AN ACCOUNT OF THE GENUS PORTULACA IN INDO-AUSTRALIA AND THE PACIFIC (PORTULACACEAE)

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SUMMARY

In the introduction a brief historical review is given of the more important earlier treatment of the genus.

In chapter 2, covering morphological observations, I have also inserted remarks on the systematic value of certain features. The axillary (and in sect. *Neossia*, nodal) hairs have often been interpreted as representing stipules. I have tried to advance arguments in order to show that their stipular homology is most unlikely.

It is confirmed that there is no essential difference between the morphological structure of the inflorescence and that of the vegetative portion of the plant.

There is no unanimity of opinion about the interpretation of the 2-whorled perianth; the outer series is often accepted to be of a bracteal nature. Von Poellnitz refers to the outer whorl as 'Involukralblätter', Legrand names them 'pseudosepalos'. However, the fact that in subg. *Portulaca*, with flowers in capituli, the whorls are inserted at the same height on the receptacle which is adnate to the basal part of the ovary, and the fact that below the receptacle there are generally two true bracts, make it almost certain that such assemblage is a contracted triad, with one developed flower and 2 'bracteoles'. This cymose nature is further sustained by the species of subg. *Portulacella* in which true cymes occur.

In chapter 3 it is argued that the present wide distribution of several species, e.g. *P. pilosa*, *P. quadrifida*, and *P. oleracea*, is mainly due to man, by his transport and cultivation. Such species behave often as ruderals and adventives beyond their original country. Of some of these the genuine native country is for these reasons even unknown or very uncertain, e.g. that of the diploid *P. oleracea*; its cultivated strain is hexaploid but this is also found as a ruderal and adventive. *P. pilosa s. l.* may be originally of Australian origin, judging from the geographical area of its nearest allies and the very large degree of variability it exhibits in Australia.

Self-pollination is obviously the rule in *Portulaca* as well as in *Talinum*, another genus of the same family; this may even be prevalent in the entire family. This implies, and explains, a profuse occurrence of more or less pure lines (local populations or races) in nature which keep constant in details (e.g. the sculpture of the testa). For this reason, not a few of these have been distinguished as (micro) species by former authors. Some of these characters are more conspicuous in the field than in the herbarium. For example, I have grown two of such lines of *Talinum paniculatum* which throughout their range differ (in living state) constantly in the following three minor characters: testa minutely tubercled or smooth, panicles narrowed or not, fruits red or yellowish. Such characters would seem to be determined merely by a few genes, and do not or hardly deserve systematical recognition as formal taxa. They are just on the border of herbarium taxonomy, and can only be solved, as to their genetical basis, by experimental taxonomic work.

Only when more and clearer characters occur combined in complexes I have accepted these in a formal taxonomic hierarchy, e.g. in *P. pilosa*. On the whole I have felt induced to be rather conservative in accepting good species, but many are reduced to synonymy or to infraspecific rank.

In chapter 4 the subdivision of the genus is discussed. It appeared that those of von Poellnitz (1934) and (to a lesser degree) Legrand (1953, 1958) are unsatisfactory. I have framed a new, more simplified, subdivision reflecting my ideas. Some taxa could not well be understood and have been referred to under the genus.

From the morphology and taxonomy it is concluded that the ancestral lineage of the genus is in Australia, which fits in with the general geographical configuration of the family which is predominantly a southern hemisphere group.

Chapter 5 contains some notes on typification, which has been effected as much as possible, mainly by lectotypification. Unfortunately, some types proved to be untraceable.

The area covered in this account ranges from India eastwards through Indo-Australia as far as the Central Pacific. I have refrained from citing specimens examined. A list of these will be published separately as an Identification List.

In the systematic treatment full synonymy, descriptions, and keys are given to taxa, both species and

infraspecific entities. Not all names could be placed, either by absence of types or lack of material. These are listed at the end; tentative suggestions are given to their proper identity.

The number of species distinguished in Portulaca has varied enormously. Linnaeus had only 2 species, *P. oleracea* and *P. pilosa*; Index Kewensis lists *c.* 600 names. In this century von Poellnitz has described in his papers precursory to his monograph described many dozens of new species. For a large part he withdrew these again and sunk them into synonymy in his monograph of 1934, in which he accepted in all 104 species. Subsequently *c.* 30 new species were added by various authors. Legrand (1962) in his revision of the American species reduced quite a number of von Poellnitz's species, still maintaining 62 species for the New World. He distinguished, however, a large number of varieties reflecting the variability of these species. More than 50 of his species belong to subsect. *Stellulato-tuberculatae*, mainly comprising the *P. pilosa* complex. In my opinion this complex consists of only one compound species, in which I have distinguished 8 subspecies for Indo-Australia. In America *P. pilosa* is obviously still more variable.

I estimate that the entire genus consists of not more than 15 good species, mainly in the Old World, viz. 4—5 in subg. *Portulacella*, 3(—5) in subg. *Portulaca* sect. *Neossia*, 2(—7) in sect. *Portulaca* subsect. *Portulaca*, and possibly only 2 in sect. *Portulaca* subsect. *Stellulato-tuberculatae*.

The two Linnean species, *P. pilosa* and *P. oleracea*, possess, in that sequence, the greatest variability.

The generic name *Meridiana* Schrank is reduced to *Trianthema* L.

1. INTRODUCTION

This revision was intended primarily as a precursor to the revision of the *Portulacaceae* for the Flora Malesiana. During the course of the work it appeared, however, that I had to spread my wings wider and wider because of synonymy and confusion by frequent misinterpretation of names. It involved also, for the frame of the infrageneric taxa, examining species of all subgenera and sections.

Linnaeus recognized in 1753 only 2 species of proper *Portulaca*, viz. *P. oleracea* and *P. pilosa;* their number had increased to 104 in von Poellnitz's monograph of 1934, and since that time some 30 more have been described. Engelmann (1850) and von Mueller (1859) gave the first subdivisions of the genus. Von Schlechtendal (1853) gave an excellent critical survey of the species then known; his advantage was that he had many species in cultivation.

In von Poellnitz's main work 'Versuch einer Monographie der Gattung Portulaca' (1934) many provisional names were legitimized and many provisional descriptions were extended; the compilation itself is composed of rather brief but uniform descriptions. This work was preceded by several smaller papers, and also later small supplementary papers were published by him. I find his work not very critical.

Legrand (1962) made a revision of the American species which proved helpful for some identifications. In two other papers (1953, 1958) he proposed new subdivisions of Portulaca; unfortunately he did not attend sufficiently to proper typification and nomenclature. I have made the typifications of his infrageneric taxa as well as I could, but must admit that my knowledge of these, mostly American, species was not as profound as it should have been for this purpose.

One of the difficulties in *Portulaca* is that herbarium material is often badly preserved if it has been dried too slowly. The best way is drying after having killed it in alcohol or boiling water. The corolla is often difficult to discern as it is marcescent.

To study the morphology properly I had at my disposal living material of *P. oleracea* and *P. pilosa* ssp. *pilosa*. Furthermore I cultivated two species of *Talinum*.

2. MORPHOLOGICAL AND SYSTEMATIC NOTES

1. Habit. — Perennial, mostly copiously branched, not rarely prostrate, frequently rooting at the nodes. Most species are succelent to various degree, either in leaves or stem or in both, but *P. wightiana* is distinctly xeromorphic (fig. 4).

Both the main root and its main branches are generally tuber-like swollen; this seems to be a general tendency, but can rather rarely be observed in the herbarium because collectors mostly neglect to collect the subterranean parts.

Except for the species of subg. *Portulacella*, which are glabrous (only *P. digyna* is entirely covered with papillae), all Portulacas possess white or pale hairs in the axils of the leaves extending sometimes on the node. Sometimes these hairs are inconspicuous (as in *P. oleracea*), but more frequently they are conspicuous; especially if the internodes are short, they may give the stem a hairy appearance.

2. Leaves. — The leaves are opposite in subg. *Portulacella* and in subg. *Portulaca sect. Neossia*, and spirally arranged in the rest of the genus, though occasionally subopposite leaves can be observed in *P. oleracea* and *P. lutea*. In *P. pilosa* the leaves are linear to lanceolate and mostly terete; in other species they are lanceolate to orbicular and flat. In *P. wightiana* the leaves are very small and hidden by the axillary scarious scales of the next-lower node; these scales are homologous with the axillary and nodal hairs in other species; the leaves are caducous.

The petiole is mostly short, occasionally proportionally longer in the involucral leaves of the capituli in subg. *Portulaca*.

Leaves generally remain growing until the branch they bear starts flowering; then they soon fall off.

3. Axillary hairs. — These structures, which are present in subg. *Portulaca* (and possibly also in *P. digyna*), and which are also recorded from other genera of *Portulacaceae*, are at variance called in literature: stipules, stipular hairs, or axillary hairs. I prefer to use the last term, as I reject attributing stipular nature to them.

Weberling (1955, p. 30) defined stipules as lateral appendages from the 'Unterblatt'. Weberling & Leenhouts (1966) found the following features common to stipules: (i) proleptic development, (ii) more or less degenerated or caducous in the mature leaf, (iii) a consistence different from other parts of the leaf, (iv) present in the first normal leaves of the seedling, (v) present in the wider relationship. With these characteristics the axillary hairs of *Portulaca* have only the third item in common.

Against their interpretation as stipules plead the following facts: (i) axillary origin (Chorinski, 1931), (ii) they appear only in the 5th to 9th leaf of the seedling and of the vegetative shoots, (iii) they are only fully developed when the corresponding leaf has fallen off, (iv) in sect. *Neossia* they surround the node, (v) they are absent in subg. *Portulacella* which is for good reasons considered to be the most primitive subdivision of the genus, (vi) stipules are poorly distributed, and besides of a rather doubtful interpretation, in the wider relationship (e.g. *Caryophyllaceae*, *Aizoaceae*, *Basellaceae*, and *Cactaceae*).

The axillary hairs are mostly confluent at the base. *P. wightiana* has axillary and nodal hyaline scales (fig. 4a, b, g, h). Exactly similar hairs occurring in capituli are considered axillary hairs of the bracts. In *P. pilosa* ssp. *okinawensis*, which doubtless belongs to *P. pilosa*, hairs are absent; I ascribe their absence to a secondary reduction.

Chorinski (1931), who studied the anatomy of these hairs in *Portulaca* and other plants, also arranged them under many-celled emergences of the axillary meristem, but refrained from suggesting homology with stipules.

4. Inflorescence. — In the interpretation of the inflorescence the contention of Troll (1964), viz. that there is no essential difference between the mode of ramification of the inflorescence and that of the vegetative part of the plant, proved to be a useful guide.

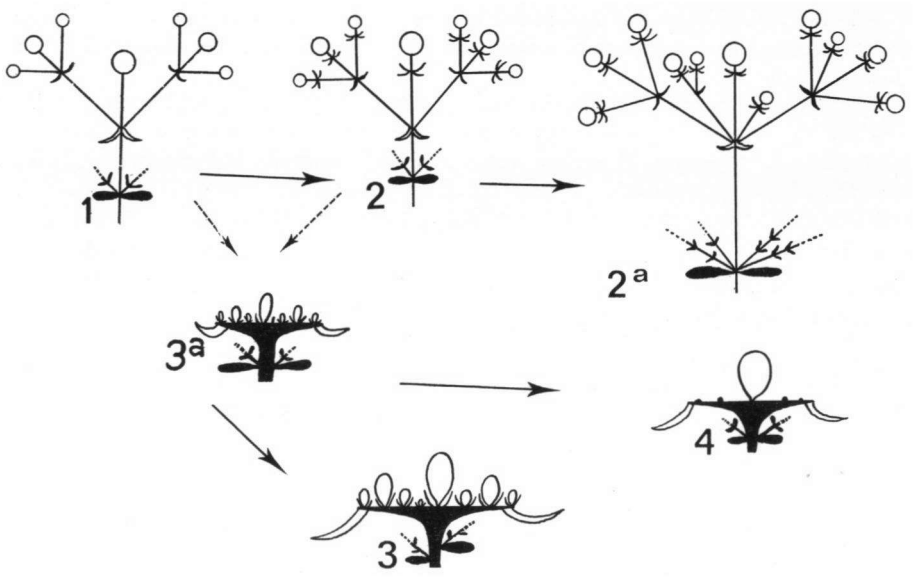

Fig. 1. *Portulaca*. Scheme of the inflorescences and their morphological interrelationship. 1 Hypothetical basic type of subg. *Portulacella*, 2 and 2a. cymes as in subg. *Portulacella* (2. as in *P. oligosperma* F. v. M., 2a. as in *P. cyclophylla* F. v. M., showing the repetition of serial branches of the vegetative part in the inflorescence), 3, 3a, and 4. capituli as in subg. *Portulaca* (3. as in sect. *Portulaca*, 3a and 4. as in sect. *Neossia;* 3a. as in *P. clavigera* Geesink, 4. reduced capitulum as in *P. quadrifida* L.).

This implies that the spiral-leaved condition in subg. *Portulaca* sect. *Portulaca* is a secondary feature.

Except for subg. *Portulacella*, where the flowers are arranged in cymes, there is a sharp demarcation in *Portulaca* between the vegetative and flowering parts of the plant.

It is worthwhile to point out some variations and deviations on this theme, keeping in mind that the inflorescence is basically of cymose nature, as closer studied for *P. pilosa* ssp. *grandiflora* by Soetiarto & Ball (1968).

In subg. *Portulacella* the inflorescences are considered to be derived from a dichasium or thyrse with opposite branches. Three species have 4 instead of 2 bracteoles under each flower (fig. 1: 2, 2a; fig. 2). *P. digyna* lacks bracteoles but possesses many caducous scales on the node of the inflorescence; these are probably homologous with the nodal hairs found in sect. *Neossia*. *P. cyclophylla* has additional serial branches in the leaf-axils and this feature is repeated (irregularly) in the inflorescence, corresponding with Troll's contention (fig. 1: 2a).

In subg. *Portulaca* the inflorescence is a terminal capitulum (fig. 1: 3, 3a; fig. 4, 5, 6), surrounded by 3—18 involucral leaves, some of which may bear an axillary axis. Von Poellnitz called these leaves 'falsche Involukralblätter'. The nerved scales between the flowers are considered bracts and bracteoles and they have, like the normal leaves, axillary hairs. The involucral leaves are spirally arranged, upwards 'condensed' into a whorl-like involucre; in most species there are no transitions between cauline and involucral leaves.

In sect. *Neossia* the minute white tubercles at the base of a tuft of hairs (or scales in *P. wightiana*) in the capitulum are supposed to represent the bracts and bracteoles (fig. 1: 4).

5. Flower. — Flowers are ephemeral and open only during a few hours of the day. By the marcescent corolla which remains sticky for a long time it is difficult to analyse flowers in the herbarium.

The merousness of the flowers is not fully constant for the species and is not correlated with the number of style-arms; e.g. *P. quadrifida* seems always 4-merous, *P. macrorhiza* 6-(occasionally 5-)merous, *P. oleracea* and *P. bicolor* 4—5-merous, *P. wightiana* 4(—5?)-merous, *P. pilosa* 4—6-merous.

6. Calyx. — Von Poellnitz (1934) considered the calyx in *Portulaca* to be absent and called the segments of the outer perianth whorl of each flower (inserted on the floral receptacle at about the same height as the petals and stamens) 'Involukralblätter', obviously homologizing them with the scale-like bracts at the base of the flower. Legrand (1953) called them 'pseudosepalos'. The position they have, their fixed number of 2 and their constant insertion, strictly different from that of the true bracts, do not promote these views and there seem to be no special morphological reasons not to refer to the outer whorl as a calyx. The calyx is mostly green, occasionally tinged purplish if the rest of the plant is also tinged.

In subsect. *Portulaca* the sepals have a dorsal keel.

In sect. *Neossia*, *P. clavigera* has a dorsal spur on at least one of the two sepals. In other taxa the sepals are usually boat-shaped without dorsal appendages.

7. Corolla. — The shape of the petals is elliptic to obovate, occasionally emarginate or mucronate. As said above well-preserved corollas for study are scant in all herbaria.

8. Pistil. — Initially the pistil consists of as many carpels as future style-arms. The carpels become early connate, the septa between them get lost, and the axillary placentation becomes central. In the pericarp a circumscissile suture is formed, along which articulation later the fruit bursts.

Legrand (1962) has used the ratio between the height of the operculum and the total height of the fruit as one of the characters in the distinction of species. I believe, however, that the variation in this ratio is too large to be very useful except in a few cases. The operculum is rarely flat, as in the American *P. plano-operculata* O. Ktze, on which O. Kuntze (1898) even based a distinct subgenus *Discoportulaca*. It seems to me that this shape is only an extreme of a series of variation leading via semi-globular to variously shaped conical opercula, depending on the species.

The surface of the operculum can be shiny or dull and this may be useful for distinction of specific or infraspecific taxa.

9. Seed. — The sculpture of the epidermal cells of the testa and the way they fit together (pl. 1 & 2) shows a great variation, the cells being flat or dome-shaped, elliptic to orbicular, smooth-walled or stellulate in outline, etc. It seems to me that each pure line is characterized by its own surface pattern. According to Kowal (1961) the outer wall of these cells, which is thickened, consists of radial crystalloids.

Fortunately seeds are mostly present in herbarium specimens. As their ultimate colour may differ with the taxon (red, brown, black) it is advisable to select the darkest seeds in a sample as the fully mature standard.

3. BIOSYSTEMATICAL NOTES

Ecology. — Ecologically, Portulacas are distinctly heliophilous herbs with a preference for bare places. Consequently, they are mainly found in savannahs, steppes, grasslands, and along shores, some of them being salt-tolerant. They do not shun heat, but are obviously not or hardly frost-resistant and consequently do not penetrate far into the mountains.

Dispersal. — These capacities make it possible for them to invade man-made country and to appear as ruderals and adventives, even as summer weed introductions in temperate countries. Also in the tropics they invade along newly made roads. Ridley (1930, p. 252, 253) stated thad seed of *Portulaca* remains viable after immersion in seawater; however, transport by seawater is not likely as the seeds do not float. This led Guppy (Ridley l.c.) to suggest that overseas dispersal in nature could only happen through immersion in or adherence to drift wood or pumice. No factual observations are available, however. Ridley suggested also dispersal by birds, but this is a mere suggestion only. He concluded that man is the main agent, with his traffic and transport of all kinds of goods, hay, cereals, seed, etc. In the Netherlands an adventive found with garbage of cereals was described as a new species, *P. advena;* I refer this to *P. pilosa* ssp. *papulosa* (Schlechtend. *ex* Poelln.) Geesink, native of S. America.

Pollination and biogenetics. — As far as known all *Portulacaceae* are self-pollinating plants. In nature, this results in locally very homogeneous populations, which even can occur mixed. An easy character to detect these local pure lines is provided by the sculpture of the seed. Many of such pure lines (local populations or races) have been described as species, because of their sharp delineation against each other. Taken together they show a sort of reticulate pattern. In general I have not formally recognized these local populations. Only if they are bound up in sets of more characters I have evaluated them as subspecies. They do not always replace each other, as subspecies should, but this is probably caused by later migration.

It is understandable that this segregation in nature through selfing has sometimes led to complex situations and this is especially the case in the largest group of *Portulaca*, subsect. *Stellulato-tuberculatae*. Of this group I have treated here 2 species, combining *c.* 60 described formerly, now partly relegated to infraspecific rank, but partly thought to be not worthy of distinction. This synthetic view may appear redundant to local workers, but such synthesis is the unavoidable outcome of monographic work on larger scale.

A similar situation is probably also present in *Portulaca* subsect. *Portulaca*. Of this I have studied only two species, *P. oleracea* and *P. lutea*, but in both I have sunk a fairly large number of so-called 'local-endemic' species, e.g. of the Hawaiian Islands.

It would be highly rewarding if a large-scale experimental taxonomic study could be made, with hybridisation experiments. Whether artificial crossings are successful is not known. Anyway I must warn those who want to undertake such a study in pointing out that already in bud self-pollination takes place.

A few phenotypic observations are worthy of record. Of course the sizes of internodes and leaves depend on temperature, exposition, humidity, and richness of soil. This effects even the number of stamens per flower; I have made some tentative tests with *P. pilosa* ssp. *pilosa* in which it appeared that under dry conditions and rather poor soil there were fewer stamens as compared with plants grown under humid conditions and in more fertile soil. The size of the corolla increased with more sunlight.

4. SYSTEMATIC SUBDIVISION OF THE GENUS

Engelmann (1850) and von Mueller (1859, 1877) raised some infrageneric subdivisions for American and Australian species respectively, but they did not treat the entire genus.

Von Poellnitz (1934) subdivided the genus as a whole for the first time. He distinguished:

Subg. Discoportulaca. — T.: *P. plano-operculata* O. Ktze.
Subg. Eu-Portulaca. — T.: *P. oleracea* L.
Sect. Carinatae. — T.: *P. oleracea* L. — This was further subdivided into 2 subsections.
Sect. Rotundatae. — T.: *P. pilosa* L. — This was further subdivided in 8 subsections.

My comment on this is that subg. *Discoportulaca* does not deserve such a high rank, as argued earlier in this paper (chapter 2 sub 8). Furthermore, I find that sect. *Rotundatae* is too heterogeneous.

Legrand's subdivision (1953, 1958) means in my opinion a distinct improvement. Unfortunately, his concepts suffer from some inconsistencies in typification and nomenclature. Furthermore, I have felt that it should be simplified and I have made also some emendations, e.g. by transferring subsect. *Squamosae* to sect. *Neossia*.

Under the subdivisions proposed in this paper I have cited all earlier names, except the sections of von Poellnitz and the numerous subsections and supraspecific taxa of lower rank of Legrand. Those of von Poellnitz I can only partly evaluate, but they seem also partly heterogeneous and partly too small to be of any use. The subsections etc. of Legrand are also partly too small, and sometimes artificial; for example *P. cyanosperma* Egler and *P. pilosa sens. str.* which belong distinctly to the same race, were placed by Legrand into two different sections. It did not seem worthwhile to disentangle all this matter.

Proposed new subdivision

Subg. PORTULACA.
  Sect. **Portulaca.**
    Subsect. *Portulaca.* — T.: *P. oleracea; P. lutea* (Pacific), and possibly some 4—5 spp in America.
    Subsect. *Stellulato-tuberculatae* Poelln. — T.: *P. pilosa sens. lat.; P. macrorhiza,* ? *P. pusilla* (America).
  Sect. **Neossia** Legrand. — T.: *P. quadrifida* L.; *P. wightiana* (India and Ceylon), *P. clavigera* (Australia), some spp. in Africa.
Subg. PORTULACELLA (F. v. M.) Legrand. — T.: *P. digyna;* at least 4 spp. in Australia.

Reviewing the above presentation it appears that subg. *Portulacella* is entirely confined to Australia where also all other sections and subsections are represented. To this can be added that subg. *Portulacella* represents in the structure of its inflorescence the most primitive condition in the genus. Furthermore, the species of subg. *Portulacella* stand so much apart mutually, that Legrand even assigned to one of them the rank of a monotypic subgenus!

From this I conclude that the ancestral lineage of *Portulaca* is found in Australia. This fits well in with the general geographical configuration of *Portulacaceae* which are predominantly a southern hemisphere group.

Apart from subg. *Portulacella*, each of the 3 sections or subsections contains one pantropical species, *P. pilosa*, *P. quadrifida*, and *P. oleracea* respectively. Unfortunately, their native countries are unknown and all three are doubtless widely dispersed by man.

5. TYPIFICATION

As far as possible types have been located, borrowed, and examined. Difficulties arose with the species described by von Poellnitz and those of contemporary botanists of which the types were obviously borrowed by von Poellnitz. The types of three species described by him before 1934 are all preserved in the Berlin Herbarium. However, those of later described species and those borrowed were all kept in his private house in Thüringen. This was bombed in the second World War, to which he himself also fell a victim. It is possible that some of this borrowed material was saved, but as yet this is not verified or located.

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A Harvard Herbarium (Arnold Arboretum and Gray Herbaria), Cambridge, Mass., U.S.A.
B Botanisches Museum, Berlin-Dahlem, Germany.
BISH Bernice P. Bishop Museum, Honolulu, Hawaii, U.S.A.
BO Herbarium Bogoriense, Bogor, Indonesia.
BR Jardin National de Belgique, Brussels, Belgium.
CAL Indian Botanic Garden, Calcutta, India.
K Royal Botanic Gardens, Kew, England.
KAG Museum of the University, Kagoshima, Japan.
MEL National Herbarium of Victoria, South Yarra, Melbourne, Australia.
P Muséum National d'Histoire Naturelle, Paris, France.
TAI Herbarium, Department of Botany, National Taiwan University, Taipei, Taiwan.
U Botanisch Museum & Herbarium, Utrecht, Netherlands.
US U.S. National Herbarium, Smithsonian Institution, Washington, D.C., U.S.A.
W Naturhistorisches Hofmuseum, Vienna, Austria.
Z Botanisches Museum und Garten der Universität, Zürich, Switzerland.

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PORTULACA

Linné, Sp. Pl. (1753) 445; G. Don, Gard. Dict. 3 (1834) 72; Schlechtend., Bot. Zeit. 11 (1853) 633—638, 649—655, 665—673, 686—693, 737—744; Benth. & Hook., Gen. Pl. 1 (1862) 156; Pax & Hoffm. in E. & P., Nat. Pfl. Fam. ed. 2, 16c (1934) 246; Poelln. in Fedde, Rep. 37 (Dec. 1934) 240; Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31 (1953); ibid. 34 (1958); Anal. Mus. Hist. Nat. Montevideo 2a, 7 (1962). — T.: *P. oleracea* L.

Annual to perennial, erect or creeping and rooting at the nodes, mostly copiously branched, often succulent herbs; roots mostly thickened. *Leaves* spirally arranged or opposite, mostly subsessile, linear to orbicular, axils mostly with hairs. *Flowers* bisexual, actinomorphous, either in axillary and/or terminal cymes, or in (1—)2—*c.* 30-flowered terminal capituli; in the latter the common receptacle infundibular, mostly with hairs or scales in the axils of the bracts (and bracteoles) between the flowers, surrounded by a whorl of *c.* 3—30 involucral leaves. *Sepals* 2, boat-shaped, deltoid to obovate, shortly connate and connivent with petals and stamens, occasionally keeled or hooded, persistent or caducous together with petals, stamens, and style. *Petals* (4—)5—6(—8), mostly obovate and unequal, shortly connate, occasionally emarginate or mucronate. *Stamens* 4—∞, anyway when in restricted number in one whorl; filaments for *c.* ½ connate; anthers 2- or 4-celled, dorsifixed, dehiscing lengthwise. *Ovary* half inferior, initially celled with as many cells as future style-arms, soon becoming 1-celled; style with 2—*c.* 18 arms. *Ovules* 4—∞ on a central, dendroid placenta, campylotropous. *Capsule* with a caducous operculum (not caducous in some specimens of *P. pilosa* ssp. *villosa*). *Seeds* 1—∞, smooth or sculptured, mostly with a caruncle. Embryo curved; no endosperm in the seed.

Distribution: Number of species unknown but according to my estimate possibly less than *c.* 40; all over the world, largely in the warmer parts of the globe.

Nomenclatural note: Index Kewensis cited '*Meridiana* L. *f.*' 1789 as a generic synonym; this reduction is also held by Pax (in E. & P. Pfl. Fam. 3, 1b, 1889, 59), De Dalla Torre & Harms (Gen. Siph.), Post & Kuntze (Lex.), Pax & Hoffmann (in E. & P. Pfl. Fam. ed. 2, 16c, 1934, 246), and has recently been copied by Index Genericorum and by Shaw (ed. 7, Willis, Dict.).

This is a surprisingly tenacious error. Linnaeus *f.* described *Portulaca meridiana* L. *f.* as a new species from India, adding in a note that in the opinion of his father this would represent a distinct genus; he says that in view of the variability in *Portulaca* he does not agree and accepts this merely as an (annual) species. Thiselton-Dyer (in Hook. *f.*, Fl. Br. Ind. 1, 1874, 247) put it correctly under the synonymy of *P. quadrifida.*

In 1804 Schrank (Bot. Zeit. Regensb. 3: 354) described a new genus and species, since long cultivated in the Botanic Garden of Ingolstadt, as *Meridiana axilliflora* Schrank, suggesting that this might be the same as *Portulaca medidiana* L. *f.* From Schrank's rather complete and detailed description it appears that his plant cannot belong to *Portulaca*, because of its axillary flowers, only one style, and its phyllotaxis. Besides, synonymy with *P. quadrifida* is out of question because of its pink flowers and alternate leaves.

To complicate matters Persoon (Syn. 2, 1807, 6) transferred Schrank's name to *Portulaca axilliflora* (Schrank) Pers. It is my contention that Persoon's plant is not a *Portulaca* too, but only based upon Schrank's description.

Meridiana Schrank (*non* Hill, 1761, *nom. cons.*) is an almost forgotten name: only Poiret took it up in the Dict. Sc. Nat. 30 (1824) 111. He relegated three species to it, viz. *M. quadrifida* Poir., based on *P. quadrifida* L., *M. axilliflora* Schrank, and *M. elliptica* Poir., as a *nomen novum* for *P. meridiana* L. *f.*, necessary because of tautonymy. Schlechtendal, Bot. Zeit. 11 (1853) 686, deemed *Meridiana* a doubtful genus.

I have reduced *Meridiana* Schrank to *Trianthema* L. (Aizoaceae). See under Excluded Species.

Infrageneric subdivision: In chapter 4 I have proposed a new subdivision. This is also used as the main frame of the key to the species offered here. In the systematical text I have inserted among the treatment of the species the infrageneric taxa to which they belong and I have added the infrageneric synonyms.

Two infrageneric names, one American and one African, I could not place as no material of the type species was available to me. They are:
Subg. *Portulacelloides* Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 5; ibid. 34, 1 (1958) 4. — T.: *P. pusilla* H.B.K.

Possibly a section in subg. *Portulaca.*
Sect. *Sedopsis* Engl. [Pflanzenwelt Afr. 3, 1 (1915) 157, *nomen*] *ex* Legrand, Com. Bot. Mus Hist. Nat. Montevideo 31, 1 (1953) 5. — *Sedopsis* Exell & Mendonça, Consp. Fl. Angol. 1 (1952) 116. — *Portulaca* subg. *Siphonopetalum* subdivision B, Legrand, Com. Bot. Mis. Hist. Nat. Montevideo 34, 1 (1958) 3. — T.: *P. sedoides* Welw.

Legrand had originally a monotypic section, to which he added two other species in 1958. Exell & Mendonça had two species under this concept which they had raised to generic rank. Tentatively I would adhere to their opinion.

KEY TO THE SPECIES

1. Flowers stalked, in a more or less lax cyme. Leaves opposite; axillary hairs absent (*P. digyna* has axillary papilli). 1. Subg. PORTULACELLA.
   2. Mature leaves lanceolate to ovate.
      3. Plant papillose, especially the operculum of the fruit (at 20 times magnification). Seeds 1(—3), smooth . . . . . **1. P. digyna**
      3. Plant glabrous. Seeds more than 6, tuberculate . . . . . **2. P. oligosperma**
   2. Mature leaves broadly ovate to orbicular.
      4. Axils of leaves on main stems with 2(—3) serial side-branches. Stamens *c.* 50. Seeds smooth. **4. P. cyclophylla**
      4. Axils of leaves on main stems with 1 lateral branch. Stamens 6—15. Seeds tuberculate. **3. P. bicolor**

1. Flowers sessile, either solitary or in distinct capituli. Leaves opposite or spirally arranged. Axillary hairs present or absent. 2. Subg. PORTULACA.
   5. All leaves opposite. Hairs or scales intra- and interpetiolar, that is all around the node. Membranous bracteoles absent. 1. Sect. **Neossia.**
      6. Almost all leaves hidden by the membranous scales of the next lower node; internodes very short. **7. P. wightiana**
      6. Leaves distinctly visible; axillary hairs seldom scale-like.
         7. Capituli 2—7-flowered. Sepals with a claviform spur (20 times magnification). Seeds smooth. **5. P. clavigera**
         7. Flowers solitary, seldom 2 together. Sepals without spur. Seeds tuberculate. **6. P. quadrifida**
   5. At least the middle cauline leaves spirally arranged. Hairs only axillary (and in the capitulum). Bracteoles membranous (between the flowers, 20 times magnification). 2. Sect. **Portulaca.**
      8. Leaves obovate to spathulate. Axillary hairs inconspicuous (20 times magnification). Sepals distinctly carinate. 1. Subsect. *Portulaca.*
         9. Capituli 1—2(—6)-flowered. Stamens 18—50. Fruit *c.* 7 mm long. . . . . **8. P. lutea**
         9. Capituli (2—)3—30-flowered. Stamens 7—15. Fruit *c.* 4 mm long. . . . . **9. P. oleracea**
      8. Leaves linear to elliptic (obovate to spathulate in *P. macrorhiza*). Hairs conspicuous (absent in *P. pilosa* ssp. *okinawensis*). Sepals not carinate, occasionally with an apical, dorsal, about dome-shaped 'spur'. 2. Subsect. *Stellulato-tuberculatae.*
         10. Leaves obovate to spathulate, *c.* 8 mm wide . . . . . **10. P. macrorhiza**
         10. Leaves linear to obovate, less than 4 mm wide . . . . . **11. P. pilosa**

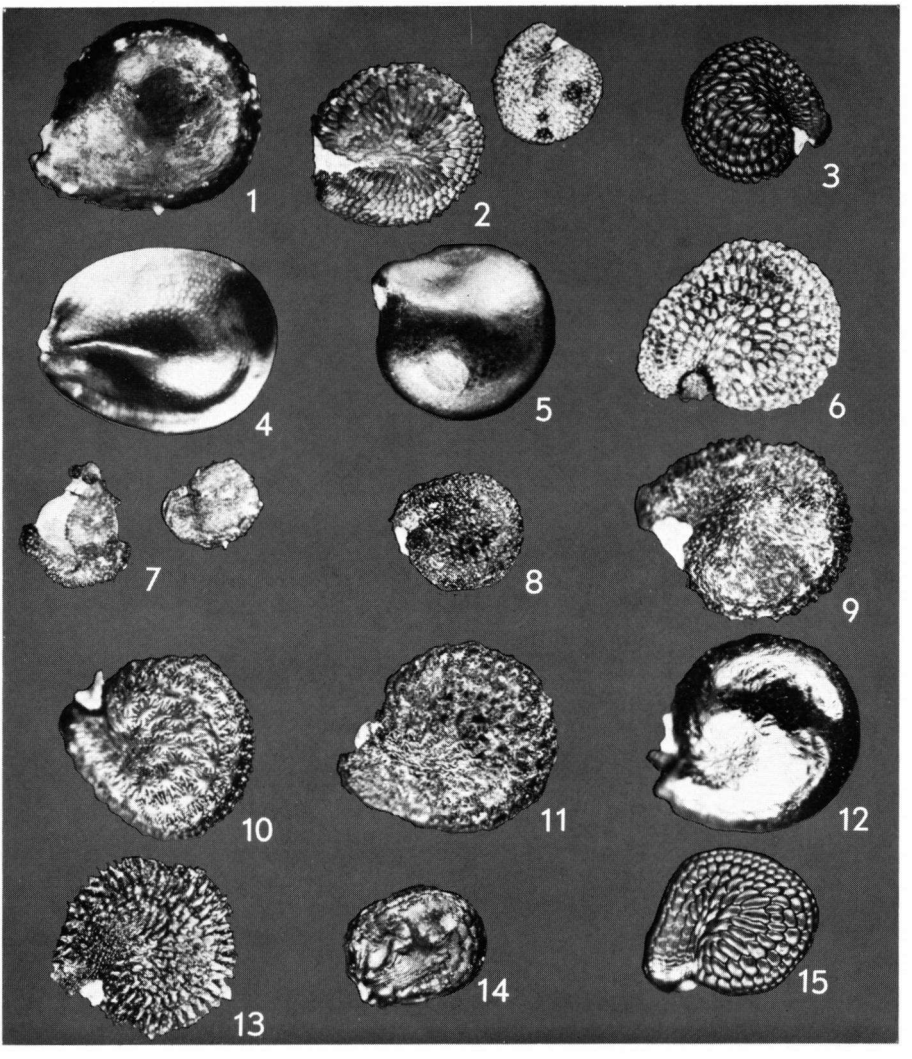

Plate 1. Seeds. 1. *P. digyna* F. v. M. (F. v. Mueller s.n., MEL); 2. *P. oligosperma* F. v. M. (Holtze s.n., MEL); 3. *P. bicolor* F. v. M. (Holtze 1080, MEL); 4. *P. cyclophylla* F. v. M. (Cusack 229, MEL); 5. *P. clavigera* Geesink (Bradshaw & Allen s.n., MEL); 6. *P. quadrifida* L. (Herb. Forsten, L); 7. *P. wightiana* Wall. *ex* W. & A. (Herb. Wight prop., B); 8. *P. oleracea* L. (Buwalda 4806, L); 9. *P. oleracea* L. (O'Shanesy s.n., MEL); 10. *P. lutea* Sol. *ex* Seemann (Brooks & Brooks 45, BISH); 11. *P. lutea* Sol. *ex* Seemann (E.H. Bryan 539, BISH); 12. *P. lutea* Sol. *ex* Seemann (F. R. Fosberg 13443, BISH); 13. *P. lutea* Sol. *ex* Seemann (H. Palmer 2, BISH); 14. *P. macrorhiza* Geesink (Zippelius s.n., L); 15. *P. pilosa* L. ssp. *decipiens* (Poelln). Geesink (C. W. Nyulasy s.n., MEL). All × 58.

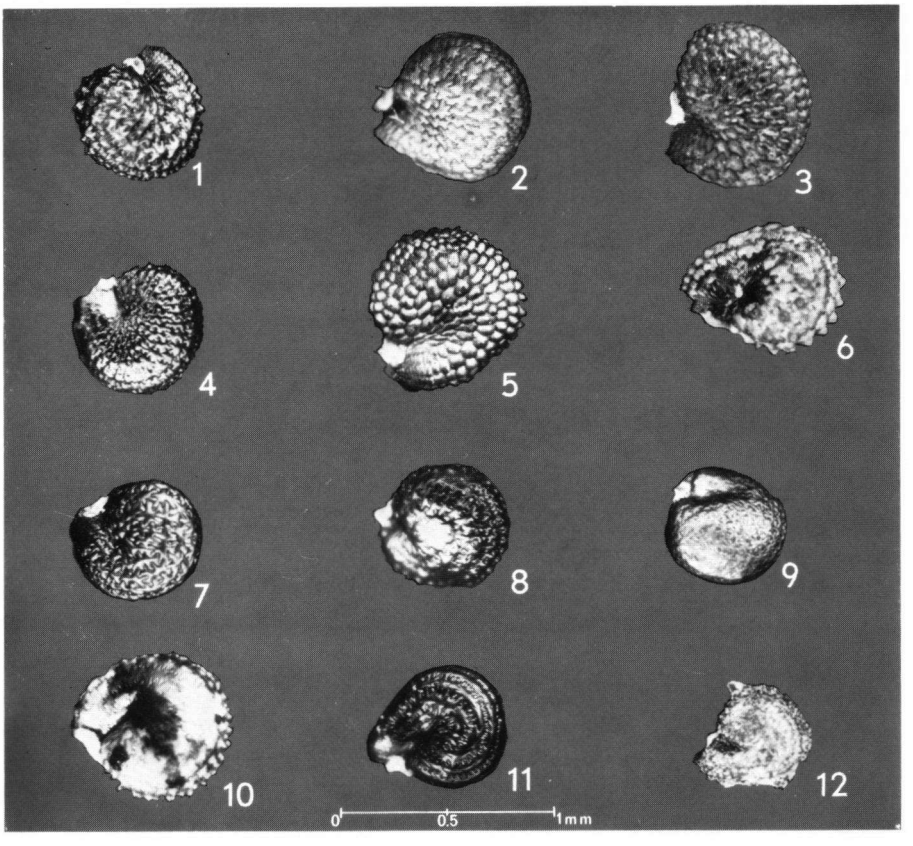

Plate 2. Seeds. 1—6. *P. pilosa* L. ssp. *pilosa*, 1. race '*pilosa*' (Geesink 3, L), 2. race '*tuberosa*' (Backer 1592, L), 3. race '*New Caledonia*' (Sarasin 891, Z), 4. race '*australis*' (Persietz 205, MEL), 5. race '*tuberosa* (F. R. Fosberg 33940, L), 6. race '*filifolia*' (Hort. Bog., BO); 7—12. *P. pilosa* L., 7. ssp. *villosa* (Cham.) Geesink (Degener 10.914, BISH), 8. ssp. *sundaensis* (Poelln.) Geesink (Verheyen s.n., L), 9. ssp. *sundaensis* (Poelln.) Geesink (O. Jaag 799, L), 10. ssp. *grandiflora* (Hook.) Geesink (no coll. mentioned, H.L.B. 947, 338...140, L), 11. ssp. *papulosa* (Schlechtend. *ex* Poelln.) Geesink (Kern & Reichgelt s.n., L), 12. ssp. *lakhonensis* (Gagn.) Geesink (Thorel s.n., type, P). All × 58.

Subgenus 1. PORTULACELLA

Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 4; ibid. 34, 1 (1958) 2. — Sect. *Portulacella* F. v. M., Fragm. Phyt. 1 (1859) 170. — T.: *P. digyna* F. v. M.

Sect. *Dichocalyx* F. v. M., Fragm. Phyt. 1 (1859) 170. — Subg. *Dichocalyx* Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 4. — T.: *P. oligosperma* F. v. M.

Sect. *Micropyxis* F. v. M., Fragm. Phyt. 1 (1859) 171. — T.: *P. bicolor* F. v. M.

Sect. *Siphonopetalum* F. v. M., Fragm. Phyt. 10 (1877) 97. — Subg. *Siphonopetalum* Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 5. — T.: *P. armitii* F. v. M.

Leaves opposite. Axillary hairs absent (*P. digyna* has axillary papilli, the whole plant being papillose!). Flowers stalked, in a more or less lax cyme. — Only in Australia.

1. **Portulaca digyna** F. v. M., Fragm. Phyt. 1 (1859) 170; Benth., Fl. Austr. 1 (1863) 170; F. M. Bailey, Queensl. Fl. 1 (1899) 94; Ewart & Davies, Fl. North. Terr. (1917) 107; Poelln. in Fedde, Rep. 37 (1934) 296. — T.: Sturt's Creek, *F. von Mueller* (MEL). — **Pl. 1: 1.**

Herb up to *c.* 15 cm, occasionally creeping; the entire plant covered with papillae, the latter being indistinct on the leaves, larger on the stem and operculum (0.2 mm long), largest in the leaf-axils and on the nodes (up to 0.8 mm). *Leaves* elliptic to ovate, up to 8 by 4 mm, the bracts smaller. *Cymes* up to *c.* 17-flowered, occasionally with 2 central flowers. On the inflorescental nodes 1—3 ± deltoid, membranous, caducous scales, *c.* 0.4 by 0.6 mm. *Sepals c.* 2 by 2 mm. *Petals* 5, broadly obovate, *c.* 2 by 2 mm, rose coloured. *Stamens* (6—)10(—15); filaments *c.* 0.8 mm; anthers *c.* 0.4 mm ∅. *Ovules* 4. Style *c.* 0.7 mm, with 2 arms. *Fruit* ± elliptic, *c.* 2.7 by 1 mm, the basal part inconspicuously papillose; operculum ¾ as long as the fruit. *Seeds* 1 (—3), *c.* 1.1 by 0.9 mm, smooth, shining; testa cells with flat surface, ± hexangular.

Distribution: Australia: NE. part of Western Australia, Northern Territory, and NW. Queensland.

2. **Portulaca oligosperma** F. v. M., Fragm. Phyt. 1 (1859) 170; Benth., Fl. Austr. 1 (1863) 170; F. M. Bailey, Queensl. Fl. 1 (1899) 94; Ewart & Davies, Fl. North Terr. (1917) 107; Domin, Bibl. Bot. 22 (1925) 651; Poelln. in Fedde, Rep. 37 (1934) 296. — T.: Upper Victoria River, *F. von Mueller* (MEL). — **Fig. 2; pl. 1: 2.**

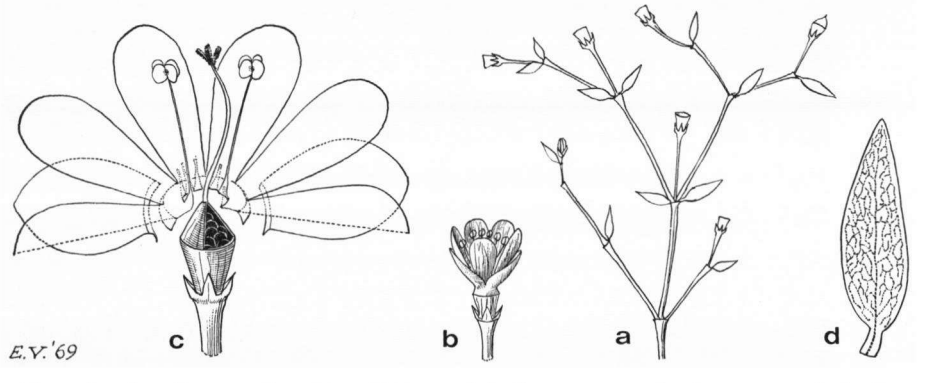

Fig. 2. *Portulaca oligosperma* F. v. M. a. Habit, × 1½, b. flower, × 5, c. floral parts exposed, the front petal halved, × 10, d. leaf (bract), × 5 (Holtze s.n., MEL 26595).

Herb up to 10 cm. *Leaves* ovate to elliptic, up to 10 by 2 mm, beneath mostly with 2 longitudinal grooves; margin recurved. *Cymes c.* 7-flowered; bracts leaf-like; bracteoles 4, elliptic to lanceolate, *c.* 1 by 0.2 mm. *Sepals* up to 2.3 mm. *Petals* 5, obovate, up to 2 by 1.1 mm. *Stamens* 10; filaments up to 2.8 mm; anthers *c.* 0.4 by 0.3 mm. Style *c.* 1.3 mm, with 5 arms. *Fruit* ovate, *c.* 5 by 1.5 mm, pericarp very thin; operculum 2/3 of the height of the fruit. *Seeds c.* 20, heterospermous, the larger up to *c.* 0.8 mm ∅, the smaller up to *c.* 0.45 mm ∅; testa cells about hexangular, in the larger seeds tuberculate at the margin, in the smaller seeds tuberculate all over the surface.

Distribution: Australia: NE. part of Western Australia, Northern Territory, and NW. Queensland.

3. Portulaca bicolor F. v. M., Fragm. Phyt. 1 (1859) 171; Benth., Fl. Austr. 1 (1863) 170; F. M. Bailey, Queensl. Fl. 1 (1899) 95; Ewart & Davies, Fl. North Terr. (1917) 107; Domin, Bibl. Bot. 22 (1925) 651; Poelln. in Fedde, Rep. 37 (1934) 297; Specht & Mountford, Rec. Am. Austr. Sc. Exp. Arnhem Land 3 (1958) 228. — T.: Victoria River, *F. von Mueller* (MEL). — **Pl. 1: 3.**

P. bicolor var. *purpurea* Poelln. in Fedde, Rep. 37 (1934) 298. — T.: N. S. W., Howell, *Boorman s.n.* (MEL).

P. armitii F. v. M., Fragm. Phyt. 10 (1877) 97; F. M. Bailey, Queensl. Fl. 1 (1899) 95; Ewart & Davies, Fl. North. Terr. (1917) 107; Poelln. in Fedde, Rep. 37 (1934) 299. — T.: Robertson River, *Armit 725* (MEL).

Herb up to *c* 6 cm, mostly creeping, main root mostly thickened. *Leaves* ± orbicular, up to 7 mm ∅, petiole up to 3 mm. *Cymes* mostly 7-flowered; bracts leaf-like; bracteoles 4, elliptic, up to *c.* 3 mm. *Sepals c.* 5.5 mm or smaller, membranaceous, cucculate at apex. *Petals* 4—5, elliptic to obovate, yellow or pink. *Stamens* (6—)10—15; filaments *c.* 1.2 mm; anthers *c.* 0.3 mm ∅. Style up to 1 mm, with 3 arms. *Fruit* ± obconical, *c.* 2.5 by 2.5 mm, pericarp very thin; operculum about flat. *Seeds* ∾, *c.* 0.7 mm ∅, somewhat shining; testa cells about elliptic, ± elevated, occasionally with a short tubercle.

Distribution: Entire northern Australia, the most southern locality being Bokhara Creek (*Leichardt*, in MEL).

4. Portulaca cyclophylla F. v. M., Proc. Linn. Soc. N.S.W. II, 5 (1890) 16; Ewart & Davies, Fl. North. Terr. (1917) 107; Poelln. in Fedde, Rep. 37 (1934) 297. — T.: Western Australia, Beringarra, *Mossingham* (not in MEL; ? NSW, *n.v.*, prob. lost). — **Pl. 1: 4.**

Herb up to 10 cm, probably spreading, with mostly developed serial (additional) buds. *Leaves* orbicular, *c.* 6 mm ∅; petiole up to *c.* 2 mm. *Cymes* up to 20-flowered, mostly with serial flowers; bracts leaf-like; bracteoles 4, obovate, lanceolate, up to 3 mm. *Sepals c.* 3 mm ∅, membranaceous. *Petals* 5, obovate, *c.* 5 by 4 mm, yellow, retuse to truncate at apex. *Stamens c.* 50; filaments up to *c.* 1.3 mm; anthers *c.* 0.8 by 0.7 mm. Style up to 2.5 mm, with 5 arms. *Fruit* obovate, *c* 4 by 3 mm; operculum ⅓ of the height of the fruit, ± conical. *Seeds* ∾, *c.* 1.2 by 0.8 mm, shining; testa cells inconspicuous, mostly hexangular.

Distribution: North Australia: NW. Australia, Arnhem Land.

Subgenus 2. PORTULACA

Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 6; ibid. 34, 1 (1958) 4.

Subg. *Euportulaca* Spegazzini, An. Soc. Ci. Argent. 82 (1917) 17; Poelln. in Fedde, Rep. 37 (1934) 243.

Note: This subgenus includes Legrand's subg. *Portulaca* and his subg. *Enantiophylla*, the latter of which I equalized with sect. *Neossia*.

Leaves opposite or spiral. Axillary hairs present or absent. Flowers sessile, either solitary or in distinct capituli. — Tropical species.

Section 1. Neossia

Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 3; ibid. 34,1. (1958) 3. — Subsect. *Tuberculatae* Poelln. in Fedde, Rep. 37 (1934) 243. — Subg. *Enantiophylla* Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 5; ibid. 34, 1 (1958) 3. — T.: *P. quadrifida* L.

Subsect. *Squamosae* Legrand, Com. Bot. Mis. Hist. Nat. Montevideo 34, 1 (1958) 15. — T.: *P. wightiana* Wall. *ex* W. & A.

Leaves opposite. Hairs or scales intra- and interpetiolar, that is all around the node. Membranous bracteoles absent.

5. Portulaca clavigera Geesink, *nov. spec.* — T.: Prince Regent R., *Bradshaw & Allen s.n.* (MEL). — **Fig. 3; pl. 1: 5.**

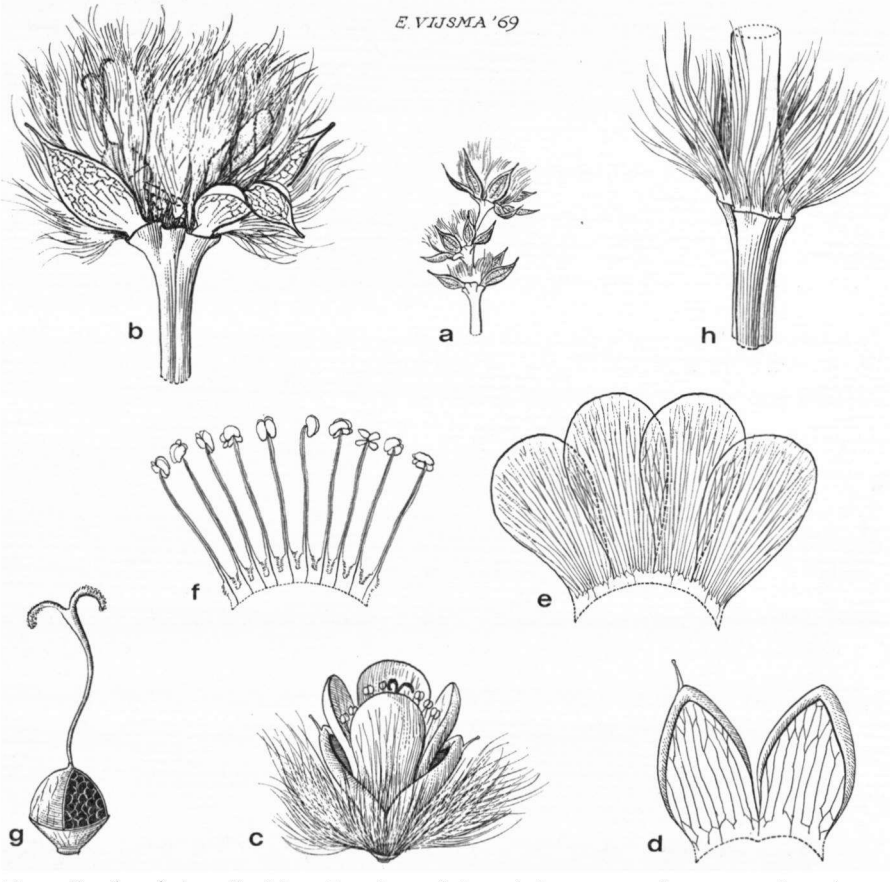

Fig. 3. *Portulaca clavigera* Geesink. a. Branch, × 1½, b. capitulum, × 5, c. flower, × 5, d. sepals, × 7, e. corolla, × 7, f. stamens, × 7, g. young fruit with style, × 7, h. axillary and nodal hairs, × 5 (Bradshaw & Allen s.n., MEL).

Herba usque ad 10 cm alta, internodiis usque ad 6 mm longis. *Folia* opposita, elliptica usque cordata, apice acuta, usque ad 9 mm longa et 6 mm lata, pilis axillaribus usque ad 4 mm longis. Capituli 2—7-flori. *Flores* pilis interdum confluentibus usque ad 7 mm longis circumdati. *Sepala* c. 4 mm longa; sepala ambae vel sepalo maiore appendice dorsali solida claviformi usque ad 0.9 mm longa, c. 0.3 mm infra apicem inserta instructo. *Petala* late obovata, c. 3.3 mm longa, 3,5 mm lata, ut videtur, colore satiore. *Stamina* 10; filamenta c. 3 mm longa; antherae c. 0.5 mm diam. *Fructus* obovoideus. apiculatus, c. 3 mm longus, sutura in tertio inferiore obvia; operculum opacum. *Semina* numerosa, c. 0.8 mm longa, testa lucida; cellulis inconspicuis generaliter sexangularibus.

Distribution: Northern part of W. Australia: Prince Regent R. Only known from the type.

6. Portulaca quadrifida Linné, Mant. Pl. 1 (1767) 73; DC., Prod. 3 (1828) 354; Wight & Arn., Prod. (1834) 356; Walp., Rep. 2 (1843) 223; Gray, Bot. U.S. Expl. Exp. 1 (1854) 140; Thw., En. Pl. Zeyl. (1858) 23; Kurz, J. As. Soc. Beng. 43, ii (1874) 81; Dyer in Hook. *f.*, Fl. Br. India 1 (1874) 246; Drake del Cast., Ill. Fl. Ins. Pac. (1890) 111; Trimen, Handb. Fl. Ceyl. 1 (1893) 90; Gagn., Fl. Gén. I.-C. 1 (1909) 275; Hayata, Ic. Pl. Form. 1 (1911) 73; Craib, Fl. Siam. En. 1 (1925) 109; Blatter, McCann & Sabnis, J. Ind. Bot. Soc. 6 (1927) 34; Poelln. in Fedde, Rep. 37 (1934) 275; Christoph., Bern. P. Bish. Mus. Bull. 128 (1935) 85; Kanehira, J. Dep. Agr. Kyushu Imp. Univ. 4 (1936) 317; Guillaumin, Fl. Nouv. Caléd. (1948) 116; Yuncker, Bern. P. Bish. Mus. Bull. 220 (1959) 112; Chun *c.s.*, Fl. Hainan 1 (1964) 384; Parham, Pl. Fiji Is. (1964) 225. — *Meridiana quadrifida* Poir., Dict. Sc. Nat. 30 (1824) 111. — T.: LINN (photograph seen). — **Pl. 1: 6.**

P. meridiana L. *f.*, Suppl. Sp. Pl. (1781) 248; Pers., Syn.2 (1807) 6. *Meridiana elliptica* Poir., Dict. Sc. Nat. 30 (1824) 112 — *P. quadrifida* var. *meridiana* DC., Prod. 3 (1828) 354. — T.: LINN (photograph seen).

P. geniculata Royle, Ill. Bot. Himal. 1 (1839) 221, *nomen.* — T.: *Royle* (LIV, *n.v.*).

P. quadrifida var. *formosana* Hayata, Ic. Pl. Form. 1 (1911) 73. — *P. formosana* Hayata *ex* Sasaki *n. nud.*, Cat. Gov. Herb. Dept. For. (1930) 201. — T.: Formosa, *Miyake* (TI, *n.v.*).

Herb up to *c.* 8 cm, creeping, rooting at the nodes; nodes encircled by a whorl of hairs. *Leaves* elliptic to cordate, 2—20 by 0.8—7 mm with *c.* 5 mm long axillary hairs. *Flowers* terminal, solitary (seldom 2) on an infundibuliform, profusely hairy platform, with 4, seldom more, leaves at its edge. *Sepals c.* 3 mm long. *Petals* 4, obovate, up to 5 by 4 mm, yellow. *Stamens* 8 or 12; filaments up to 3.5 mm; anthers *c.* 0.3 mm ∅. Style up to *c.* 4 mm with (3—)4(—5) arms. *Fruit* ± obovate, up to *c.* 3.5 by 3 mm; operculum *c.* ⅔ of the height of the fruit, shining, straw-yellow. *Seeds* 2—3, 0.8—1 mm ∅, dull; testa cells elliptic, radially elongated, their surface either convex or with a pyramidal tubercle.

Distribution: Pantropic, in the Pacific east as far as Gilbert, Samoa, and Fiji Is, absent from Australia.

7. Portulaca wightiana Wall. [Cat. (1828) n. 6842, *nomen*] *ex* Wight & Arn., Prod. (1834) 356; G. Don, Gard. Dict. 3 (1834) 75; Walp., Rep. 2 (1843) 233; Schlechtend., Bot. Zeit. 11 (1853) 637, 689; Dyer in Hook. *f.*, Fl. Br. India 1 (1874) 247; Trimen, Handb. Fl. Ceyl. 1 (1893) 89; Poelln. in Fedde, Rep. 37 (1934) 314. — T.: *Herb. Wight propr.* (K, *n.v.*; B, BR). — **Fig. 4; pl. 1: 7.**

Herb up to 10(?) cm, with very short internodes. *Leaves* cordate to ovate, inconspicuous, up to 4 by 2.7 mm, soon caducous, with axillary scales, these enveloping the internodes, deltoid to ovate, *c.* 3 by 2 mm, acute, membranaceous. Capituli 2—7-flowered. *Flowers* surrounded by up to 4 mm long scales, dissolved into hairs towards the centre

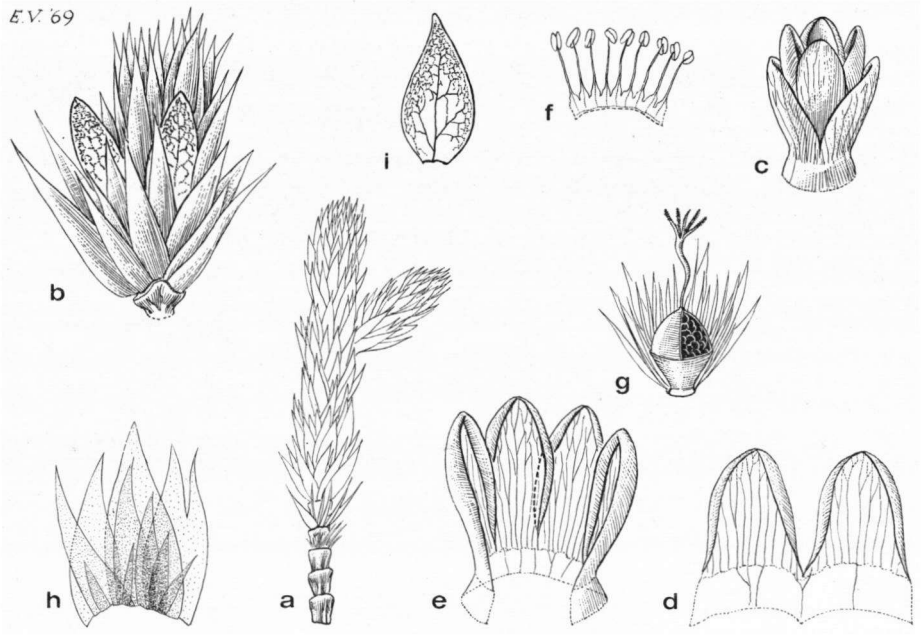

Fig. 4. *Portulaca wightiana* Wall. *ex* W. & A. a. Habit, × 1⅓, b. apical part of a branch, × 5, c. flower, × 5, d. sepals, × 7, e. corolla, × 7, f. stamens, × 7, g. young fruit with style, operculum partly removed, × 7, h. some axillary and nodal scales, × 5, i. leaf, × 5 (Holtermann s.n., B).

of the capitulum. *Sepals c.* 3 by 3.3 mm. *Petals* 4(—5?), elliptic, up to 2.8 by 1,7 mm. *Stamens* (5?—)10; filaments up to 0.8 mm; anthers up to 0.9 by 0.3 mm. Style *c.* 1 mm, with 3—6 arms. *Fruit* ± globular, *c.* 2 mm ∅; operculum ⅔ as long as the fruit, dull? *Seeds c.* 0.5 mm ∅, red (unripe?); testa cells ± hexangular with a central tubercle.

Distribution: Southern India (only the type), Ceylon (*Holtermann*, in B). Only 2 sheets seen.

Section 2. **Portulaca**

Note: This section is equal to Legrand's subg. *Portulaca.*

At least the middle-cauline leaves spiral, the upper and basal ones sometimes subopposite. Hairs only axillary and in the capitulum. Bracteoles membranous (between the flowers, 20 times magnification).

Subsection 1. *Portulaca*

Sect. *Spathulatae* Engelmann, Boston J. Nat. Hist. 1 (1850) 154. — Sect. *Carinatae* Poelln. in Fedde, Rep. 37 (1934) 242. — Sect. *Portulaphiton* Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 6; ibid. 34, 1 (1958) 5.

Leaves obovate to spathulate. Axillary hairs not very distinct (comb-shape). Sepals distinctly carinate.

8. Portulaca lutea Solander [*ex* Forst., Pl. Esc. (1786) 2, *nomen*] *ex* Seemann, Fl. Vit. (1865) 9; Christoph. & Caum, Bern. P. Bish. Mus. Bull. 81 (1931) 28; Wilder, ibid. 86

(1931) 49; ibid. 120 (1934) 23; Poelln. in Fedde, Rep. 37 (1934) 301; Christoph., Bern. P. Bish. Mus. Bull. 128 (1935) 85; F.B.H. Brown, ibid. 130 (1935) 78; Svenson, Am. J. Bot. 22 (1935) 231; Poelln., Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 5; Stone, Adv. Fr. Pl. Sc. 4 (1963) 143. — T.: *Drawing by Parkinson*, belonging to a not published description by Solander (BM. *n.v.*, on authority of Seemann). — **Pl. 1: 10—13.**

P. flava DC., Prod. 3 (1828) 355, *nomen*; G. Don, Gard. Dict. 3 (1834) 75, *nomen* (Obviously a slip of DC., because he quoted '*P. flava* (Forst. pl. esc. 72)').

P. fosbergii var. *substellulata* Poelln., Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 4; Parham, Pl. Fiji Is (1964) 225. — Lectotype: Fiji Is, Naiabo I., *Bryan 452* (BISH).

P. johnii Poelln., Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 4. — Lectotype: Austr. Is, Hotuatua I., Raivavae, *St. John & Wight 16106* (BISH).

Herb. up to *c.* 70 cm. *Leaves* spirally arranged to subopposite, obovate to orbicular, up to *c.* 30 mm long, not translucent in dry state, with up to 6 mm long axillary hairs. Capituli 1—6-flowered. *Flowers* surrounded by up to 4 by 2 mm long bracteoles and by up to *c.* 2 mm long hairs. *Sepals* suborbicular, up to *c.* 9 mm long, fleshy in the centre, carina up to 4 by 1.5 mm, apical. *Petals* 5, broadly obovate to obovate, up to *c.* 10 mm, apex emarginate to mucronate, yellow. *Stamens* 18—*c.* 50; filaments up to *c.* 4 mm; anthers up to *c.* 0.7 by 0.5 mm, at least occasionally red. Style up to *c.* 5 mm, with (4—)5 arms. *Fruit* ± ovate, *c.* 7 by 5 mm; operculum $\frac{2}{3}$ as high as the fruit, shining, straw-yellow. *Seeds* ∽, up to *c.* 1 mm ∅; testa cells stellulate, flat or convex, with tubercles or spines or ± smooth.

Distribution: Tropical Pacific from the Solomons to the Marquesas.

Ecology: Mostly near the shores.

Note: This species can possibly be considered as a subspecies of *P. oleracea*. A definite conclusion must be postponed till a full study has been made of the other American species of this subsection. The var. *howellii* Legrand from the Galapagos Is is considered to be a distinct species by U. Eliasson, Svensk Bot. Tidskr. 60 (1966) 428.

9. Portulaca oleracea Linné, Sp. Pl. (1753) 445; Pers., Syn. 2 (1807) 6; DC., Prod. 3 (1828) 353; G. Don, Gard. Dict. 3 (1834) 73; Wight & Arn., Prod. (1834) 256; Walp., Ann. 2 (1852) 660; Gray, Bot. U.S. Expl. Exp. 1 (1854) 139; Thw., En. Pl. Zeyl. (1858) 23; Benth., Fl. Austr. 1 (1863) 169; Dyer in Hook. *f.*, Fl. Br. Ind. 1 (1874) 247; Hemsley, Rep. Chall. Exp. Bot. 1, 3 (1884) 122; Drake del Cast., Ill. Fl. Ins. Pac. (1890) 111; Fl. Polyn. Fr. (1893) 8; Trimen, Handb. Fl. Ceyl. 1 (1893) 89; F. M. Bailey, Queensl. Fl. 1 (1899) 92; Gagn., Fl. Gén. I.—C. 1 (1909) 274; Rechinger, Denkschr. K. Ak. Wiss. Wien 89 (1913) 110; Ewart & Davies, Fl. North. Terr. (1917) 107; Domin, Bibl. Bot. 22 (1925) 649; Craib, Fl. Siam. En. 1 (1925) 109; Blatter, McCann & Sabnis, J. Ind. Bot. Soc. 6 (1927) 34; Christoph., Bern. P. Bish. Mus. Bull. 85 (1931) 128; Wilder, ibid. 86 (1931) 49; Christoph., ibid. 120 (1934) 23; Poelln. in Fedde, Rep. 37 (1934) 258; F. B. H. Brown, Bern. P. Bish. Mus. Bull. 130 (1935) 78; Svenson, Am. J. Bot. 22 (1935) 251; Kanehira, J. Dep. Agr. Kyushu Imp. Univ. 4 (1936) 317; Guillaumin, Fl. Nouv. Caléd. (1948) 116; Glassman, Bern. P. Bish. Mus. Bull. 209 (1952) 56; Specht & Mountford, Rec. Am. Austr. Sc. Exp. Arnhem Land 3 (1958) 228; Yuncker, Bern. P. Bish. Mus. Bull. 220 (1959) 112; Larsen, Dansk Bot. Ark. 23 (1963) 63; Stone, Adv. Fr. Pl. Sc. 4 (1963) 142; Chun *c.s.*, Fl. Hainan 1 (1964) 384; Parham, Pl. Fiji Is (1964) 225. — T.: LINN (photograph seen). — **Pl. 1: 8—9.**

P. oleracea var. *sativa* DC., Prod. 3 (1828) 353. — *P. oleracea* ssp. *sativa* Thellung, Fl. Adv. Montpellier (1912) 222. — T.: *De Candolle* (GE, *n.v.*).

P. oleracea var. *sylvestris* DC., Prod. 3 (1828) 353. — *P. oleracea* ssp. *sylvestris* Thellung, Fl. Adv. Montpellier (1912) 222. — T.: *De Candolle* (GE, *n.v.*).

P. diptera Zippelius *ex* Spanoghe, Linnaea 15 (1841) 207, *nomen.* — T.: Timor, *Zippelius* (L).

P. oleracea var. *gracilescens* Domin, Bibl. Bot. 22 (1925) 650. — T.: Queensland, *Domin* (PR, *n.v.*).

P. oleracea var. *granulato-stellulata* Poelln., Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 5; Stone, Adv. Fr. Pl. Sc. 4 (1963) 142. — Lectotype: Oahu, *Hosaka 419* (BISH).

P. fosbergii Poelln., Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 13. — T.: Austr. Is, Rurutu, *Fosberg 11976* (BISH).

P. fosbergii var. *major* Poelln., Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 4. — Lectotype: Austr. Is, Tubuai, *St. John & Fosberg* 16292 (BISH).

Herb up to *c.* 40 cm. *Leaves* spirally arranged to subopposite, up to 40 by 20 mm, with inconspicuous, up to *c.* 1 mm long, axillary hairs. Capituli 2—30-flowered. Mostly 2 of the involucral leaves with an additional axillary axis ending in a secondary capitulum. *Flowers* surrounded by up to *c.* 5 by 6 mm long bracteoles and inconspicuous hairs. *Sepals* up to *c.* 8 by 8 mm, carina up to *c.* 3 mm long and 2 mm high. *Petals* (4—)5, broadly obovate, up to 10 by 8 mm, yellow. *Stamens* 7—10(—15); filaments up to 4 mm; anthers 0.2—0.5 by 0.2—0.4 mm. Style up to *c.* 5 mm with (4—)5 arms. *Fruit* ovate, *c.* 4 by 3 mm; operculum $\frac{2}{3}$ to $\frac{1}{2}$ of the length of the fruit, shining, straw-yellow. Seeds ∾, 0.5—1 mm ∅, granulate; testa cells stellulate, with many fine tubercles.

Distribution: Pantropic.

Ecology: Waste places, sea-shores, waysides.

Note: See the note under *P. lutea.*

Subsection 2. *Stellulato-tuberculatae*

Poelln. in Fedde. Rep. 37 (1934) 243. — Sect. *Teretifoliae* Engelmann, Boston J. Nat. Hist. 6 (1850) 154. — Sect. *Rotundatae* Poelln. in Fedde, Rep. 37 (1934) 243, excl. subsect. *Tuberculatae.* — Sect. *Catoclasis* Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 8; ibid. 34, 1 (1958) 10, excl. subsect. *Squamosae.* — T.: *P. pilosa* L.

Sect. *Lanceolatae* Engelmann, Boston J. Nat. Hist. 6 (1850) 154. — Sect. *Hipsoclasis* Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 6; ibid. 34, 1 (1958) 6. — T.: *P. lanceolata* Engelmann (sec. Legrand conspecific with *P. umbraticola* H. B. K.).

Subg. *Discoportulaca* O. Ktze, Rev. Gen. Pl. 3, 2 (1898) 16. — T.: *P. plano-operculata* O. Ktze (sec. Legrand conspecific with *P. umbraticola* H.B.K.).

Sect. *Pseudohipsoclasis* Legrand, Com. Bot. Mus. Hist. Nat. Montevideo 31, 1 (1953) 7; ibid. 34, 1 (1958) 8. — Lectotype: *P. ragonesi* Legrand.

Leaves linear to spathulate. Hairs conspicuous (absent in *P. pilosa* ssp. *okinawensis*). Sepals not carinate, occasionally with an apical, dorsal, about dome-shaped spur.

10. Portulaca macrorhiza Geesink, *nov. spec.* — *P. macrorhiza* Zippelius *ex* Spanoghe, Linnaea 15 (1841) 207, *nomen;* Pax & Hoffm. in E. & P., Nat. Pfl. Fam. ed. 2, 16c (1934) 247, t. 105. — T.: Timor, *Zippelius* (L). — **Pl. 1: 14.**

Herba usque ad 10 cm alta. *Folia* obovata vel spathulata, usque ad 30 mm longa et 8 mm lata, apice obtusa vel truncata; pilis axillaribus usque ad 4 mm longis. Capituli 2—3-flori. *Flores* pilis usque ad 3 mm circumdati. Bracteolae deltoideae, c. 1.5 mm longa et 1.7 mm lata. *Sepala* c. 5.3 mm longa. *Petala* (5—)6, c. 7 mm longa et 5(?) mm lata, lutea, late obovata. *Stamina* c. 60; filamenta usque ad 4 mm longa; antherae ellipticae, c. 0.6 mm longae

et 0.4 mm latae. *Stylus* c. 4 mm longa, lobis stigmatosis 2—3. *Fructus* globosus, c. 3 mm diam.; operculum dimidio instructum, lucidum, pallidum. *Semina* elliptica, c. 0.7 mm longa et 0.5 mm lata; testa lucida, cellulis ellipticis, substellulis.

Distribution: Lesser Sunda Islands: Timor.

Ecology: On the beach and on the limestone karst of the Plateau of Baucau in Portuguese Timor at *c.* 400 m, according to field notes of van Steenis, who found this species for the second time in 1953.

11. Portulaca pilosa Linné, Sp. Pl. (1753) 445; DC., Prod. 3 (1828) 354; Hayata, Ic. Pl. Form. 1 (1911) 73; Craib, Fl. Siam. En. 1 (1925) 109; Poelln. in Fedde, Rep. 37 (1934) 261; Guillaumin, Fl. Nouv. Caléd. (1948) 116; L. H. Bailey, Man. Cult. Pl. (1949) 365; Blake, Proc. R. Soc. Queensl. 70 (1959) 41; Chun *c.s.*, Fl. Hainan 1 (1964) 384. — T.: LINN (photograph seen).

See for the synonyms under the subspecies.

Leaves spiral, linear to obovate, thickened, 2—30 mm long, with axillary hairs (except in ssp. *okinawensis*). Capituli 1—12-flowered. *Flowers* surrounded by membranous bracteoles and hairs (no hairs in ssp. *okinawensis*). *Petals* 4—6. *Stamens* (6—)10—*c.* 75. *Style* 4—18-fid. *Fruit* ovate to obovate; operculum ½—¾ as high as the fruit. Testa cells elliptic to stellulate.

Distribution: Tropics; some subspecies are cultivated and are escaped or occur as adventives.

Ecology: Waste places, near shores, along waysides, probably intolerant for seawater.

Notes: I have come to the conclusion that this is a very complex species in which I have here combined about 60 names. To give some idea of the variability I have distinguished 8 subspecies, which are characterized by a set of several characters. These subspecies were probably originally geographically replacing but, probably largely through the disturbance by man, they no longer occupy separate ranges. Through self-pollination they do not mix when growing together, so that one may find in a smaller area two or three of them, that keep distinct.

Besides, some races occur, in ssp. *pilosa* which show a set of very minor characters. These I have tabulated but refrained from naming.

My impression is that, predominantly in America, there is an additional very large number, about one hundred species accepted by Legrand in his sections *Hipsoclasis*, *Pseudohipsoclasis*, and *Catoclasis*, which should be subordinated to the *P. pilosa* complex; some of these may deserve distinction as further subspecies or races. I estimate that *P. pilosa* is a compond species comprising some 150 names as accepted by von Poellnitz and Legrand.

KEY TO THE SUBSPECIES

1 Ripe seeds red-brown, dark-brown, or shining black.
  2. Cells of the testa stellate.
    3. Plant glabrous . . . . . **6. ssp. okinawensis**
    3. Plant not glabrous.
      4. Hairs up to *c.* 12 mm long. Fruit 3—4 mm Ø; operculum shiny. Flowers white or pink. **4. ssp. villosa**
      4. Hairs up to 6 mm long. Fruit 2—2½ mm Ø; operculum dull. Flowers orange to red. **5. ssp. sundaensis**
      4. Hairs up to *c.* 6 mm long. Fruit *c.* 5—6 mm Ø; operculum shiny. Flowers bright yellow (race '*pachyrhiza*') . . . . . **1. ssp. pilosa**
  2. Cells of the testa elliptic, lobed or not.
    5. Seeds 0.8—1 mm Ø; fruit 5—8 mm long; stamens *c.* 50, the anthers 1.2 mm long. **2. ssp. decipiens**

5. Seeds 0.4—0.6 mm Ø; fruit up to 3 mm long; stamens up to 25, the anthers *c.* 0.35 mm long.
   6. Testa cells inconspicuous, about hexangular, with a spine up to 0.06 mm; style 8-fid, the stigmas elliptic . . . . . **8. ssp. lakhonensis**
   6. Testa cells conspicuous, lobed, not spiny; style 4—7-fid, the stigmas filiform.
      7. Testa cells radially elongated, style 5—7-fid (race '*australis*') . . . . . **1. ssp. pilosa**
      7. Testa cells tangentially elongated, style 4—5-fid . . . . . **7. ssp. papulosa**
1. Ripe seeds bluish, grey, or dull black.
   8. Cells of the testa about elliptic, without a central nipple or tubercle (high magnification).
      9. Seeds 0.8—1 mm Ø. Fruit 5—8 mm long. Stamens *c.* 50; anthers *c.* 1.2 mm long. **2. ssp. decipiens**
      9. Seeds 0.6(—0.7) mm Ø. Fruit up to 4 mm long. Stamens up to *c.* 30; anthers 0.4—0.7 mm (race '*tuberosa*') . . . . . **1. ssp. pilosa**
   8. Cells of the testa lobed or stellate, with or without a central nipple or tubercle.
      10. Petals *c.* 25 mm long. Anthers *c.* 1.4 mm long. Fruit *c.* 5 mm Ø . . . . . **3 ssp. grandiflora**
      10. Petals up to 12 mm long. Anthers up to 0.7 mm long. Fruit *c.* 2—3(—4) mm Ø (races '*New Caledonia*' and '*filifolia*') . . . . . **1. ssp. pilosa**

1. ssp. pilosa. — Pl. 2: 1—6.

P. tuberosa Roxb. [Hort. Beng. (1814) 91, *nomen*] Fl. Ind. ed. Carey 2 (1832) 464; Wight & Arn., Prod. (1834) 356; Walp., Rep. 2 (1843) 233; Dyer in Hook. *f.*, Fl. Br. Ind. 1 (1874) 246; Trimen, Handb. Fl. Ceyl. 1 (1893) 90; Poelln. in Fedde, Rep. 37 (1934) 312; Hosokawa, J. Jap. Bot. 13, 3 (1937) 65, 203. — T.: India, Walajabad, *Roxburgh* (CAL?, *n.v.*; not received with a loan from CAL).

P. australis Endl., Atakta Bot. (1833) 7, t. 6; Schlechtend., Bot. Zeit. 11 (1853) 37; Benth., Fl. Austr. 1 (1863) 169; F. M. Bailey, Queensl. Fl. 1 (1899) 94; Ewart & Davies, Fl. North. Terr. (1917) 107; Domin, Bibl. Bot. 22 (1925) 650; Poelln. in Fedde, Rep. 37 (1934) 300. — T.: N. Australia, Gulf of Carpenteria: *drawing of Bauer* belonging to the original description.

P. cristata Wall., Cat. (1832) n. 6844, *nomen*. — Cf. Wight & Arn., Prod. (1834) 356.

P. suffruticosa Wall. [Cat. (1832) n. 6842, *nomen*] *ex* Wight & Arn., Prod. (1834) 356; G. Don, Gard. Dict. 3 (1834) 73; Walp., Rep. 2 (1843) 223; Thw., En. Pl. Zeyl. (1858) 24; Trimen, Handb. Fl. Ceyl. 1 (1893) 90; Poelln. in Fedde, Rep. 37 (1934) 313. — T.: India, *Herb. Wallich* (K, *n.v.*).

P. helianthemoides Zippelius *ex* Spanoghe, Linnaea 15 (1841) 207, *nomen*. — T.: Timor, *Zippelius* (L).

P. cincta Fenzl, Nat. Tijd. Ned. Ind. 14 (1857) 162; Poelln. in Fedde, Rep. 37 (1934) 312. — T.: Java, Res. Besoeki, Noesa Baroeng, *Zollinger* (holotype BO, isotype B).

P. filifolia F. v. M., Fragm. Phyt. 1 (1859) 169; Benth., Fl. Austr. 1 (1863) 169; F. M. Bailey, Queensl. Fl. 1 (1899) 94; Ewart & Davies, Fl. North. Terr. (1917) 107; Domin, Bibl. Bot. 22 (1925) 650; Poelln. in Fedde, Rep. 37 (1934) 302; Specht & Mountford, Rec. Am. Austr. Sc. Exp. Arnhem Land 3 (1958) 228. — T.: NW. Australia, Sturt's Creek, *F. von Mueller* (MEL).

P. cyathostyla Gagn., Bull. Soc. Bot. Fr. 56 (1909) 40; Fl. Gén. I.—C. 1 (1909) 277; Poelln. in Fedde. Rep. 37 (1934) 313. — T.: Vietnam, Me-Kong, *Thorel* (P).

P. pachyrhiza Gagn., Bull. Soc. Bot. Fr. 56 (1909) 41; Fl. Gén. I.-C. 1 (1909) 275, t. 19; Merr., En. Philip. 2 (1923) 136 (race '*tuberosa*'); Poelln. in Fedde, Rep. 37 (1934) 316. — T.: Laos, Me-Kong, Lakhon, *Thorel* (P).

P. talmyana Gagn., Bull. Soc. Bot. Fr. 56 (1909) 42; Fl. Gén. I.-C. 1 (1909) 276; Poelln. in Fedde, Rep. 37 (1934) 315. — T.: Cochinchina, Ile Condor *Talmy* (P).

P. samoensis Poelln. in Fedde, Rep. 33 (1933) 163; ibid. 37 (1934) 300; Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 9; Glassman, Bern. P. Bish. Mus. Bull, 209 (1952) 56; Yuncker, ibid. 220 (1959) 112; Parham, Fl. Fiji Is (1964) 225. — T.: Samoa, Matautu, *Vaupel 178* (holotype B, isotype BISH).

P. remota Poelln. in Fedde, Rep. 37 (1934) 302. — T.: W. Australia, between Ashburton R. and Yule R., *E. Clement*, untraceable.

P. cyanosperma Egler, Occ. Pap. Bern. P. Bish. Mus 13, 15 (1937) 167; Stone, Adv. Fr. Pl. Sc. 4 (1963) 143. — T.: Hawaiian Is, Lehua, *Caum 12* (BISH, isotype seen).

P. javanensis Poelln., Rev. Sudamer. Bot. 7 (1943) 273. — T.: Java, island in Baai of Batavia, *Warburg 2434*, untraceable.

P. javanensis var. *grisea* Poelln., Rev. Sudamer. Bot. 7 (1943) 273. — T.: Siam, Pedang, *Yapp 289* (holotype prob. lost, isotype L, CAL).

P. hainanensis Chun & How, Act. Phytotax. Sin. 7 (1958) 8; Chun *c.s.*, Fl. Hainan 1 (1964) 385. — T.: Hainan, *How 70899* (SYS?, *n.v.*).

Herb. 10—30 cm. *Leaves* elliptic to linear, 4—28 by 0.5—4 mm; axillary hairs 1—18 mm. Capituli (1—)2—10-flowered (occasionally more or less congested with adjacent quasi-axillary capituli, e.g. in the races *'australis'* and *'filifolia'*). Bracteoles 0.7—2.5 by 0.7—2.2 mm, hairs between them *c.* 3—18 mm. *Sepals* 2—6 by 1—4 mm, occasionally inconspicuously hooded at the apex, *Petals* 4—6, obovate, 2.5—12 by 1.8—11 mm, yellow or pink. *Stamens* (7—)20—30(—35?); filaments 1—5 mm; anther globose to elliptic, 0.35—0.7 mm. *Style* 2—8 mm, 3—7-fid. *Fruit* ± globose, *c.* 2—3(—4) mm ∅; operculum ½ to ⅔ times as long as the fruit, shiny, straw-yellow to olive green. *Seeds* 0.4—0.7 mm ∅, dull bright to dark grey, black shining or bluish; testa cells elliptic, elliptic with lobes, or stellate, tubercled all over the seed, only at the margin of the seed, or smooth.

Notes: This is the most variable subspecies of the *pilosa* complex. The Indo-Pacific material can be arranged into six types, here called 'races', which can be distinguished by the features of their seed. They tend to show a more or less geographical distribution of their own, but this is blurred and not distinctive; this can be ascribed to secondary diffusion without mixing because of selfing.

I have tabulated below the characters and added figures of five types, the seeds of the sixth (*'pachyrhiza'*) being not fully mature, but apparently tending to become like those of ssp. *villosa* and ssp. *sundaensis* pictured in pl. 2: 7 and 9.

Race	Locality	Petals	Stamens	Anther length in mm	Seed diam. in mm	Colour seed	Shape testa cells	Testa cells tubercles	pl. 2
'pilosa'	pantrop. excl.Austr.	pink	(7-)20-30	0.5	0.4-0.6	blue	stellate	pyramidal	1
'tuberosa'	E. Asia, Malesia, W. Pacific	yellow	(17-)25-30	0.4-0.7	0.6-0.7	dark grey	ell.-lobed stellate at the margin	elevated, to the Pacific with tubercles	2, 5
'australis'	Australia pantrop.	yellow	(8-)20-25	0.4	0.5-0.7	dark brown to black	ell.-lobed stellate at the margin	elevated	4
'filifolia'	Australia pantrop.	yellow	12-30	0.4	0.6-0.7	bright grey	stellate	pyramidal	6
'New Caledonia'	New Caledonia, Tonga	yellow	25-30	0.4	0.6-0.7	blue	stellate	elevated	3
'pachyrhiza'	Thailand, Me-kong	bright yellow	c. 24-45	0.5	0.7-0.9	black shiny	stellate	flat, somewhat elevated	like 7 & 9

The characters are of a minor nature and I assume they rest genetically on a few genes only.

I regard ssp. *pilosa* as a sort of core showing similarity with other subspecies; for example the races *'australis'* and *'pachyrhiza'* approach ssp. *villosa*, ssp. *sundaensis*, and ssp. *okinawensis*

I have arranged all synonyms under ssp. *pilosa*. For those who want a finer pinning down of some of the synonyms. I list here those which could be identified with one of the 'races':

To race *'pilosa'*: *P. cyanosperma, P. cyathostyla, P. pilosa.*

To race '*tuberosa*': *P. cincta, P. hainanensis, P. helianthemoides, P. javanensis, P. javanensis* var. *grisea, P. samoensis, P. suffruticosa, P. talmyana, P. tuberosa.*

To race '*australis*': *P. australis, P. remota.*

To race '*pachyrhiza*': *P. pachyrhiza, P. psammotropha*?

I have refrained from mentioning the synonyms based on American material; four have been mentioned by Legrand (1962, p. 78 seq.) under *P. pilosa* and its varieties.

2. ssp. **decipiens** (Poelln.) Geesink, *nov. stat.* — *P. decipiens* Poelln. in Fedde, Rep. 33 (1933) 159; ibid. 37 (1934) 303. — T.: Australia, Port Darwin, Fanny Bay, *Schultz 705*, prob. lost. — **Pl. 1: 15.**

Herb up to 30(?) cm. *Leaves* lanceolate to linear, up to 30 by 4 mm, with up to 10 mm long axillary hairs. Capituli up to 12-flowered. *Flowers* surrounded by up to 14 mm long hairs and deltoid bracteoles *c.* 2.3 by 0.9 mm. *Sepals c.* 14 by 8 mm, coriaceous. *Petals* (4?—)5, broadly elliptic? up to *c.* 20 mm long, yellow. *Stamens c.* 50; filaments up to *c.* 10 mm; anthers up to 1.2 by 0.8 mm. *Style* up to *c.* 14 mm, 4—5-fid. *Fruit* ovate, up to 8 by 4 mm; operculum occupying $\frac{3}{4}$ of the height of the fruit, ± conical, mostly with an apical constriction, shining, straw-yellow. *Seeds c.* 0.8 mm ∅, shining, dark grey to black; testa cells elliptic with undulate margin, radially elongated.

Distribution: Australia: North of the Tropic of Capricorn (also Groote Eylandt).

3. ssp. **grandiflora** (Hook.) Geesink, *nov. stat.* — *P. grandiflora* Hook., Bot. Mag. n.s. 3 (1829) t. 2885; G. Don, Gard. Dict. 3 (1834) 74; Poelln. in Fedde, Rep. 37 (1934) 264; L. H. Bailey, Man. Cult. Pl. (1949) 364, t. 6. — T.: Tropical America, *Hooker* (K. *n.v.*). — **Pl. 2: 10.**

Herb. up to *c.* 30 cm. *Leaves* linear, up to 25 by 3 mm, with *c.* 5 mm long axillary hairs. Capituli up to *c.* 5-flowered, flowering successively. *Flowers* surrounded by up to 10 mm long hairs and deltoid bracteoles up to 4.7 by 2 mm (with transitions between involucral leaves and bracteoles). *Sepals c.* 8 mm long, with a very small apical keel. *Petals* 5 (always?), ± obovate, *c.* 25 mm ∅, pink, red, orange, or yellow, cultivated in many colours. *Stamens c.* 40—75; filaments up to *c.* 6 mm; anthers elliptic, *c.* 1.4 by 0.3 mm, 4-celled and 2-celled. *Style* up to *c.* 13 mm, 5—18-fid. *Fruit* ± globose, *c.* 5 mm ∅; operculum $\frac{1}{2}$ to $\frac{2}{3}$ of the height of the fruit, shining, straw-yellow. *Seeds c.* 0.7 mm ∅, shining; testa cells ± stellulate, the marginal ones with a central tubercle.

Distribution: Tropical America.

Notes: Sometimes escaped from cultivation.

I have refrained from mentioning ten further synonyms based on American material, already cited by Legrand (1962, p. 91) under *P. grandiflora* and its varieties.

4. ssp. **villosa** (Cham.) Geesink, *nov. stat.* — *P. villosa* Cham., Linnaea 6 (1831) 565; Walp., Rep. 2 (1843) 234; Schlechtend., Bot. Zeit. 11 (1853) 737; Gray, Bot. U.S. Expl. Exp. 1 (1854) 140; Drake del Cast., Ill. Fl. Ins. Pac. (1890) 111; Poelln. in Fedde, Rep. 37 (1934) 298; Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 6; Egler in Fedde, Rep. 44 (1938) 264; Stone, Adv. Fr. Pl. Sc. 4 (1963) 147. — T.: Hawaiian Is, *Chamisso* (LE, *n.v.*). — **Pl. 2: 7.**

P. sclerocarpa Gray, Bot. U.S. Expl. Exp. 1 (1854) 141; Drake del Cast., Ill. Fl. Ins. Pac. (1890) 111; Poelln. in Fedde, Rep. 37 (1934) 298; Occ. Pap. Bern. P. Bish. Mus. 12, 9 (1936) 9; Stone, Adv. Fr. Pl. Sc. 4 (1963) 147. — T.: Hawaiian Is, *U.S. Expl. Exp.* (holotype US, *n.v.*, isotype A, BISH).

P. caumii F. B. H. Brown in Christoph. & Caum, Bern. P. Bish. Mus. Bull. 81 (1931)

29, t. 13a; Poelln. in Fedde, Rep. 37 (1934) 317. — T.: Hawaiian Is, Nihoa, *Caum 66* (holotype + 2 isotypes BISH).

P. hawaiiensis Degener, Fl. Haw. (1937) fam. 117; Stone, Adv. Fr. Pl. Sc. 4 (1963) 146. — T.: Hawaii, South Point, *Degener 10914* (holotype BISH, isotype A, BISH).

Herb up to *c.* 30 cm. *Leaves* obovate to linear, 5—22 by *c.* 3 mm, with up to *c.* 12 mm long axillary hairs. Capituli up to ?7-flowered. *Flowers* surrounded by up to 1.4 by 0.7 mm long bracteoles and up to *c.* 13 mm long hairs. *Sepals* up to 5 by 4 mm. *Petals* (4—)5(—6), obovate, up to 8 by 5 mm, white or pink with or without a white base. *Stamens* 18—50; filaments up to 4 mm; anthers *c.* 0.7 by 0.55 mm. *Style c.* 1—2 mm, (6—)7—8-fid. *Fruit* ± ovate, *c.* 3—5 by 3—4 mm; operculum *c.* ⅔ of the height of the fruit, shining, straw-yellow. *Seeds c.* 0.6—0.7 mm ∅, shining; testa cells stellulate or irregular.

Distribution: Hawaiian Islands.

Note: The fact that in the material described as *P. sclerocarpa* the operculum does not fall off and that its pericarp is thicker than in other specimens, I do not consider important.

5. ssp. **sundaensis** (Poelln.) Geesink, *nov. stat.* — *P. sundaensis* Poelln. in Fedde, Rep. 50 (1941) 105. — T.: Lesser Sunda Is, Sumbawa, *Mrs. Rensch* (holotype B, isotype BO). — **Pl. 2: 8, 9.**

Herb up to *c.* 10 cm. *Leaves* oblong to obovate, up to 8 by 3 mm, with up to 6 mm long hairs. Capituli 2—3-flowered. *Flowers* surrounded by bracteoles up to 0.7 by 1 mm and by *c.* 6 mm long hairs. *Sepals c.* 2.6 by 2.2 mm. *Petals* 5, obovate, *c.* 2.3 by 1.7 mm, orange, apex subacute. *Stamens* (6—)10—15; filaments *c.* 1.5 mm; anthers 0.3—0.4 by 0.25—0.35 mm. *Style c.* 1.6 mm, 5-fid. Fruit ± globose. *c.* 2.5 mm ∅; operculum ¾ the height of the fruit, dull, yellow to grey-brown. *Seeds c.* 0.55 mm ∅, occasionally shining, grey-brown to black; testa cells stellulate, occasionally with a tubercle.

Distribution: Malesia: Lesser Sunda Is, Sumbawa, type, Flores (*Verheyen* in L), Alor (*Jaag 799* in L, Z), Wetar (*Bloembergen 3764* in A, L).

6. ssp. **okinawensis** (Walker & Tawada) Geesink, *nov. stat.* — *P. okinawensis* Walker & Tawada, J. Wash. Ac. Sc. 41 (1951) 138, fig. on 139. — T.: Japan, Ryukyu Is, Onna-Mura, *Tawada 222* (US, *n.v.;* topotype *Walker & Tawada 6395*, KAG).

Herb up to *c.* 10 cm. *Leaves* oblong to obovate, up to *c.* 5 by 2 mm, *without axillary hairs.* Capituli 1—2-flowered. *Flowers* surrounded by *c.* 1.4 by 0.7 mm long bracteoles, hairs absent. *Sepals c.* 3 by 3 mm. *Petals* 5—6, *c.* 6.6 by 4(?) mm, white, orange, or white with reddish base. *Stamens* 15—25; filaments *c.* 3.5 mm; anthers *c.* 0.65 by 0.50 mm. *Style c.* 4 mm, 5-fid. *Fruit* ± globose, *c.* 2.5 mm ∅; operculum ⅔ to ¾ the height of the fruit, dull, yellowish to grey-brown. *Seeds c.* 0.6 mm ∅, ± shining; testa cells stellulate, like those of *P. pilosa* ssp. *villosa.*

Distribution: Japan: Ryukyu Is.

7. ssp. **papulosa** (Schlechtend.) Geesink, *nov. stat.* — *P. papulosa* Schlechtend. [Bot. Zeit. 11 (1853) 671, prov. name] *ex* Poelln. in Fedde, Rep. 37 (1934) 257; Geesink, Gorteria 4 (1969) 189, fig. 1. — T.: unlocalized, cultivated from seed by Schlechtendal (acc. to Legrand in B, *n.v.*). — **Pl. 2: 11.**

P. advena Reichg. & Poelln. in Fedde, Rep. 46 (1939) 77. — T.: Netherlands, Erp, *Th. J. Reichgelt s.n.*, culta (holotype L).

Herb up to *c.* 10 cm. *Leaves* 2—6 by 1—2 mm, with up to 4 mm long axillary hairs. Capituli 2—4-flowered. *Flowers* surrounded by bracteoles *c.* 3.5 by 3 mm long and by up

to *c.* 6 mm long hairs. *Sepals c.* 1.5 by 1.5 mm. *Petals* (4—)5, ± elliptic, *c.* 2.5 by 1.5 mm. yellow. *Stamens* (6—)10(—12); filaments up to *c.* 2.2 mm; anthers *c.* 0.30 by 0.30 mm, *Style c.* 1 mm, 4—5-fid. *Fruit* ± globose, *c.* 2.5 mm ∅; operculum *c.* ⅔ the heigt of the fruit, straw-yellow to grey-brown. *Seeds c.* 0.6 mm ∅, shining; testa cells stellulate, tangentially elongated.

Distribution: S. America: Uruguay, Argentinia. Adventively found in Holland in cereal garbage.

Note: This subspecies has some four further synonyms based on American material and cited by Legrand (1962, p. 116) under *P. papulosa.*

8. ssp. **lakhonensis** (Gagn.) Geesink, *nov. stat.* — *P. lakhonensis* Gagn., Bull. Soc. Bot. Fr. 56 (1909) 41; Fl. Gén. I.-C. 1 (1909) 276; Poelln. in Fedde, Rep. 37 (1934) 314. — T.: Laos, Lakhon, *Thorel* (P). — **Pl. 2: 12.**

Herb up to *c.* 15 cm. *Leaves* oblong, acute, *c.* 7 by 2 mm, with up to *c.* 4 mm long axillary hairs. Capituli *c.* ?3-flowered. *Flowers* surrounded by up to 2.5 mm long hairs and deltoid bracteoles *c.* 1.5 by 1.2 mm. *Sepals c.* 3 by 3 mm. *Petals* 5, obovate, 0.3 by 2 mm. *Stamens* 20; filaments up to *c.* 2 mm; anthers *c.* 0.36 by 0.30 mm. *Style c.* 1.2 mm, 8-fid. *Fruit* ± obconical, *c* 2.5 mm ∅; operculum *c.* ⅛ the height of the fruit, ± flat. *Seeds* (unripe) *c.* 0.5 mm ∅, red; testa cells with an up to 0.06 mm long spine.

Distribution: Laos.

Note: The single specimen known of this subspecies has unripe seeds. Possibly, it is an inadequate specimen of *P. pilosa* ssp. *pilosa* race *'tuberosa'* or *'pachyrhiza'*.

INSUFFICIENTLY KNOWN SPECIES AND VARIETIES

P. bonensis Tuyama, Bot. Mag. Tokyo 53 (1939) 6. — T.: Japan, Bonin, *Hattori* (TI, *n.v.*).

This is probably *P. pilosa* ssp. *pilosa* (race *'tuberosa'*).

P. conspicua Domin, Bibl. Bot. 22 (1925) 651. — T.: Australia, NW. Queensland, Cloncurry, *Domin* (PR, *n.v.*).

This is probably *P. cyclophylla.*

P. dubia Tepper [Trans. R. Soc. S. Austr. 22 (1893) 16, prov. name] *ex* Poelln. in Fedde, Rep. 37 (1934) 295. — T.: not indicated; acc. to Hj. Eichler (in litt.) prob. lost.

This is probably *P. pilosa* ssp. *pilosa* (race *'pilosa'*).

P. formosana Poelln. in Fedde, Rep. 50 (1941) 6, *non* Hayata *ex* Sasaki, 1930. — T.: Formosa, *Faurie 200* (prob. lost).

This is probably *P. pilosa* ssp. *pilosa* (race *'tuberosa'*).

P. insularis Hosokawa, Trans. Nat. Hist. Soc. Form. 22 (1932) 229. — T.: Formosa, *Hosokawa 1628* (TAI, *n.v.*).

This is probably *P. pilosa* ssp. *pilosa.*

P. intraterranea Black, Trans. Proc. R. Soc. S. Austr. (1926) 283. — T.: S. Australia, Warburton R., *Reese* (AD?, *n.v.*).

This is possibly *P. pilosa* ssp. *pilosa* (race *'filifolia'*).

P. microsperma Domin, Bibl. Bot. 22 (1925) 650; Poelln. in Fedde, Rep. 37 (1934) 299. — T.: Australia, N. Queensland, Chillagoe, *Domin* (PR, *n.v.*).

This is probably *P. pilosa* ssp. *pilosa* (race *'australis'*).

P. napiformis F. v. M. *ex* Benth., Fl. Austr. 1 (1863) 169; F.M. Bailey, Queensl. Fl. 1 (1899) 94; Ewart & Davies, Fl. North. Terr. (1917) 107; Poelln. in Fedde, Rep. 37 (1934) 301. — T.: Australia, North. Terr., Victoria R., and Beagle Valley, *F. von Mueller* (not in MEL, *n.v.*).

This is probably *P. pilosa* ssp. *pilosa* (race *'australis'*)

P. oleracea var. *grandiflora* F. v. M. *ex* Benth., Fl. Austr. 1 (1863) 169. — T.: Australia, North. Terr., Sturt's Creek, *F. von Mueller* (not in MEL, prob. lost).

Black, Trans. Proc. R. Soc. S. Austr. (1926) 283 and von Poellnitz in Fedde, Rep. 37 (1934) 261, consider it a synonym of *P. intraterranea*; *vide supra.* I can not suggest its identity.

P. psammotropha Hance in Walp., Ann. 2 (1852) 660; Schlechtend., Bot. Zeit. 11 (1853) 740; Poelln. in

Fedde, Rep. 37 (1934) 315. — T.: China, Tungsha Tao (= Pratas Is), *Hance* (BM, *n.v.*).

This is probably *P. pilosa* ssp. *pilosa* (race '*pachyrhiza*').

P. vilmoriana Leveillé in Fedde, Rep. 8 (1910) 259; Poelln. in Fedde, Rep. 37 (1934) 315. — T.: Korea, Quelpart, *Taquet 2512* (P, *n.v.*).

This is possibly *P. pilosa* ssp. *pilosa* (race '*pachyrhiza*') or an escaped *P. pilosa* ssp. *grandiflora*.

EXCLUDED SPECIES

P. axilliflora (Schrank) Pers., Syn., 2 (1807) 6; G. Don, Gard. Dict. 3 (1834) 75; Walp., Rep. 2 (1843) 233; Schlechtend., Bot. Zeit. 11 (1835) 686; Poelln. in Fedde, Rep. 37 (1934) 311. — *Meridiana axilliflora* Schrank, Bot. Zeit. Regensb. 3 (1804) 354.

As has been mentioned under the generic description, Schrank's monotypic genus cannot belong to *Portulaca*. For its identity we have thought that it might belong to Lythraceae, notably *Ammannia*, or Aizoaceae, notably *Trianthema*. An obstacle to accept the first affinity is the solitary, sessile, axillary flowers, for the latter the opposite leaves and the 5-merous flowers.

From a letter by Dr. Merxmüller (dated 24-9-69) we learned that unfortunately no type specimen of Schrank's plants — cultivated in the botanical garden at Ingolstadt — is preserved. However, Dr. Merxmüller provided the essential information that in the Munich Herbarium there are several sheets in the Schreber Herbarium of *Trianthema portulacastrum*, testimony that this species was at Schranks period cultivated in Bavarian gardens. More important is, that both Dr. Merxmüller and Dr. Friedrich have observed that in *Trianthema portulacastrum* also occasionally 4-merous flowers occur. Follo wingthis encouraging observation we have re-examined herbarium sheets of this plant. Though its leaves are opposite — Schrank admitted this only for the 'Jugendblätter' — it appears that full-grown plants show indeed an alternate branching, and this has confused Schrank's description. Summarizing, we agree with Dr. Merxmüller, that Schrank's plant must belong to *T. portulacastrum* and the genus *Meridiana* Schrank is a synonym of *Trianthema*. Kind thanks are due to Dr. Merxmüller for his keen interest and vital help.

INDEX TO SPECIFIC AND INFRASPECIFIC EPITHETS

The numbers refer to the numbers of the species in the text; the number after a colon refers to the number of the subspecies.

Epithets followed by 'Insuff.' are listed and commented on in the last chapter listing the insufficiently known species and varieties. One is referred to Excluded species as 'Excl.'.