *Rorippa*, *Camelina*, and others) and may appear as casual aliens virtually anywhere.

In Malesia there are 6 genera with a total of 24 species. The genus *Papuzilla* (3 spp.), regarded as a New Guinean endemic, is here included within *Lepidium*. In each of the genera *Cardamine* and *Rorippa* 3 spp. are endemic to New Guinea and some adjacent areas, and *Rorippa backeri* is an endemic of Java.

The affinities of the endemic *Rorippa* species is with Australia and New Zealand, while the *Cardamine* species belong to an alliance of tropical montane species around the widespread *C. africana*.

The remaining 14 species may all have been introduced by man and partly naturalized.

Ecology. The native species are montane (some secondarily at lower levels). Natural occurrences are open forests, rocky outcrops, riverbanks, mostly places without a closed vegetation cover. Many are favoured by clearings, fires, road building, etc.

Dispersal. All Malesian species (except *Raphanus sativus*) disperse by small seeds without special devices. Some seeds are mucilaginous (get sticky with water), which may facilitate transport with birds and other agents.

Morphology. In spite of its size, the family is remarkably uniform. Lignification is rarely substantial except in basal parts, the hypocotylar region and roots. The herbaceous life-form seems to be primary, at least so far as many woody groups seem to have evolved from herbaceous forms. Annuals are common in many genera.

In floral parts little specialization is to be found, but not rarely reductions as to stamens, petals and nectaries. The position of the nectaries varies in relation to the filament bases (and is of taxonomic importance) but no particular elaboration is found.

Variation and specialization are important and often drastic as to fruits and diaspores, which means that without developed fruits many species are not determinable.

The seeds are variously ornamented, often winged. The testa is rather uniformly built from one-cell-thick layers: epidermis (which may contain mucilage), subepidermis (which may be absent), palissade layer (usually with pigmented wall thickenings) and a parenchymatous pigmented layer. The ripe seed is almost filled up by the embryo; endosperm is reduced to a one-cell-thick 'aleurone' layer adjacent to the testa. The folding of the cotyledons and their position in relation to the radicle is of taxonomic importance.

Vegetative anatomy. Wood anatomy is quite variable within the family and largely associated with stem width. The xylem in thin-stemmed species forms a closed cylinder and the cambium forms a continuous ring. In thicker stems sclerenchymatous tissue separates the xylem bundles and the cambium cylinder is mostly discontinuous. In woody species medullary rays may also separate the xylem bundles. The variation largely reflects degrees of adaptations to arid conditions and occurs within genera and species as well as intra-individually according to age. Even in strongly lignified species the wood elements are of little advanced types, making it probable that woodiness has evolved comparatively recently in the family.

Secretory cells containing myrosinase (myrosin cells) are widely distributed in the family, but in various organs in various genera. Their distribution has been regarded to be of some taxonomic value.

Hairs are always unicellular, but shape varies from unbranched to forked, stellate, T-shaped, etc. and is of considerable taxonomic interest at various levels.

The stomata are mostly of a characteristic type with one small and two larger subsidiary cells: so-called anisocytic or cruciferous stomata. This type is, however, by no means restricted to the *Cruciferae*.

References: CARLQUIST, Aliso 7 (1971) 365–384; INAMDAR & RAO, Feddes Rep. 94 (1983) 183–190; IVERSEN, BAGGERUD & BEISVAAG, Z. Pflanzenphysiol. 94 (1979) 143–154; KOWAL & CUTLER, Kew Bull. 30 (1975) 503–507; METCALFE & CHALK, Anatomy of the Dicotyledons 1 (1950) 79–87; PANT & KIDWAI, Ann. Bot. (N.S.) 31 (1967) 513–521; RAO & INAMDAR, Bot. Mag. Tokyo 96 (1983) 15–28.

Palynology. As with macromorphology, the pollen morphological variation within *Cruciferae* is small in proportion to the number of genera and species. Shape of the grains ranges from suboblate to subprolate, but prolate and perprolate shape is easily attained by invagination of the long colpi under dry conditions (e.g. during transport through the air). The grains are small to medium-sized (10–45 µm), rarely somewhat larger.

The apertural system is nearly always 3-colpate. Seldom also 2-, 4-, 5-, 6-, or 7-colpate grains occur. ERDTMAN (1952) records the rare occurrence of inaperturate pollen, which probably represents a kind of tritenuate apertural system.

Exine stratification is mostly distinct, sexine and nexine being clearly distinguishable. A reticulate tectum with up to 1 µm broad muri is usually present. Columellae may be distinct or not, which mainly depends on their size.

On the strength of extensive material (200 out of about 380 genera) CHIGURIAEVA (1973) established 5 main pollen types within *Cruciferae*. Most characters used in this subdivision are quantitatively determined and the various pollen types occur together in most tribes of the family. Besides, compared with the pollen morphological range in the whole family, relatively much variation appeared to be present within single species. Thus, pollen morphology seems of little significance for taxonomy in *Cruciferae*. As to be expected, cruciferous pollen keys out very difficultly (ERDTMAN c.s., 1963).

References: CHIGURIAEVA, Pollen morphology of *Cruciferae*, in Kuprijanova, Pollen and spores morphology of the recent plants. Proc. III Int. Palyn. Conf. (1973) 93–98; ERDTMAN, Pollen morphology and plant taxonomy, Angiosperms (1952) 133–134; ERDTMAN, PRAGLOWSKI & NILSSON, An introduction to a Scandinavian Pollen Flora II (1963). — R.W.J.M. VAN DER HAM.

Phytochemistry. The family is rather uniform and highly characteristic also from the chemical point of view. Particularly the seeds but also other organs contain glucosides with sulphur and nitrogen in their molecules, so-called mustard oil glucosides, or glucosinolates, compounds unique to the family. The enzyme myrosinase, localized in particular cells, will split the glucosinolates when cell walls are crushed in the presence of water into three compounds, among those the pungent mustard oils. They are either isothiocyanates of usually pleasant flavour or thiocyanates with a strong, often garlic-like odour (*e.g.* in *Lepidium* and *Thlaspi*).

Very important in the seeds are also lipid acids, particularly unsaturated ones with 18, 20 or 22 carbon atoms. Particular for the family and very widespread is the erucic acid, which because of unliked properties should be kept at a minimum in strains of *e.g.* *Brassica* cultivated as oil seed crops. Others of those fatty acids (oleic, linolenic and linoleic acids) are of utmost economic importance. Among alkaloid-like compounds sinapin, a protoalkaloid of bitter taste, is very common in the family and concentrated in the seeds. Proteins are of importance in the seeds, while starch is lacking.

References: HEGNAUER, *Chemotaxonomie der Pflanzen* 3 (1964) 586–607; VAUGHAN *c.s.* (ed.), *The biology and chemistry of the Cruciferae* (1976) 191–330.

Chromosomes. By far the most widespread basic number is $x=8$, but dysploidy occurs within several genera (*e.g.* *Brassica*) and may account for $x=7$, which prevails in a few genera (*e.g.* *Thlaspi*, *Sisymbrium*); $x=5$ is known from *Arabidopsis*, the southern hemispheric tribes *Stenopetaleae* and *Heliophilleae*, and on polyploid level in *Crambe*. Polyploidy, often combined with aneuploidy, is extensive in most of the large genera, *e.g.* *Cardamine*. The chromosomes are small and do not readily lend themselves to structural studies.

References: FEDOROV (ed.), *Chromosome numbers of flowering plants* (1969); MANTON, *Ann. Bot. n.s.* 1 (1932) 438–462.

Taxonomy. The uniformity of this large family makes subdivision difficult. A number of tribal classifications have been proposed, most of them ending up with 15–20 tribes, 9 of those distinct and largely restricted to limited parts of the southern hemisphere. They include few genera and mostly also few species. Among widespread tribes, rich in genera and species, *Brassicaceae* (with *Brassica* and *Raphanus* in the Malesian flora) is the only one really distinct, and not been disagreed upon as to its circumscription. Most of the other tribes have been rather schematically delimited and may contain a nucleus of closely related genera to which others seem to have been more arbitrarily added. According to SCHULZ's system the Malesian genera should be included within *Lepidieae* (*Lepidium* and *Capsella*) and *Arabideae* (*Cardamine* and *Rorippa*).

References: HEDGE in VAUGHAN *c.s.* (ed.), *The biology and chemistry of the Cruciferae* (1976) 1–45; SCHULZ, *Cruciferae*, in Engler & Prantl (ed.), *Die natürlichen Pflanzenfamilien* ed. 2, 17b (1936) 227–658.

Cultivated species. The following species have been reported as cultivated only, and are not treated separately: *Aromoracia rusticana* G.M. & SCHERB. See BACKER & BAKH.f. *Fl. Java* 1 (1963) 188. — *Brassica chinensis* L. See HEYNE, *Nutt. Pl. Ned. Indië* (1927) 677; OCHSE & BAKH. *Indische Groenten* (1931) 162; STONE, *Fed. Mus. J.* 26 (1981) 81. — *B. napus* L. See HEYNE, *Nutt. Pl. Ned. Indië* (1927) 677; OCHSE & BAKH. *Indische Groenten* (1931) 168. — *B. oleracea* L. See KOORD. *Meded. Lands Plantentuin* 19 (1898) 341; *Exk. Fl. Java* 2 (1912) 284; HOCHR. *Candollea* 2 (1925) 367; HEYNE, *Nutt. Pl. Ned. Indië* (1927) 677; OCHSE & BAKH. *Indische Groenten* (1931) 169; DOCTERS VAN LEEUWEN, *Verh. Kon. Akad. Wet. Amsterdam* sect. II, 31 (1933) 166; BACKER & BAKH.f. *Fl. Java* 1 (1963) 188. — *B. rapa* L. (*B. campestris* L.). See KOORD. *Exk. Fl. Java* 2 (1912) 284; HOCHR. *Candollea* 2 (1925) 367; HEYNE, *Nutt. Pl. Ned. Indië* (1927) 678; OCHSE & BAKH. *Indische Groenten* (1931) 174; BACKER & BAKH.f. *Fl. Java* 1 (1963) 188; GILLI, *Ann. Naturhist. Mus. Wien* 83 (1980) 429. — *B. rugosa* PRAIN. See KOORD. *Exk. Fl. Java* 2 (1912) 286; HEYNE, *Nutt. Pl. Ned. Indië* (1927) 678. — *Cochlearia officinalis* L. See BACKER, *Schoolfl. Java* (1911) 57; KOORD. *Exk. Fl. Java* 2 (1912) 283. — *Iberis amara* L. See BACKER & BAKH.f. *Fl. Java* 1 (1963) 188. — *I. umbellata* L. See BACKER & BAKH.f. *Fl. Java* 1 (1963) 188. — *Lobularia*

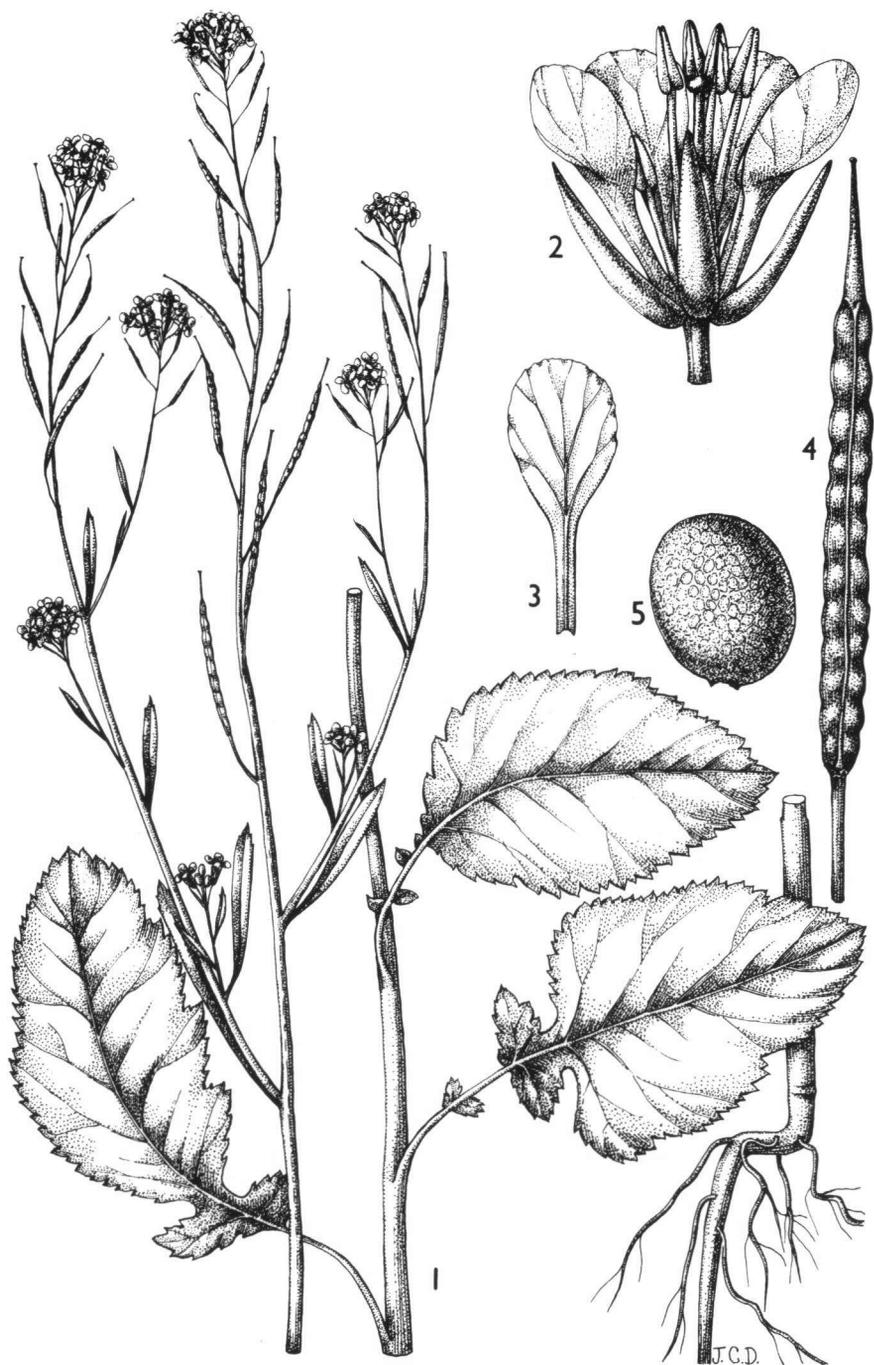


Fig. 1. *Brassica juncea* (L.) CZERN. 1. Habit, $\times 0.6$; 2. flower, $\times 6$; 3. petal, $\times 6$; 4. silique, $\times 2$; 5. seed, $\times 12$ (1-3 DRUMMOND & HEMSLEY 3360; 4, 5 CONRADS 230; drawn after African material). Courtesy Fl. Trop. E. Afr., Crucif. (1982) 4, f. 1.

maritima (L.) DESV. See BACKER & BAKH.f. Fl. Java 1 (1963) 192. — *Matthiola incana* (L.) R.BR. See BACKER & BAKH.f. Fl. Java 1 (1963) 192. — *Sinapis alba* L. See KOORD. Meded. Lands Plantentuin 19 (1898) 342; Exk. Fl. Java 2 (1912) 284.

In addition the following species has been reported, probably as occasional, but it is in L represented only by indeterminable material: *Barbarea vulgaris* R.BR. See BACKER, Schoolfl. Java (1911) 55; KOORD. Exk. Fl. Java 2 (1912) 288; BACK. & BAKH.f. Fl. Java 3 (1968) 643.

KEY TO THE GENERA

1. Fruit a siliqua, *i.e.* less than three times as long as broad. Ovary ovoid to pyriform.
 2. Silicule with two seeds, orbicular, elliptic in outline..... 3. *Lepidium*
 2. Silicule with more than two seeds, triangular in outline 4. *Capsella*
1. Fruit a siliqua, *i.e.* more than three times as long as broad. Ovary \pm cylindrical.
 3. Siliqua corky-spongy, non-dehiscent 2. *Raphanus*
 3. Siliqua opening by two valves.
 4. Siliqua narrowing into a conical beak (rostrum), terminated by the style..... 1. *Brassica*
 4. Siliqua without a rostrum, \pm abruptly terminated by the style.
 5. Siliqua with a thickened replum (*i.e.* thickened edge of the septum of the siliqua, on which the seeds grow), explosively dehiscent by coiling valves 5. *Cardamine*
 5. Siliqua with a thin replum; valves opening without coiling 6. *Rorippa*

1. BRASSICA

LINNÉ, Sp. Pl. (1753) 666; Gen. Pl. ed. 5 (1754) 299; ENDL. Gen. Pl. (1839) 882; B. & H. Gen. Pl. 1 (1862) 84; BAILLON, Hist. Pl. 3 (1871) 248; PRANTL in E. & P. Nat. Pfl. Fam. III, 2 (1891) 177; SCHULZ, Pflanzenr. IV-105, Heft 70 (1919) 21; in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 321. — Fig. 1.

Annual, biennial or perennial herbs, rarely subshrubs, glabrous or with hispidulous simple hairs. *Leaves* undivided to pinnatipartite. *Racemes* terminal, usually ebracteate, corymbiform to paniculate, with many rather large flowers, in fruit elongate, lax. *Sepals* erect, connivent or spreading, the inner larger and somewhat saccate. *Petals* yellow or white, spatulated to clawed. *Stamens* 6, the lateral ones often ascending, filaments linear. Lateral nectaries prismatic or reduced, median ones semiglobose to filiform, often large. *Ovary* cylindrical, sometimes on a gynophore; stigma semiglobose to slightly bilobed, ovules numerous, usually uniseriate. *Fruit* a siliqua, readily dehiscent, terete or slightly laterally compressed, in transverse section \pm biconvex, attenuate into a conical to filiform beak with 0–3 seeds; valves rather thick, convex, with prominent midnerve and inconspicuous side-nerves. *Seeds* usually globose, reticulate, not mucilaginous.

Distr. As indigenous mostly Mediterranean; a number of the nearly 40 *spp.* have widely spread as weeds, some of them in connection with cultivation.

Ecol. Natural habitats are open, rather dry places like seacliffs, *etc.* In the tropics only as weeds of cultivation, roadsides, waste places, *etc.*

1. *Brassica juncea* (L.) CZERN. Consp. Pl. Chark. (1859) 8; BACKER, Fl. Batavia (1907) 49; MERR. Fl. Manila (1912) 214; KOORD. Exk. Fl. Java 2 (1912) 286; MERR. Int. Rumph. Herb. Amb. (1917) 240;

SCHULZ, Pflanzenr. IV-105, 70 (1919) 55; OCHSE & BAKH. Ind. Groenten (1931) 164, f. 99–101; BURK. Dict. (1935) 361; BACKER & BAKH.f. Fl. Java 1 (1963) 188; HENTY, Harmful Pl. PNG, Bot. Bull. Lae 12

(1980) 43. — *Sinapis juncea* LINNÉ, Sp. Pl. (1753) 668. — *Sinapis timoriana* DC. Syst. Nat. 2 (1821) 616; MIQ. Fl. Ind. Bat. 1, 2 (1858) 93; DECNE, Herb. Timor. Descr. (1835) 97; BOERL. Handl. Fl. Ned. Ind. 1, 1 (1890) 59; QUIS. Medic. Pl. Philip. (1951) 332. — *B. bessleriana* ANDRZ. ex TRAUTV. Bull. Soc. Nat. Moscou 33 (1860) 134; KOORD. Meded. Lands Plantentuin 19 (1898) 341. — *B. integrifolia* (WEST) RUPR. Fl. Ingrica 1 (1860) 96; MERR. En. Philip. 2 (1923) 207. — Fig. 1.

Annual herb, glabrous or somewhat hispid at bases of stem and petioles, somewhat glaucous. *Stem* erect, usually 30–150 cm high, with long ascending branches in upper part. Basal and lower *leaves* petioled, not auriculate, with obovate attenuate blade up to 20 by 10 cm, rather coarsely and irregularly dentate, and 1–3 pairs of small lateral lobes; median and upper leaves ± distinctly petioled, not auriculate, obovate and obtuse or oblanceolate and acute, usually 5–10 cm long, irregularly dentate. *Racemes*

corymbiform, rather loose, with numerous flowers; in fruit lax, up to 50 cm long; pedicels ascending, 5–12 mm long. *Sepals* green, oblong, 4–6 mm long. *Petals* bright yellow, clawed, with obovate blade, 6–10 mm long. *Anthers* 1.5–2.5 mm long. *Ovary* with 10–20 ovules. *Siliquae* linear, often somewhat torulose, sometimes inflated, 25–75 by 2–3.5 mm, attenuate into a narrowly conical seedless beak, 6–12 mm long; valves with distinct ± keeled midnerve. *Seeds* dark brown, globose, 1–1.5 mm in diameter, with a distinct fine reticulum.

Distr. Wild origin unknown, perhaps E. Europe or SW. Asia; widely spread with cultivation in Asia, S. Europe, Africa and America; in *Malesia*: Malay Peninsula, Java, Borneo (Brunei, Sarawak), Celebes, Moluccas, Philippines, New Guinea.

Ecol. Weed of waste land, open places, cultivations (sometimes in gardens); mostly at 2000–3000 m.

Note. *Brassica juncea* has in later years become the world's most important mustard crop.

2. RAPHANUS

LINNÉ, Sp. Pl. (1753) 669; Gen. Pl. ed. 5 (1754) 300; ENDL. Gen. Pl. (1839) 886; B. & H. Gen. Pl. 1 (1862) 101; PRANTL in E. & P. Nat. Pfl. Fam. III, 2 (1891) 179; BAILLON, Hist. Pl. 3 (1871) 250; SCHULZ, Pflanzenr. IV-105, 70 (1919) 194; in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 347.

Annual to perennial herb, ± hispid with simple hairs. *Leaves* lyrate-pinnatifid to pinnatifid. *Racemes* terminal, ebracteate, ± corymbiform, with many rather large flowers, in fruit elongate, lax. *Sepals* erect, the inner larger and somewhat saccate. *Petals* white, yellow or ± violet, clawed. *Stamens* 6; filaments linear; anthers linear, obtuse. *Lateral nectaries* very small, median semi-globose or filiform. *Ovary* biarticulate; lower segment very short, upper segment long with 2–20 ovules; stigma capitate. *Fruit* a transversely articulate siliqua; lower segment usually stalk-like, very short, seedless; upper segment indehiscent, cylindrical, in transverse section circular, ± constricted between the seeds, sometimes lomentaceous; beak narrow, seedless. *Seeds* ovoid to globose, reticulate to smooth.

Distr. About 8 *spp.*, native in the Mediterranean area; 2 *spp.* are almost cosmopolitan weeds.

1. *Raphanus sativus* LINNÉ, Sp. Pl. (1753) 669; BACKER, Fl. Batavia (1907) 50; MERR. Fl. Manila (1912) 214; KOORD. Exk. Fl. Java 2 (1912) 287; HEYNE, Nutt. Pl. Ned. Ind. (1927) 679; OCHSE & BAKH. Ind. Groenten (1931) 178; BURK. Dict. (1935) 1566; BACKER & BAKH. f. Fl. Java 1 (1963) 188; QUIS. Medic. Pl. Philip. (1951) 336; STONE, Fed. Mus. J. 26 (1981) 80. — *R. caudatus* LINNÉ, Mant. Pl. (1767) 95; MIQ. Fl. Ind. Bat. 1, 2 (1858) 93.

Annual or usually biennial herb with thickened

napiform to cylindrical taproot, hispid especially in lower parts. *Stem* erect, usually branched, 15–150 cm high. Basal and lower cauline *leaves* lyrate-pinnatifid to -pinnatisect, petioled, not auriculate, up to 15 cm long; terminal lobe large, at least half as long as the whole leaf, elliptic to ovate, acute, ± cuneate, ± coarsely dentate; lateral lobes in up to 7 pairs (but usually much fewer), small, oblong or narrowly triangular, ± dentate; upper leaves shortly to indistinctly petiolate, undivided, oblong to lan-

ceolate, acute, cuneate, serrate to dentate. *Racemes* loosely corymbiform to paniculate with many flowers on 10–20 mm long pedicels, in fruit elongate, lax with up to 30 mm long pedicels. *Sepals* lanceolate, obtuse, 5–10 mm long. *Petals* white, yellow or lilac, ± dark-veined, 15–20 mm long with obovate, emarginate to rounded blade, 5–6 mm broad. *Anthers* ± 2.5 mm long. *Siliqua* 20–90 by 7–15 mm; lower segment much reduced; upper segment of ± spongy to corky consistency, not or slightly constricted between the 1–12 seeds; beak conical, 10–20 mm long.

Seeds brownish, ellipsoid to globose, 1.5–4 mm long, finely reticulate.

Distr. Only known as a cultivated species, which has probably originated from hybrids between forms of *R. raphanistrum* L. In *Malesia* as a weed (probably escaped from cultivation) at least in Java, probably elsewhere. Cultivated also in the Malay Peninsula and the Philippines, probably elsewhere.

Ecol. Cultivated land, waste places, roadsides; usually 1800–2200 m altitude.

3. LEPIDIUM

LINNÉ, Sp. Pl. (1753) 644; Gen. Pl. ed. 5 (1754) 291; ENDL. Gen. Pl. (1839) 879; B. & H. Gen. Pl. 1 (1862) 87; BAILLON, Hist. Pl. 3 (1871) 284; PRANTL in E. & P. Nat. Pfl. Fam. III, 2 (1891) 160; THELL. Die Gattung Lepidium (1906); SCHULZ in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 407; HEWSON, Brunonia 5 (1982) 73. — *Papuzilla* RIDLEY, Trans. Linn. Soc. Lond. II, Bot. 9 (1916) 17; SCHULZ in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 410; P. ROYEN, Mt. Fl. New Guinea 3 (1982) 2014. — **Fig. 2.**

Annual or perennial, small to medium-sized herbs or subshrubs with taproot, often finely pubescent with simple hairs. *Stems* erect or ascending, sometimes procumbent, freely branching. *Leaves* membranous or coriaceous, simple to imparipinnatifid. *Racemes* terminal or axillary, ebracteate, densely corymbose, with small to minute flowers, in fruit narrowly cylindrical, contracted or elongate but usually rather dense. *Sepals* elliptic, not saccate, greenish. *Petals* usually whitish, somewhat longer or shorter than the sepals, or often lacking. *Stamens* 6, 4, or 2, median and/or lateral ones reduced; filaments usually linear to subulate. *Nectarial glands* usually 6 or 4, adjacent to the bases of the lateral filaments. *Ovary* flat, dorsiventrally compressed, elliptic in outline, ovules 2. *Fruit* a silicula, dehiscent, flat, strongly compressed, narrowly septate, usually orbicular to elliptic in outline, winged (especially distally) or not, with the short style as an apical notch. *Seeds* single in each locule, very finely reticulate, mucilaginous, usually reddish brown, rather flat, elliptic to obovate in outline, sometimes narrowly and unilaterally winged.

Distr. Worldwide; a number of the c. 150 *spp.* are cosmopolitan weeds.

Ecol. Largely open, wet or dry ground without closed vegetation, in elevated regions. Very often in disturbed places.

KEY TO THE SPECIES

1. Inflorescences terminal with numerous flowers. Spines absent.
2. Leaves deeply divided. Siliculae with prominent wings 1. *L. sativum*
2. Leaves undivided, serrate. Siliculae wingless 2. *L. virginicum*
1. Inflorescences very short with 5 or fewer flowers inserted at base of spines.
3. Subshrub, more than 20 cm high 5. *L. maccowagei*
3. Cushion forming, rhizomatous, partly woody herbs, less than 15 cm high.

4. Cushions over 5 cm thick. Leaves mostly serrate or incised with up to 4 pairs of lobes 4. *L. minutiflorum*
 4. Cushions less than 5 cm thick. Leaves mostly deeply pinnatifid with up to 7 pairs of lobes

3. *L. laeteviride*

1. *Lepidium sativum* LINNÉ, Sp. Pl. (1753) 644; HEYNE, Nutt. Pl. Ned. Ind. (1927) 676; BURK. Dict. (1935) 1331; BACKER & BAKH.f. Fl. Java 1 (1963) 188.

Annual herb with slender taproot, up to 70 cm high, erect, simple or much branched, glabrous or with scattered minute hairs. *Leaves* membranous, petioled, very sparsely pubescent, up to 10 cm long, imparipinnate- or bipinnatifid, with 2–4 pairs of lateral lobes; lobes linear, lanceolate or oblanceolate, up to 3 cm long; uppermost leaves sometimes simple, serrate. *Racemes* terminal, with rather conspicuous whitish flowers, in fruit loose, up to 25 cm long; pedicels in fruit 3–6 mm long, ascending to almost erect, straight, glabrous. *Sepals* green with membranous margins, elliptic, 1–1.5 mm long. *Petals* white or violet, spatulate to slightly clawed, with rounded apex, 1.7–3 mm long. *Stamens* 6, with a single small nectary between each of them. *Ovary* elliptic, emarginate, with projecting style. *Siliculae* elliptic in outline, 4.5–6.6 mm long, 3–4 mm broad, with prominent apical wings, deeply emarginate; style distinct, with stigma completely within or just level with the top of the sinus. *Seeds* wingless, reddish brown, 2–3 mm long, c. 1.5 mm broad.

Distr. Probably native in Ethiopia and neighbouring countries to the west and north, and in the Near East; spread by cultivation or inadvertently to many parts of the world; in *Malesia* introduced: Java, Flores, probably elsewhere.

Ecol. Occurs as an occasional escape from cultivation; uncertain whether naturalized anywhere in the area.

2. *Lepidium virginicum* LINNÉ, Sp. Pl. (1753) 645; MERR. En. Philip. 2 (1923) 207; BACKER & BAKH.f. Fl. Java 1 (1963) 187.

Annual or short-lived perennial herb with taproot, 20–80 cm high with one to few erect-ascending stems, branching above, puberulent with thin falcate hairs. *Leaves* membranous, lowest ones lyrate-pinnatifid, up to 7 cm long, median and upper ones mostly oblanceolate, acutely serrate. *Racemes* terminal with minute flowers, rather dense in fruit, up to 15 cm long; pedicels in fruit 3.5–5.5 mm long, patent, straight, glabrous. *Sepals* greenish, c. 1 mm long. *Petals* white, longer or shorter than sepals, very narrow. *Stamens* 2 (median) with triangular nectaries. *Ovary* elliptic, emarginate, style not projecting. *Siliculae* wingless, suborbicular, 3–3.5 by 2.7–3.5 mm, rather widely and deeply emarginate; style short with stigma completely contained within sinus. *Seeds* narrowly winged, red-brown, c. 1.5 by 0.9 mm.

Distr. Native of North America; widespread as a weed; in *Malesia* known from E. Java (Mt Tengger) and the Philippines (Luzon).

Ecol. In Java naturalized in young forest at c. 1500 m. Elsewhere a weed in settled areas.

3. *Lepidium laeteviride* (P.ROYEN) HEWSON, Brunonia 5 (1982) 74. — *Papuzilla laeteviridis* P.ROYEN, Nova Guinea, Bot. 19 (1964) 430; Mt Fl. New Guinea 3 (1982) 2014, f. 615, pl. 154. — Fig. 2.

Perennial, mat- or cushion-forming, rhizomatous herb with persistent old leaf bases. *Stems* up to 3.5 cm long, sparingly branched, puberulent, and with a few leaf-opposed, up to 1 cm long spines. *Leaves* coriaceous, sessile; basal ones in a rosette, sparsely puberulent, bipinnatifid with up to 7 pairs of lobes, acute, without spines; cauline leaves obovate, entire or acutely serrate. *Racemes* axillary at the base of spines with 1–3 minute flowers, in fruit hardly elongating, up to 10 mm long; pedicels 2–3 mm long, patent, sparsely pubescent. *Sepals* green with hyaline margins, c. 1 mm long. *Petals* white, shorter than sepals, 0.6–0.8 mm long. *Stamens* 2 (median), with 4 linear nectaries, one on either side of each stamen. *Ovary* elliptic with inconspicuous style. *Siliculae* in outline broadly ovate to obovate, 3–3.5 by 2.5–3 mm, with very narrow wing in upper third, shallowly emarginate; style very short, stigma sessile or nearly so. *Seeds* wingless, dark brown, 1.5–2 by 0.8–1.3 mm.

Distr. *Malesia*: Papua New Guinea (Morobe District, Sarawaket Range, Mt Bangeta).

Ecol. On overgrown screes and among boulders at c. 4100 m.

4. *Lepidium minutiflorum* (RIDLEY) HEWSON, Brunonia 5 (1982) 74. — *Papuzilla minutiflora* RIDLEY, Trans. Linn. Soc. Lond. II, Bot. 9 (1916) 16, f. 7–14, pl. 1; MERR. & PERRY, J. Agr. Arb. 24 (1943) 207; P.ROYEN, Nova Guinea, Bot. 19 (1964) 428; Mt. Fl. New Guinea 3 (1982) 2014, f. 614.

Perennial, mat- or cushion-forming rhizomatous herb with persistent old leaf bases. *Stems* up to at least 12 cm, intricately branched, puberulent, with numerous leaf- or bract-opposed, up to 1.2 cm long spines. *Leaves* coriaceous, sessile, up to 25 mm long, glabrous to sparsely puberulent, impari- (or rarely bi-)pinnate with 2–4 pairs of lobes, or undivided, acutely serrate or entire. *Racemes* axillary at the base of spines with 1–3 minute flowers, in fruit little elongating, to 5 mm long; pedicels 2–4 mm long, straight, patent, puberulent. *Sepals* green with hyaline margins, 1–1.5 mm long. *Petals* white, shorter than or equalling sepals, linear. *Stamens* 2 (median)



Fig. 2. *Lepidium laeteviride* (P. ROYEN) HEWSON. *a.* Habit, $\times 4$; *b.* flower, $\times 12$; *c.* ditto, calyx removed; *d.* petals; *e.* ovary; *f.* ovary, lateral view; all $\times 16$; *g.* fruit; *h.* seeds; *i.* fruit valve; all $\times 4$ (P. ROYEN 20026).

with 4 shield-like nectaries, one on either side of each stamen. *Ovary* elliptic with very short style. *Siliculae* broadly to cordate in outline, 2.5–5 by 2–4 mm, with narrow wing in upper third, not or indistinctly narrowly and shallowly emarginate; style 0.5–1 mm long, stigma exserted from the sinus. *Seeds* wingless, dark brown, 1–2 by 0.5–1.3 mm.

Distr. Malesia: West New Guinea (Mts Carstensz & Wilhelmina), Papua New Guinea (W. Sepik District: Mt Capella).

Ecol. Screes, wet open places, tussock grassland, heaths; 3100–4350 m.

5. *Lepidium maccowagei* HEWSON, *Brunonia* 5 (1982) 75. — *Papuzilla minutiflora* auct. non RIDLEY: P. ROYEN, Mt. Fl. New Guinea 3 (1982) 2014, *p.p.*, as to Papua New Guinea specimens.

Subshrub with taproot, 20–35 cm high or more, woody, branched, puberulent, with numerous leaf-

opposed, up to 1.3 cm long spines. *Leaves* coriaceous, sessile, up to 14 by 5 mm, glabrous to puberulent, ovate to obovate, acutely serrate. *Raceme* reduced to a single flower at the base of a spine; pedicels 3–5 mm long, straight, patent, puberulent. *Sepals* green with hyaline margins, 0.7–1 mm long. *Petals* white, shorter than or equalling sepals, linear. *Stamens* 2 (median) with 4 linear nectaries, one on either side of each stamen. *Ovary* elliptic with very short style. *Siliculae* broadly elliptic to obovate, 3.5–6.5 by 2.5–3.8 mm, with narrow wing in upper third, narrowly and shallowly emarginate; style c. 0.3 mm long, just level with the top of the sinus or slightly exserted. *Seeds* wingless, red-brown, 2–2.5 by 1.1–1.5 mm.

Distr. Malesia: Papua New Guinea (Southern Highlands: Mt Giluwe, Kaguba).

Ecol. Screes, stream-edges, etc., at lower altitudes along roadsides; 2750–3500 m.

4. CAPSELLA

MEDICUS, *Pflanzengatt.* 1 (1792) 85; ENDL. *Gen. Pl.* (1839) 878; B. & H. *Gen. Pl.* 1 (1862) 86; BAILLON, *Hist. Pl.* 3 (1871) 287; SCHULZ in E. & P. *Nat. Pfl. Fam.* ed. 2, 17b (1936) 453.

Annual to short-lived perennials, small to medium-sized with taproot. Hairs simple, or forked, or branched. *Racemes* terminal, ebracteate, corymbose, with small flowers, in fruit loose. *Sepals* somewhat spreading, not saccate. *Petals* white, sometimes reddish or yellowish, \pm clawed, rarely absent. *Stamens* 6; filaments linear; anthers ovoid, obtuse. *Nectaries* as semicircular glands at each side of each lateral stamen. *Ovary* dorsiventrally flattened, obovate in outline, with 10–40 ovules in each locule. *Fruit* a silicula, dehiscent, flat, with narrow septum, obtriangular to obcordate, valves keeled. *Seeds* numerous, not mucilaginous.

Distr. About 5 spp., mainly European; doubtfully congeneric species in other parts of the world; in *Malesia* introduced.

1. *Capsella bursa-pastoris* (L.) MEDICUS, Pflanzengatt. 1 (1792) 85; BACKER, Schoolfl. Java (1911) 58; KOORD. Exk. Fl. Java 2 (1912) 291; MERR. En. Philip. 2 (1923) 208; BACKER & BAKH. f. Fl. Java 1 (1963) 192; EVERAARTS, Weeds Veget. Java (1981) 51, f. 38.

Annual to short-lived perennial herb, 5–50 cm high. *Stems* 1–few, erect or ascending, simple or sparsely branched. Rosette *leaves* numerous, petiolate, imparipinnatifid to coarsely dentate, oblanceolate in outline, 3–15 cm long; cauline leaves rather few, smaller, oblong to lanceolate, undivided (lower leaves sometimes lyrate-pinnatifid), sagittate and clasping, coarsely to finely distantly dentate or entire. Stem and leaves with simple and branched hairs. *Racemes* dense, with numerous small flowers, in fruit elongate, loose, sparsely hairy or glabrous;

pedicels spreading to divaricate, 5–20 mm long. *Sepals* green, mostly pubescent, oblong (sometimes with a tinge of purple), c. 1.5 mm long. *Petals* white, clawed, distinctly exceeding sepals, 1.8–3 mm long. *Silicula* obtriangular, with straight or slightly concave margins, \pm emarginate, 5–10 mm long, 2.5–8 mm broad; style c. 0.3 mm long. *Seeds* reddish brown, oblong, 0.8–1 by c. 0.4 mm, minutely verrucose.

Distr. Almost cosmopolitan as a weed, probably native in Europe, introduced in *Malesia*, recorded from highlands of E. Java, Philippines (Luzon) and E. New Guinea; probably more widespread.

Ecol. Weed of cultivated soil in mountain areas; 2000–2500 m.

Vern. *Shepherd's purse* (E).

5. CARDAMINE

LINNÉ, Sp. Pl. (1753) 654; Gen. Pl. ed. 5 (1754) 295; ENDL. Gen. Pl. (1839) 865; B. & H. Gen. Pl. 1 (1862) 70; PRANTL in E. & P. Nat. Pfl. Fam. III, 2 (1891) 184; BAILLON, Hist. Pl. 3 (1871) 234; SCHULZ, Bot. Jahrb. 32 (1903) 280; in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 527. — *Pteroneurum* DC. Syst. Nat. 2 (1821) 269. — Fig. 3.

Annual, biennial or perennial, small to large herbs, with a taproot and often with creeping or tuberous rhizomes. Hairs often present, simple. *Stems* erect, ascending, sometimes basally rooting. *Racemes* mostly terminal, ebracteate, densely to laxly corymbose, with a few to numerous small to medium-sized flowers, in fruit at least basally elongate and lax. *Sepals* not saccate, not spreading; margins hyaline. *Petals* white, cream, violet or purple, spatulate to clawed, sometimes lacking. *Stamens* 6–4, rarely fewer; filaments linear to subulate. *Nectaries* horseshoe-shaped or a close ring-shaped tissue around the lateral stamen and usually as a conical gland outside each median pair of stamens. *Ovary* cylindrical, usually with a short narrower style; stigma flat; ovules

4–40. *Fruit* a siliqua, dehiscent, linear, straight, tapered towards the narrow style; stigma flat; fruit disrupting explosively by the valves coiling from the base upwards; replum swollen; valves without prominent nerves. *Seeds* uniseriate, flattened, usually broadly elliptic to oblong, minutely rugose to colliculate, not mucilaginous.

Distr. In subarctic, temperate, and montane tropical areas all over the world; *c.* 130 *spp.*, of which 6 *spp.* in *Malesia*.

Ecol. Most species grow in moist places, many in or along running water, in marshes, *etc.* Quite a few form undergrowth in rather dense forests. Very few species are widely spread as weeds, though many are locally favoured by human interactions (clearings, ditches, *etc.*).

Note. Specific delimitation is notoriously difficult in this genus through frequent hybridization and occurrence of polyploids.

KEY TO THE SPECIES

1. Leaves tripartite or undivided.
 2. Leaves undivided or terminal leaflet at least 6 times as long as the lateral ones 1. *C. papuana*
 2. Leaves tripartite, terminal leaflet not more than 3 times as long as the lateral ones 2. *C. africana*
1. Most leaves with two or more pairs of lateral leaflets.
 3. Leaflets oblanceolate in outline. Plants usually very slender with internodes much longer than leaves 3. *C. altigena*
 3. Leaflets ovate to orbicular in outline. Plants not very slender, with most internodes equalling or shorter than leaves.
 4. Petals at least 6 mm long 4. *C. keysseri*
 4. Petals not exceeding 4 mm.
 5. Pedicels of siliquae patent at an angle with stem exceeding 45° (usually *c.* 60°). Seeds at least 1.1 mm long 5. *C. flexuosa*
 5. Pedicels of siliquae erect to erecto-patent (angle with stem *c.* 45° or less). Seeds shorter than 1.1 mm 6. *C. hirsuta*

1. *Cardamine papuana* (LAUT.) O.E.SCHULZ, Bot. Jahrb. 55 (1918) 271, f. 1E; MERR. & PERRY, J. Arn. Arb. 24 (1943) 207; P.ROYEN, Mt. Fl. New Guinea 3 (1982) 2021. — *C. africana* L. *ssp. borbonica* (PERS.) O.E.SCHULZ *var. papuana* LAUT. in K.Sch. & Laut. Fl. Deut. Schutzgeb. Südsee, Nachtr. (1905) 271; PULLE, Nova Guinea 8 (1911) 641. — Fig. 3.

Perennial, rhizomatous, glabrous (rarely pubescent) herb with 15–50 cm high, erect or ascending shoots, appearing solitarily or with 2 or 3 together. *Stems* unbranched or with a few rather long branches in the upper part. *Leaves* tripartite or unifoliate (side-lobes reduced); basal leaves (often not present) up to 12 cm long with 9 cm long petioles; cauline leaves rather few, up to 8 cm long, without or with only slightly auriculate, 2–8 cm long petioles; terminal leaflet ovatotriangular, acute to acuminate, at base cuneate or rounded (rarely truncate), distantly serrate-dentate, 3–12 by 1–4 cm on 5–20 mm long petiolules (in partite leaves); lateral leaflets ovate, acute, sparsely serrate or dentate, 0.5–3 by 0.2–2 cm on 1–4 mm long petiolules. *Racemes* terminal (but often surpassed by upper leaves) with 5–15 flowers on 0.5–5 cm long peduncles, in fruit condensed or

loose, 1–6 cm long; pedicels straight, erecto-patent, 5–12 mm long. *Sepals* green with hyaline margins, oblong, 2.5–4 mm long. *Petals* white, broadly spathulate, usually notched, 2 or 3 times longer than sepals, 8–12 mm long, ± half as broad. *Stamens* 6, with linear filaments; anthers *c.* 0.8 mm long. *Ovary* cylindrical with indistinctly demarcated style and somewhat expanded stigma. *Siliqua* straight, linear, 20–40 by 1.5–2 mm; style 0.5–1.7 by 0.3–0.5 mm. *Seeds* dark to light brown, oblong in outline, 1.7–2 by 1–1.3 mm, smooth.

Distr. Malesia: New Guinea (throughout), rather widely distributed.

Ecol. Wet cliffs, rocky banks of streams in forests; 500–3100 m.

2. *Cardamine africana* LINNÉ, Sp. Pl. (1753) 655; SCHULZ, Bot. Jahrb. 32 (1903) 414; KOORD. Exk. Fl. Java 2 (1912) 290; BOLDINGH, Zakfl. Landb. Java (1916) 67; KOORD. Fl. Tjibodas 3 (1923) 80; RIDLEY, J. Mal. Br. R. As. Soc. n. 87 (1926) 52; HENTY & PRITCHARD, Weeds New Guinea, Div. Bot. Lae, Bot. Bull. 7 (1973) 96. — *C. borbonica* PERS. Syn. Pl. 2 (1807) 195. — *Pteroneurum javanicum* BLUME,



Fig. 3. *Cardamine papuana* (LAUT.) O.E.SCHULZ. a. Habit, $\times 0.6$; b. siliqua, $\times 2$; c. seed, scale bar 1 mm (SCHODDE 5540). Del. K.G. FORSS.

Bijdr. (1825) 51; ZOLL. & MOR. Syst. Verz. (1845/46) 35; MIQ. Fl. Ind. Bat. 1, 2 (1858) 93. — *C. javanica* (BLUME) MIQ. Ill. Arch. Ind. (1871) pl. X; BOERL. Handl. Fl. Ned. Ind. 1, 1 (1890) 58; BACKER, Schoolfl. Java (1911) 56. — *C. africana* L. ssp. *borbonica* (PERS.) SCHULZ, Bot. Jahrb. 32 (1903) 414; DOCTERS VAN LEEUWEN, Verh. Kon. Akad. Wet. Amsterdam,

sect. II, 31 (1933) 167; BACKER & BAKH.f. Fl. Java 1 (1963) 191; STEEN. Mt. Fl. Java (1972) pl. 13/6; P.ROYEN, Mt. Fl. New Guinea 3 (1982) 2021; STREIMANN, Canberra Nat. Bot. Gard. (1983) 100 ('var. *borbonica*').

Perennial rhizomatous herb with 10–80 cm high, erect or ascending shoots appearing solitary or clus-

tered. *Stems* often basally rooting, unbranched or with a few branches, most from the lower parts, glabrous or basally puberulent. *Leaves* tripartite (rarely with one additional small pair of leaflets), glabrous or hispidulous above; basal leaves up to 15 cm long with up to 8 cm long petioles, soon disappearing; cauline leaves few to numerous, 5–20 cm long, in lower leaves with proportionally very long (up to 12 cm), slightly auriculate petioles; terminal leaflet broadly to narrowly ovate or subtriangular, acute to acuminate (but the tip often obtuse with a short point), at base truncate or rounded (in upper leaves also cuneate), often oblique, crenate, serrate or incised (especially plants from New Guinea), 1.5–7.5 by 0.8–4 cm on 2–20 mm long petiolules; lateral leaflets of similar shape as the terminal, slightly to considerably smaller, 0.5–6.5 by 0.2–3 cm on 0.5–10 mm long petioles. *Racemes* terminal with 5–20 flowers on 1–25 cm long peduncles, in fruit condensed or loose, 2–25 cm long; pedicels straight, erecto-patent, 4–30 mm long. *Sepals* green with hyaline margins, elliptic, 1.4–4.5 mm. *Petals* white to pale violet, spatulate, broadly obtuse, at least twice as long as sepals, 3–12 mm long, $\pm 1/3$ as broad. *Stamens* 6 with subulate filaments; anthers 1–1.5 mm long. *Ovary* cylindrical with short narrower style and somewhat expanded stigma. *Siliqua* straight, linear, 20–55 by 1.3–2.5 mm, tapered towards style, which is 0.6–2.5 by c. 0.4 mm. *Seeds* red or dark brown, broadly elliptic or oblong in outline, 1.5–2.5 by 1–1.5 mm, smooth.

Distr. Ubiquitous in tropical montane areas. In Africa from Ethiopia south to South Africa (Cape Province) and westwards to Mt Cameroun; also in Fernando Póo, São Tomé, Comores, Madagascar and Réunion. In America in many Caribbean islands, Central America and NW. South America; in Asia in India and Sri Lanka; in *Malesia*: Sumatra (northern parts: W., E. coast, Tapanuli, Atjeh), Java (W., E.), Lesser Sunda Islands (Bali, Lombok, Sumbawa), Ceram, Papua New Guinea.

Ecol. Undergrowth in montane forests, often also in clearings, along roads and paths. Usually in damp, shady places; 200–2400 m.

3. *Cardamine altigena* O.E.SCHULZ, Bot. Jahrb. 62 (1929) 479; MERR. & PERRY, J. Arn. Arb. 24 (1943) 207; HOOGLAND, Blumea Suppl. 4 (1958) 227; P.ROYEN, Mt. Fl. New Guinea 3 (1982) 2021, f. 616, pl. 154.

Perennial, slender herb with 20–50 cm long stems, ascending to largely prostrate and running with rooting nodes from which more stems may arise. *Stems* glabrous with few, slender branches. *Leaves* glabrous or sparsely ciliate, imparipinnate with 1–3 pairs of lateral leaflets (rarely leaflets lacking); basal leaves 2–7 cm long with 1.5–3 mm long petioles,

soon disappearing; cauline leaves distantly inserted, rather few, up to 6 cm long with non-auriculate, up to 2 cm long petioles; terminal leaflets trifid, orbicular or reniform, in upper leaves oblanceolate, obtuse, 0.5–1.5(–3) by 0.1–1.2(–2) cm, on 0–8 mm long petiolules; lateral leaflets trifid to oblanceolate, 0.2–0.7 by 0.1–0.5 cm, petiolules c. 1 mm. *Racemes* terminal, with 3–10 flowers, often very slender; pedicels straight, erect to erecto-patent, 8–15 mm long. *Sepals* green to reddish white with hyaline margins, oblong, 1.8–2.7 mm long. *Petals* white, spatulate, obtuse, 3.5–6 mm long, $\pm 1/3$ as broad. *Stamens* 6, tetradynamous, with subulate filaments; anthers 0.3–0.5 mm long. *Ovary* cylindrical with indistinct style and flat stigma. *Siliqua* straight linear, 13–35 by 1.3–1.8 mm; style 0.4–2 by c. 0.5 mm. *Seeds* red-brown, oblong in outline, 1.4–1.7 by c. 1.1 mm, smooth.

Distr. Malesia: New Guinea (throughout), widespread in high mountain areas.

Ecol. Preferably in or near running water; along streams, in wet grassy slopes; 1700–4000 m.

4. *Cardamine keysseri* O.E.SCHULZ, Bot. Jahrb. 62 (1929) 480; P.ROYEN, Mt. Fl. New Guinea 3 (1982) 2025, f. 617, pl. 156.

Annual to probably short-lived perennial herb with 10–40 cm high, ascending main stem, basally prostrate and rooting at nodes, from which one to several new stems may arise. *Stems* in lower parts mostly hispidulous without or with rather few, usually arcuate branches. *Leaves* glabrous or with a few scattered hairs, imparipinnate with 2–4 pairs of lateral leaflets; basal leaves 4–8 cm long with 1–4 cm long petioles, soon disappearing; cauline leaves often numerous, up to 9 cm but mostly much smaller with non-auriculate petioles; leaflets trifid, acute (often with a point), at base attenuate, cuneate (rarely truncate), 0.3–2.5 by 0.2–1.4 mm; terminal leaflet often larger and proportionately narrower than the lateral; petiolules 0–15 mm. *Racemes* terminal with 5–10 flowers on up to 4 cm long peduncles, in fruit up to 10 cm long; pedicels straight, erecto-patent, 4–10 mm long. *Sepals* green to reddish with hyaline margins, oblong, 2.5–3.5 by c. 1.2 mm. *Petals* white, spatulate, obtuse or emarginate, 2–3 times longer than sepals, 7–8 mm long, \pm half as broad. *Stamens* 6 of nearly equal length with subulate filaments; anthers c. 0.8 mm long. *Ovary* bottle-shaped, with short distinct style and slightly expanded stigma. *Siliquae* straight, linear, 20–38 by 1–2 mm; style 0.5–1.4 by c. 0.5 mm. *Seeds* red-brown, elliptic in outline, 1.4–1.8 by 1.2–1.4 mm, smooth.

Distr. Malesia: New Guinea (throughout), rather widespread.

Ecol. Sandy or gravelly streambanks, moist forest clearings, moist eroded soil, in gardens; 900–4000 m.

5. *Cardamine flexuosa* WITH. Arr. Brit. Pl. ed. 3, 3 (1796) 578; SCHULZ, Bot. Jahrb. 32 (1903) 473; KOORD. Exk. Fl. Java 2 (1912) 290; BOLDINGH, Zakfl. Landb. Java (1916) 67; RIDLEY, J. Fed. Mal. St. Mus. 8, 4 (1917) 15. — *Pteroneurum decurrens* BLUME, Bijdr. (1825) 51. — *C. decurrens* (BLUME) ZOLL. & MOR. Syst. Verz. (1845/46) 35; MIQ. Fl. Ind. Bat. 1, 2 (1858) 93; Ill. Arch. Ind. (1871) pl. X; BOERL. Handl. Fl. Ned. Ind. 1, 1 (1890) 58; BACKER, Voorl. Schoolfl. (1908) 11; Schoolfl. Java (1911) 56. — *C. regeliana* MIQ. Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 73; MERR. En. Philip. 2 (1923) 208; RIDLEY, J. Mal. Br. R. As. Soc. n. 87 (1926) 52.

Mostly perennial, diffusely branching herb; from the base usually many erect to ascending, curved or flexuous stems, in lower parts sometimes prostrate and rooting, 10–50 cm high with few to numerous scattered hairs. Basal leaves rarely persistent; cauline leaves nearly glabrous to sparsely pubescent, mostly numerous, imparipinnate with a terminal and 2 or 3 pairs of lateral leaflets, 2–10 cm long; petiole non-auriculate; leaflets narrowly to broadly ovate or orbicular in outline, obtuse, truncate to cuneate, usually crenate and often shallowly trifid; terminal leaflets 0.7–3.5 by 0.7–2 cm on distinct petiolules; lateral leaflets 0.4–1.5 by 0.3–1.5 cm on 1.5–7 mm long petiolules. Racemes terminal with 5–20 flowers, in fruit rather lax, up to 12 cm long; pedicels in fruit patent (angle to stem over 45°), 6–12 mm long with patent to erect siliquae, angled upwards at junction with the pedicel. Sepals green with narrow hyaline margins, oblong, obtuse, c. 1.5 mm long. Petals white, spathulate, 2.5–4 mm long. Stamens 6, distinctly tetradynamous; anthers 0.3–0.4 mm long. Ovary cylindrical with a rather short style, narrower than the ovary, and a flat stigma. Siliqua straight, linear, 18–30 by 0.8–1.2 mm; style 0.7–2 by c. 0.3 mm. Seeds reddish brown, often with a vestigial wing, broadly oblong in outline, 1.1–1.4 by 0.8–1.1 mm, nearly smooth.

Distr. Circumpolar in northern temperate region. Also in some montane areas further south. In *Malesia*: N. Sumatra (Atjeh), Java, Celebes (Menado), Philippines (Mindanao, Luzon), Moluccas (Buru, Ceram).

Ecol. Moist places in forests, among rocks and boulders, at streams, in clearings; 1000–2200 m.

6. *Cardamine hirsuta* LINNÉ, Sp. Pl. (1753) 655; BOERL. Handl. Fl. Ned. Ind. 1, 1 (1890) 58; KOORD. Nat. Tijd. Ned. Ind. 62 (1902) 234; SCHULZ, Bot. Jahrb. 32 (1903) 464; BACKER, Schoolfl. Java (1911) 56; KOORD. Exk. Fl. Java 2 (1912) 290; RIDLEY, Trans. Linn. Soc. Lond. II, Bot. 9 (1916) 17; KOORD.

Fl. Tjibodas 3 (1923) 80; HOCHR. Candollea 2 (1925) 371; BURK. & HEND. Gard. Bull. S. S. 3 (1925) 345; DOCTERS VAN LEEUWEN, Verh. Kon. Akad. Wet. Amsterdam, sect. II, 31 (1933) 168; BACKER & BAKH.f. Fl. Java 1 (1963) 191; STEEN. Mt. Fl. Java (1972) pl. 13/5; HENTY & PRITCHARD, Weeds New Guinea, Div. Bot. Lae, Bot. Bull. 7 (1973) 96, fig.; GILLI, Ann. Naturhist. Mus. Wien 83 (1980) 429; EVERAARTS, Weeds Veget. Java (1981) 53, f. 39. — *C. flexuosa auct. non WITH.*: STONE, Fed. Mus. J. 26 (1981) 80.

Usually annual, branching from the base but not or very sparsely above (occasionally perennial and then branched above and devoid of leaf-rossette). Stems erect or in tall specimens curving, 5–30 cm high, glabrous or with scattered hairs. Basal leaves forming a distinct rosette, cauline leaves rather few; all leaves imparipinnate, with a terminal and 2–6 pairs of lateral leaflets, 1.5–10 cm long (including petiole); petiole non-auriculate, with a few straight hairs at base; leaflets rhombic, ovate, orbicular or reniform, truncate to broadly cuneate (in upper parts also narrowly cuneate), entire to deeply crenate, occasionally with secondary lobes, glabrous or with scattered hairs; terminal leaflet 0.5–1.5 by 0.3–2 cm, distinctly petioled, the lateral ones oblique, 0.2–1 by 0.2–1.1 cm, nearly sessile or with a petiole up to the length of the leaflet. Racemes terminal, very dense, with several small whitish flowers, in fruit rather lax (up to c. 10 cm long); pedicels in fruit erect to suberect (angle to stem usually c. 45° or less), 3–8 mm long with erect siliquae overtopping the flowers. Sepals green with narrow white margins, oblong, obtuse, c. 1.5 mm long. Petals white, narrowly spathulate, usually 2–3 mm long (rarely absent). Stamens 4–6; anthers c. 0.4 mm long. Ovary cylindrical with a very short style narrower than the ovary, and a flat stigma. Siliqua glabrous, linear, 12–27 by c. 1 mm; style 0.5–1 by c. 0.4 mm. Seeds reddish brown with a vestigial wing, broadly oblong to suborbicular in outline, c. 1 by 0.8 mm, smooth.

Distr. Native at least in Europe, and probably in some tropical mountain areas (Ethiopia, E. Africa, Cameroun). Widespread as a weed in most parts of the world and probably naturalized in many areas; in *Malesia*: possibly native in some mountain areas, elsewhere a weed or naturalized; Malay Peninsula (incl. also Singapore), Sumatra (N. parts, Bencoolen), Java, Borneo (Sabah), Philippines (Luzon), New Guinea (throughout).

Ecol. Moist, open ground in montane forests, clearings, etc.; 850–3000 m. Weed in gardens, flowerbeds, also at low altitudes.

6. RORIPPA

SCOP. Fl. Carniol. (1760) 520; JONSELL, Symb. Bot. Upsal. 19² (1968); STUCKEY, Sida 4 (1972) 279. — *Nasturtium* R.BR. in Ait., Hort. Kew. ed. 2, 4 (1812) 109; ENDL. Gen. Pl. (1839) 863; B. & H. Gen. Pl. 1 (1862) 68; PRANTL in E. & P. Nat. Pfl. Fam. III, 2 (1891) 184; BAILLON, Hist. Pl. 3 (1871) 232; SCHULZ in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 551. — *Trochiscus* GILLI, Ann. Naturhist. Mus. Wien 83 (1980) 430. — Fig. 4.

Annual to perennial, small to rather tall herbs with a taproot, sometimes also with root-runners or adventive roots from the stem-nodes, practically glabrous to pubescent with simple, pointed hairs. *Stems* prostrate to erect, usually much branched. *Leaves* membranous, usually pinnatifid to pinnate, often auriculate. *Racemes* terminal, less often axillary, with or without bracts, nearly corymbose, with numerous, rather small to small flowers, in fruit cylindrical and loose. *Sepals* greenish, elliptic, not saccate, spreading. *Petals* yellow or white, equalling or up to \pm twice as long as the sepals. *Stamens* 6, distinctly tetradynamous, with usually linear filaments; anthers ovate to oblong, yellow, blunt. *Nectarial tissue* \pm surrounding the lateral filament bases, usually also extending outside the median ones but sometimes lacking there. *Ovary* spheroid to narrowly cylindrical, with numerous ovules. *Fruits* terete, very variable in shape (globose to narrowly linear), without or rarely with a very short gynophore, usually with a short but distinct style and flat to slightly bifid stigma, dehiscent by 2 valves with or without very fine midnerve. *Seeds* many to numerous, not mucilaginous, finely and variously sculptured, yellowish to dark brown, ellipsoid to spheroid, wingless, 0.5–1.5 mm diameter.

KEY TO THE SPECIES

- | | |
|---|-----------------------------------|
| 1. Racemes bracteate | 8. <i>R. benghalensis</i> |
| 1. Racemes ebracteate (rarely with a few bracts at the lowest pedicels). | |
| 2. Siliquae not more than 1.5 mm thick | 7. <i>R. heterophylla</i> |
| 2. Siliquae more than 1.5 mm thick. | |
| 3. Pedicels of fruits straight. | |
| 4. Seeds not over 0.8 mm long | 9. <i>R. micrantha</i> |
| 4. Seeds longer than 0.8 mm. | |
| 5. Cauline leaves numerous; seeds distinctly reticulate (c. 150 areoles per face)..... | 2. <i>R. backeri</i> |
| 5. Cauline leaves absent or few; seeds very finely reticulate (over 300 areoles per face) | 3. <i>R. peekelii</i> |
| 3. Most pedicels of fruits curved. | |
| 6. Petals white. Seeds coarsely reticulate | 1. <i>R. nasturtium-aquaticum</i> |
| 6. Petals yellow. Seeds with very fine surface patterns. | |
| 7. Ripe siliquae inflated, semiglobose | 6. <i>R. schlechteri</i> |
| 7. Ripe siliquae \pm ellipsoid to sausage-shaped, not inflated. | |
| 8. Seeds with warty processes. Very tall and stout plants | 5. <i>R. hybosperma</i> |
| 8. Seeds without processes. Moderately high plants | 4. <i>R. palustris</i> |

1. *Rorippa nasturtium-aquaticum* (L.) HAYEK, Sched. Fl. Stir. Exs. 3-4 (1905) 22. — *Sisymbrium nasturtium-aquaticum* LINNÉ, Sp. Pl. (1753) 657. — *Nasturtium officinale* R.BR. in Ait., Hort. Kew. ed.

2, 4 (1812) 110; MIQ. Fl. Ind. Bat. 1, 2 (1858) 73; BOERL. Handl. Fl. Ned. Ind. 1, 1 (1890) 58; KOORD. Meded. Lands Plantentuin 19 (1898) 342; BACKER, Schoofl. Java (1911) 55; KOORD. Exk. Fl. Java 2



Fig. 4. Harvest of *Rorippa nasturtium-aquaticum* (L.) HAYEK (Photogr. W.F. WINCKEL, 1918).

(1912) 288; MERR. En. Philip. 2 (1923) 208; HEYNE, Nutt. Pl. Ned. Ind. (1927) 680; OCHSE & BAKH. Ind. Groenten (1931) 176, f. 108; BURK. Dict. (1935) 1534; QUIS. Medic. Pl. Philip. (1951) 335; BACKER & BAKH. f. Fl. Java 1 (1963) 191; GILLI, Ann. Naturhist. Mus. Wien 83 (1980) 430; LENCH & OSBORNE, Fresh-water Pl. Papua New Guinea (1985) 105. — *Rorippa officinalis* (R.Br.) P.ROYEN, Mt. Fl. New Guinea 3 (1982) 2029. — Fig. 4.

Perennial, practically glabrous herb. *Stems* juicy and hollow, prostrate to ascending, usually rooting at the lower nodes, richly branched, 10–100 cm long. *Leaves* petiolate, auriculate, pinnatisect, oblong in outline, up to 10 cm long; lateral leaflets in 2–9 pairs, sessile, narrowly obovate, elliptic or nearly orbicular, entire to faintly dentate; terminal leaflet of similar shape, often somewhat larger. *Racemes* mostly terminal, ebracteate with numerous small white flowers, in fruit rather loose but short, usually c. 10 cm long; pedicels spreading to somewhat reflexed, 8–12 mm long. *Sepals* green, elliptic, c. 2 mm long. *Petals* white, often with a violet tinge, obovate, c. 4 mm long. *Anthers* c. 0.7 mm long. *Ovary* narrowly ellipsoid, with short but distinct style. *Silique* broadly linear, often curved and torulose, 10–18 by

2–2.5 mm, 7–12 times as long as broad, with seeds arranged in two distinct rows; style 0.8–1.8 by c. 0.5 mm, with a slightly expanded stigma; valves rather thin, bulging when seeds are ripe. *Seeds* shining, dark red-brown, nearly orbicular in outline, 1–1.3 mm long, covered by a distinct rather high reticulum, which forms 25–50 areoles at each side of the seed.

Distr. Native in Europe and West Asia, perhaps also in Ethiopia; widely cultivated ('watercress') and spread with European settlements to temperate and montane areas throughout the world; in *Malesia*: Java (especially West, rarer in Central and East), Lesser Sunda Islands (Flores), Borneo (Sabah), Philippines (Luzon), Papua New Guinea. Probably naturalized in many more areas than so far recorded.

Ecol. Along streams, ditches and all sorts of running water, on shores or floating in shallow water; c. 350–2500 m. Forms often large mats which very rarely produce flowers.

2. *Rorippa backeri* (O.E.SCHULZ) JONSELL, Bot. Notis. 132 (1979) 536. — *Nasturtium backeri* O.E.SCHULZ, Notizbl. Bot. Gart. Berlin 9 (1925) 84; BACKER & BAKH. f. Fl. Java 1 (1963) 191; STEEN. Mt. Fl. Java (1972) pl. 12/7.

Annual or short-lived perennial herb with taproot, glabrous, 30–150 cm high. *Stems* erect, usually solitary, unbranched or with few erecto-patent branches. Basal and lower cauline *leaves* originally numerous (in older specimens lacking), 40–150 by 10–30 mm, petiolate, lyrato-pinnate with 1–4 pairs of oblong 5–12 by 2–10 mm lateral lobes; terminal lobe elliptic to ovate, 20–35 by 9–30 mm; cauline leaves numerous, 3–10 by 0.7–2 cm, lyrato-pinnatifid with long petioles, auriculate, with usually one pair of side-lobes; terminal lobe 1.5–5 by 0.7–2 cm; margins serrate to distantly crenate. *Racemes* ebracteate, terminal, sometimes numerous from upper branches, in flower much condensed with 30–70 flowers, in fruit up to 80 cm long; pedicels divaricate at $\pm 90^\circ$, straight, stout, 5–8 mm long. *Sepals* oblong, 2.5–4 mm long. *Petals* white, broadly spatulate, 3.5–7 mm long. *Stamens* 6; anthers 0.6–0.8 mm long. *Ovary* narrowly cylindrical with c. 0.5 mm long style. *Siliquae* linear, straight or fairly curved, 30–50 by 1.7–2.2 mm; valves rather firm; style 0.8–1.2 by c. 0.4 mm; stigma flat, slightly broader than style. *Seeds* dark brown, broadly oblong to subspheroid in outline, 1.2–1.4 by 0.9–1.1 mm, regularly reticulate-foveolate.

Distr. Malesia: Java (eastern part: Mts Merbabu, Willis, Jang & Idjen: Suket).

Ecol. In burnt forests, thickets, locally common; 1600–3000 m. *Fl. fr.* throughout the year.

3. *Rorippa peekelii* (O.E.SCHULZ) P.ROYEN, Mt. FI. New Guinea 3 (1982) 2032. — *Nasturtium peekelii* O.E.SCHULZ, Bot. Jahrb. 55 (1918) 270, f. 1D; VON MALM in Fedde, Rep. 41 (1937) 295; SCHULZ in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 555, f. 337D; VELDKAMP, Blumea 28 (1982) 166. — *Nasturtium novo-guineense* GILLI, Ann. Naturhist. Mus. Wien 83 (1980) 429. — **Fig. 5.**

Annual to shortlived perennial herb with taproot, glabrous, 20–60 cm high. *Stems* one to few, \pm straight, spreading, sometimes prostrate-ascending, usually with few erecto-patent branches from the lower parts. Basal *leaves* mostly numerous, in a \pm dense rosette, 4–13 by 1–5 cm, petiolate, lyrato-pinnate with 1–3 pairs of oblong, lateral lobes, 0.4–2.5 by 0.2–1.5 cm; terminal lobe elliptic-ovate, 1.5–5 by 1–3 cm; margins sinuate to irregularly serrate; cauline leaves similar but smaller, the uppermost without side-lobes, petiolate, without or with rather small auricles, sometimes in axillary rosettes; margins crenate to acutely serrate. *Racemes* ebracteate, terminal, in flower very condensed with 20–50 flowers, in fruit very prolonged, up to 30 cm long; pedicels divaricate at $60\text{--}90^\circ$, straight, rather thin, 4–13 mm long. *Sepals* elliptic-oblong, 2–3.7 mm long. *Petals* white, broadly spatulate, 3–4 mm long. *Stamens* 6; anthers c. 0.7 mm long. *Ovary* nar-

rowly cylindrical with c. 0.3 mm long style. *Siliquae* linear, straight, 23–30 by 1.4–2 mm; valves rather firm; style 0.7–2.5 by 0.4–0.5 mm; stigma \pm flat, slightly broader than style. *Seeds* red-brown, subglobose to oblong, very finely reticulate-foveolate, 1.1–1.3 by 0.9–1.1 mm.

Distr. Malesia: E. Timor (Mts Mutis & Tatamailau), Papua New Guinea (W., E. & S. Highlands), Bismarck Archipelago (New Ireland).

Ecol. Along streams on rocks and beaches, a weed in gardens and along damp tracks. In New Guinea 1350–3500 m altitude, in Timor 1600–2850 m.

4. *Rorippa palustris* (L.) BESS. Enum. Pl. Volhyniae (1822) 27; JONSELL, Symb. Bot. Upsal. 19² (1968) 157. — *Sisymbrium amphibium* L. var. *palustre* LINNÉ, Sp. Pl. (1753) 657. — *Nasturtium palustre* (L.) DC. Syst. Nat. 2 (1821) 121; BLUME, Bijdr. (1825) 50; MIQ. Fl. Ind. Bat. 1, 2 (1858) 93; BACKER, Schooffl. Java (1911) 55. — *Rorippa islandica* (OED.) BORB. Bal. Fl. (1900) 392; BACKER & BAKH.f. Fl. Java 1 (1963) 190. — *Nasturtium homalospermum* O.E.SCHULZ, Bot. Jahrb. 55 (1918) 270, f. 1C, incl. var. *macrocarpum*; in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 551, f. 337C. — *Nasturtium indicum auct. non DC.*: K.SCH. & LAUT. Fl. Deut. Schutzgeb. Südsee (1901) 334, p.p.

Annual or shortlived perennial herb with taproot, glabrous, 10–110 cm high. *Stems* erect, solitary or a few together, unbranched or branched in upper parts. Basal *leaves* lyrato-pinnatisect, usually evanescent; cauline leaves few to numerous, 2.5–12 by 0.7–3 cm, lyrato-pinnatisect with 2–6 pairs of lanceolate lateral lobes, shortly to indistinctly petiolate, auriculate; terminal lobe 1/3 to 1/2 of total leaf length; margin irregularly serrate-crenate. *Racemes* ebracteate, terminal, often branched, and from upper leaf axils, in flower much condensed with numerous flowers, in fruit up to 50 cm long and rather dense; pedicels somewhat curved, patent to deflexed, 3.5–7 mm long. *Sepals* oblong, 1.6–2.4 mm long. *Petals* pale yellow, spatulate, 1.6–2.6 mm long. *Anthers* 0.3–0.6 mm long. *Ovary* cylindrical with distinct style and not or slightly expanded stigma. *Siliquae* sausage-like, often curved, 5–12 by 1.7–3 mm; valves rather firm; style 0.4–1 by c. 0.3 mm with not or slightly broader stigma. *Seeds* brown to light brown, spheroid, 0.6–0.9 mm, finely colliculate.

Distr. Over the whole north temperate area; widespread in many montane regions in subtropics and tropics; introduced to south temperate areas and elsewhere. In *Malesia:* Java (W., E.), Lesser Sunda Is. (Alor), Moluccas (Tanimbar), New Guinea (West: Vogelkop; East: Sepik, S. Highlands).

Ecol. Moist or marshy places, ditches and other



Fig. 5. *Rorippa peekelii* (O.E.SCHULZ) P.ROYEN. *a.* Habit, $\times 0.7$; *b.* fruiting raceme, $\times 0.7$; *c.* siliqua, $\times 2$; *d.* seed, scale bar 1 mm (*a* BRASS 30519, *b* SAYERS NGF 21316, *c, d* WOMERSLEY NGF 14272). Del. K.G. FORSS.

kinds of disturbed moist ground; from near sea-level to c. 2100 m.

5. *Rorippa hybosperma* (O.E.SCHULZ) JONSELL, *comb. nov.* — *Nasturtium hybospermum* O.E. SCHULZ, Bot. Jahrb. 55 (1918) 268, f. 1B; in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 551, f. 337b. — *Nasturtium indicum auct. non DC.*: K.SCH. & HOLLR. Fl. Kaiser Wilh. Land (1889) 49; WARB. Bot. Jahrb. 13 (1891) 317; K.SCH. & LAUT. Fl. Deut. Schutzgeb. Südsee (1901) 334, p.p.

Annual herb with taproot, glabrous, 50–150 cm high. *Stem* solitary, erect or in basal part ascending, shining, mostly rather stout, with many long erecto-patent branches. *Leaves* petiolate, auriculate, 3–17 by 1–8 cm, lyrato-pinnate with 1–3 pairs of oblong-elliptic lateral lobes, 0.8–4 by 0.3–1.5 cm; terminal lobe elliptic-ovate, 1.5–7 by 0.8–2.5 cm; margins crenulate-serrulate. *Racemes* terminal on stem and side-branches, ebracteate or with a few bracts in the lowest part, in flowers very condensed, in fruit rather loose, sometimes branched, up to 25 cm long; pedicels patent, the lower somewhat curved, 5–10 mm long. *Sepals* elliptic, 1.5–1.8 mm long. *Petals* yellow, spatulate, 2–2.5 mm long. *Stamens* 6; anthers c. 0.5 mm long; filaments narrowly subulate. *Ovary* cylindrical with a c. 0.3 mm long style. *Siliquae* sausage-shaped, often curved, 12–17 by 1.5–2.7 mm; valves thin; style 0.9–1.5 by 0.2–0.3 mm, with a broader stigma. *Seeds* yellow brown, spheroid, finely colliculate and with prominent irregular warts around the margin, c. 1.2 mm long.

Distr. Malesia: Philippines (N. Mindanao: Dulawan), New Guinea (West; East: Nuru, Sepik, Lae).

Ecol. Along streams and rivers and in marshes in the lowland. Also a weed in moist places.

6. *Rorippa schlechteri* (O.E.SCHULZ) P.ROYEN, Mt. Fl. New Guinea 3 (1982) 2031. — *Nasturtium schlechteri* O.E.SCHULZ, Bot. Jahrb. 55 (1918) 266, f. 1A; in E. & P. Nat. Pfl. Fam. ed. 2, 17b (1936) 554, f. 337A; VELDKAMP, Blumea 28 (1982) 166. — *Trochiscus macrocarpus* GILLI, Ann. Naturhist. Mus. Wien 83 (1980) 430.

Annual to short-lived perennial with taproot, 15–50 cm high. *Stem* solitary, erect, unbranched or with rather few, comparatively long branches. *Leaves* indistinctly petiolate, auriculate, 1.5–15 by 0.9–3.5 cm, lyrato-pinnate with 1–3 pairs of oblong lateral lobes, 0.2–1.5 by 0.1–0.6 mm; terminal lobe elliptic-ovate, 0.8–4 by 0.3–2.5 mm; margins irregularly dentate. *Racemes* terminal and on side-branches, ebracteate, in flower very condensed, in fruit rather loose, up to 15 cm long; pedicels patent to reflexed, 3–10 mm long. *Sepals* oblong, 1.5–2 mm long. *Petals* yellow, spatulate, 1.7–2.5 mm

long. *Stamens* 6; anthers c. 0.5 mm long; filaments linear. *Ovary* ellipsoid with c. 0.2 mm long style. *Siliquae* inflated, semiglobose to broadly ellipsoid, 5–9 by 3–6 mm; valves thin; style 0.6–0.9 by c. 0.3 mm, with flat, slightly broader stigma. *Seeds* red-brown, spheroid, 0.8–1 mm, minutely foveolate.

Distr. Malesia: Papua New Guinea.

Ecol. Moist or marshy places, various kinds of disturbed moist ground; c. 200–2600 m.

Vern. Heleki, Okapa, *heyenka*, Tairora, *kemu kembili*, Kaugel.

7. *Rorippa heterophylla* (BLUME) WILLIAMS, Fl. Trinidad & Tobago 1 (1929) 24. — *Nasturtium heterophyllum* BLUME, Bijdr. (1825) 50; MIQ. Ill. Arch. Ind. (1871) pl. IX; BOERL. Handl. Fl. Ned. Ind. 1, 1 (1890) 58; BACKER, Fl. Batavia (1907) 47; Schoolfl. Java (1911) 55; KOORD. Exk. Fl. Java 2 (1912) 288; HEYNE, Nutt. Pl. Ned. Ind. (1927) 680; OCHSE & BAKH. Ind. Groenten (1931) 175, f. 107; BURK. Dict. (1935) 1534. — *Cardamine sublyrata* MIQ. Ann. Mus. Bot. Lugd.-Bat. 2 (1848) 178. — *Nasturtium indicum* (L.) DC. *var. javana* BLUME, Bijdr. (1825) 50; MIQ. Fl. Ind. Bat. 1, 2 (1858) 93. — *Nasturtium diffusum auct. non DC.*: MIQ. Fl. Ind. Bat. 1, 2 (1858) 93; BOERL. Handl. Fl. Ned. Ind. 1, 1 (1890) 58. — *Nasturtium indicum auct. non (L.) DC.*: BOERL. Handl. Fl. Ned. Ind. 1, 1 (1890) 58; BACKER, Fl. Batavia (1907) 47; Schoolfl. Java (1911) 55; MERR. Fl. Manila (1912) 213; KOORD. Exk. Fl. Java 2 (1912) 289; RIDLEY, Trans. Linn. Soc. Lond. II, Bot. 9 (1916) 16; MERR. Interpr. Rumph. Herb. Amb. (1917) 240; RIDLEY, Fl. Mal. Pen. 1 (1922) 119; MERR. En. Philip. 2 (1923) 208; KOORD. Fl. Tjibodas 3 (1923) 80; HOCHR. Candollea 2 (1925) 370; HEYNE, Nutt. Pl. Ned. Ind. (1927) 680; BURK. Dict. (1935) 1534; H.J.LAM, Blumea 5 (1945) 570; QUIS. Medic. Pl. Philip. (1951) 335; BACKER & BAKH. f. Fl. Java 1 (1963) 190. — *R. indica* (L.) HIERN *var. apetalata* (LOUR.) HOCHR. Candollea 2 (1925) 370. — *R. dubia* (PERS.) HARA, J. Jap. Bot. 30 (1955) 196; BACKER & BAKH. f. Fl. Java 1 (1963) 190.

Annual herb with taproot, nearly glabrous. *Stems* erect or ascending, one or more from the base, 5–50 cm high, not or little branched. *Leaves* in a rosette and along the stem, the lower 1.5–8 cm long with 8–60 mm long petioles, narrowly obovate in outline, undivided or lyrato-pinnatifid with 1–3 pairs of small lateral lobes; terminal lobe ovate, 1–7 by 0.8–4 cm, dentate, obtuse, basally cuneate or truncate; upper leaves rather few, undivided, narrowly ovate. *Racemes* terminal, and on short patent side-branches, ebracteate, with many small, very condensed flowers, in fruit usually rather dense, 2–10 cm long; pedicels spreading, straight, 2–8 mm long. *Sepals* green, elliptic, c. 2 mm long. *Petals* often reduced or lacking, sometimes up to 3.2 mm long, nar-

rowly spathulate. *Stamens* up to 3 mm long with c. 0.7 mm long anthers. *Ovary* narrowly cylindrical, with very short style and flat expanded stigma. *Siliqua* linear, straight, 14–25 by 0.7–1.3 mm; valves rather thin; style narrow, 0.5–1.3 by c. 0.3 mm; stigma broader than style. *Seeds* uniseriate, red-brown, roundedly quadrangular in outline, c. 0.7 mm long, very finely colliculate.

Distr. Indigenous in East Asia, at least from Japan to Burma; introduced in other tropical areas, also in Africa and America; in *Malesia*: Sumatra, Malay Peninsula, Java, Lesser Sunda Islands (Timor), Philippines (Luzon, Mindanao), Moluccas (Ambon, Buru, Ceram), Celebes, Papua New Guinea.

Ecol. Open, moist ground, often cultivated places; 250–1500 m.

8. *Rorippa benghalensis* (DC.) HARA, J. Jap. Bot. 49 (1974) 132. — *Nasturtium benghalense* DC. *Syst. Nat.* 2 (1821) 198; SCHULZ in Fedde, *Rep.* 33 (1934) 281.

Annual, pubescent herb, with taproot. *Stems* erect or ascending, up to 50 cm high, branched at least in upper parts. *Leaves* obovate in outline, auriculate, lyrate-pinnatifid, irregularly serrate-dentate, up to 15 by 3 cm, successively transgrading into smaller undivided bracts; terminal lobe ovate, 1.5–5 by 1–3 cm; lateral lobes in 1–4 pairs. *Racemes* terminal or axillary, at least in lower and middle parts bracteate, with numerous small light yellow flowers, in fruit rather dense, up to 7 cm long; pedicels spreading, straight, 3–7 mm long. *Sepals* green, elliptic, c. 1.5 mm long. *Petals* pale yellow, spathulate, 1–2 mm long, about as long as the sepals. *Anthers* c. 0.5 mm long. *Ovary* cylindrical with very short style and flat expanded stigma. *Siliqua* linear, straight, 6–17 by 1–1.5 mm; valves rather thin; style 0.3–0.8 by c. 0.4 mm; stigma flat, broader than style. *Seeds* biseriate,

dark brown, spheroid, c. 0.5 mm long, minutely foveolate.

Distr. India to Vietnam; in *Malesia*: Java, Lesser Sunda Islands (Sumbawa).

Ecol. Weed in settled areas, perhaps only incidental.

9. *Rorippa micrantha* (ROTH) JONSELL, Svensk Bot. Tidskr. 68 (1974) 384; Fl. Trop. E. Afr., Cruciferae (1982) 55, f. 19. — *Sisymbrium micranthum* ROTH, *Nov. Pl. Sp.* (1821) 324.

Annual herb with taproot. *Stems* erect or ascending, up to 70 cm high but usually much shorter, branched at least in upper parts, somewhat pubescent especially basally. Basal *leaves* lyrate-pinnatifid in an evanescent rosette; cauline leaves petiolate, auriculate, nearly amplexicaul, broadly oblong-elliptic in outline, imparipinnatisect to lyrate-pinnatifid; lateral lobes usually in 2–5 pairs, sessile, elliptic to lanceolate, serrate, up to 3 cm long. *Racemes* terminal and axillary, ebracteate, with numerous small yellowish flowers, in fruit rather loose, up to 20 cm long; pedicels spreading, straight, 2.5–5 mm long. *Sepals* light to yellowish green, elliptic, 1.5–2.5 mm long. *Petals* pale yellow, sometimes with a violet tinge, spathulate, 2–3 mm long, usually longer than the sepals. *Anthers* c. 0.7 mm long. *Ovary* ellipsoid to cylindrical, with very short style and flat expanded stigma. *Siliqua* linear, straight, 14–25 by 1.8–2.5 mm; valves rather firm; style 1–2.2 by 0.5–0.8 mm; stigma broader than style and slightly bifid. *Seeds* red-brown, finely orbicular to broadly elliptic in outline, 0.5–0.8 by 0.4–0.8 mm, finely reticulate-foveolate.

Distr. India, widespread in Africa from Egypt to Zaire and South Africa, also in Madagascar; in *Malesia*: collected a few times in E. Java (Pasuruan, Besuki, etc.).

Ecol. Weed in settled areas, perhaps only incidental.