

# Trianthea SESUVIOIDEAE

H. E. K. Hartmann

**Trianthea** L. 1753: 223; Jeffrey 1960: 235–237; Hartmann 2001: 330–337; Hartmann 2008: 191; Hartmann et al. 2011: 177–213; Hartmann et al. 2013: 209–221 ≡ *T.* § *Rocama* (Forskål) DC. 1828: 352 **Typus** *T. portulacastrum* L. **Etym** Gk *tri-*, prefix for three, *antheon*, flower, referring to the flowers in crowded cymes, sometimes three in a group ≡ *Portulacastrum* Jussieu ex Medikus 1789: 99 **Typus** *Portulacastrum monogynum* Medikus = **T. portulacastrum** L. ≡ *Remè* Adanson 1763: 245 **Typus** not given = *Ancistrostigma* Fenzl 1839: 293 **Typus** *Ancistrostigma cypseloides* Fenzl ≡ **T. cypseloides** (Fenzl) Bentham = *Papularia* Forskål 1775: 69 ≡ *T.* subg. *Papularia* (Forskål) Jeffrey 1960: 247 ≡ *T.* subg. *Papularia* (Forskål) Jeffrey ex Adamson 1962: 247 **Typus** *Papularia crystallina* Forskål ≡ **T. crystallina** (Forskål) Vahl.

Annual to perennial herbs, branches basally sometimes woody, prostrate, diffuse or, more rarely, creeping; **L** of a pair unequal in size, petioles widening at the base forming papery sheaths named pseudostipules, blades terete to flat, epidermis ± glabrous, papillate, or hairy; **Fl** solitary or in ± compact cymes, each **Fl** with a bract and 2 bracteoles, perigon basally connate forming a tube with a plain nectary ring often with only few

nectary slits in the bottom part of the tube, perigon lobes 5, stamens 5 to many, adnate to the upper part of the perigon, ovary with a single stigma; **Fr** a circumscissile pyxidium, the operculum falling off containing 1 to several seeds, the base persisting on the plant with 1 to several seeds; **S** triangular, reniform or curved, smooth or ornamented, often papillate, black; **Ecol** in dry areas, often in saline places in tropical and subtropical climates (Fig. 1); **Distr** in a broad belt around the equator from 40° N to 40° S.

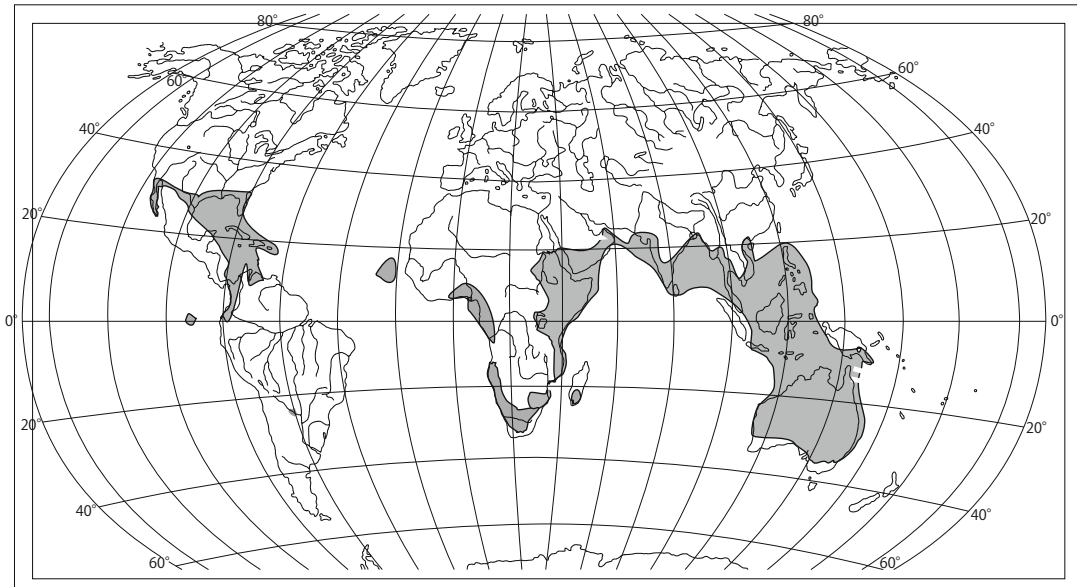
*Note:* Delimitation of the genus follows Jeffrey (1960: 235–238), who stated that, in spite of the mentioning of two “styles” by Linnaeus in the original description, a monogynous plant was meant when **T. portulacastrum**, and the genus, were described (Linnaeus 1753: 223). The genera **Sesuvium** and **Zaleya** possess at least two stigmas per ovary, **Sesuvium** differing, furthermore, from **Trianthea** and **Zaleya** by the possession of numerous seeds in an axillary position. **Zaleya** can be distinguished from the other two genera by the possession of an operculum breaking into two units representing two clausae, each containing one seed.

De Candolle (1828: 352) divided the genus **Trianthea** into two sections:

*T.* § *Zaleya* (Burman) DC. 1828: 352 with 10 stamens and *T.* § *Rocama* (Forskål) DC. 1828: 352 with 5 stamens. Since **T. portulacastrum**, as *T. monogyna*, is placed in *T.* § *Rocama*, that section is synonymous with **Trianthea**.

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**Fig. 1** Distribution: The genus is found in a broad band between 40° N and S, leaving the wet tropical lowlands free (Copyright H.E.K. Hartmann)

#### Key to the Subgenera of *Trianthema*

1. Ovules 4 to many, seeds 4 to many, very rarely only 1, flowers usually solitary	<b>T. subg. <i>Trianthema</i></b>
– Ovules 2, one above the other, rarely only one, flowers usually in cymes	<b>T. subg. <i>Papularia</i></b>

Jeffrey (1960: 237) re-establish **Zaleya** and **Trianthema** at genus rank and divided the latter into two subgenera, **T. subg. *Trianthema*** and **T. subg. *Papularia***. These names are validly published, in contrast to suggestions by Bittrich (1990: 120) and Hartmann (2001), see Hartmann et al. (2011). Hartmann et al. (2011) were the first to investigate material on a worldwide base, placing all named species in one of the two subgenera and presenting a first survey of **Trianthema** subg. **Papularia**. A first indication of such a subdivision based on molecular studies was indicated in Hassan et al. (2005) and is supported by additional studies with different markers (unpublished data).

Regarding the gender of **Trianthema**, it has been established by use that the name is feminine, but that **Trianthema portulacastrum** is correct since it represents the older Synonym of Sauvages (1751), according to art. 23.5 in ICBN 2006, example 6. For the latest discussion see Hartmann et al. (2011).

Adanson (1763: 245) cited the synonyms **Portulaca** based on Hermann 1698: 213, t. 213, and **Trianthema** L. Therefore, *Remè* is a substitute for both aforementioned names and thus superfluous and illegitimate.

#### **T. subg. *Trianthema***

Annual to perennial herbs or shrubs, adventitious roots in some species present, these plants forming huge mats; **I** usually with sparse bladder cells, mostly low, but in some species long, resulting in a hairy appearance; **L** usually with straight margins, bladder cells mostly inconspicuous, but long in some species forming hairs, blades acuminate or rounded, oblong to almost globose, also linear, usually wider than thick, pseudostipules mostly narrow, rarely broader than the blade's width; **Inf** in most cases a single **Fl**, but in some species some more, never >5, bract and the bracteoles rarely grown together with the base of the **Fl**, which usually is free, bracteoles mostly acute or

acuminate, never fimbriate, tepals with long sub-apical horns overtopping the tepal tips, tube and teeth about the same length, stamens very rarely 5 in some flowers of a species, the majority of **Fl** with more than 10 and up to 100 stamens; **Fr** operculum from elongate to oval, at least concave in shape, the centre in most species higher than the lower edge of the operculum, very rarely flattish in few species; **S** many per fruit, 4–8 or 6–8 in most species, 2 and 1 very rarely in certain species, smooth, with crests or with papillae; **Ecol** often in saline places, also near or at the shore, also in mangrove vegetation; **Distr** in a broad band

between 40°N and S, the majority of species known from Australia.

*Note:* The Australian material has been studied in detail for the Flora of Australia (Prescott 1984); remarkable are the opercula and the seeds, both characters offering clear correlations in distinct character states permitting the construction of a key for the Australian material.

**T. subg. Papularia** (Forskål) Jeffrey 1960: 237

**Typus T. crystallina** (Forskål) Vahl

Annual to perennial plants, the latter often also flowering in their first year, rarely deciduous,

#### Key to the Species of *T. subg. Trianthema*

1. Plants with many and stiff hairs	2
– Plants glabrous or with low bladder cells	6
2. Operculum cylindrical with a truncate top, the centre depressed	<b>T. pilosa</b>
– Operculum flat or convex	3
3. Operculum flat on top with a hyaline cover	<b>T. patellitecta</b>
– Operculum with a raised centre	4
4. Operculum ending in the persisting recurving stigma	<b>T. rhynchocalyptra</b>
– Operculum with a rounded top	5
5. Pyxidium with a single big seed and a wing below the tip of the operculum	<b>T. megasperma</b>
– Pyxidium with two seeds, the long apically rounded operculum with a slight dip at the top; only in E Africa	<b>T. ceratosepala</b>
6. The single flower firmly connate with the basal pair of bracteoles, the complex squeezed into the narrow gap between the petiole and the axis, the top of the operculum surrounded by a thinner rim	<b>T. portulacastrum</b>
– Flowers free, the top of the operculum concave and sometimes petering out into the stigma	7
7. Flowers in elongated loose cymes > leaves	<b>T. cypseloides</b>
– Flowers solitary, sometimes 2–3	8
8. Top of operculum shaped like a narrow dome, with a central small dip, stamens very many; only known from Venezuela	<b>T. hecatandra</b>
– Top of the operculum bearing a stigma at or near the highest point; only in Australia	9
9. Seeds smooth	13
– Seeds rough from papillae of different sizes or from prominent more or less semicircular crests over the sides	10
10. Stigma comma shaped in side view, somewhat flattened, subapically fixed to the dome-shaped operculum	<b>T. glossostigma</b>
– Stigma erect	11
11. Seeds with many semicircular crests over the sides, leaves thick to clavate	<b>T. turgidifolia</b>
– Seeds with prominent papillae	12
12. Operculum as high as wide	<b>T. oxycalyptra</b>
– Operculum higher than wide	<b>T. cussackiana</b>
13. Seeds black, leaf tips rounded	<b>T. compacta</b>
– Seeds brown to black; leaf tips mucronate	<b>T. kimberleyi</b>

erect, decumbent or procumbent branches, never rooting, but sometimes the hypocotyl thickening conspicuously with age, young **I** with bladder cells, older usually smooth and woody (if perennial); **L** equipped with pseudostipules at the base of the stalk, shapes often specifically distinct, blades flat, bladder cells from inconspicuous to prominent; **Inf** mostly with several flowers in more or less dense groups, rarely expanding during the ripening process of the fruit, young plants very rarely with a single flower in the axil of the leaf; **Fl** free perigon tips with subapical enations or thickenings, the basal tube with few nectary slits in a ring, five to fewer stamens fixed at the top of the perigon tube, anthers and pollen often in bright contrasting colours, the only central stigma surrounded by an elevated ring like a thick earthen wall; **Fr** a pyxidium, the operculum always with a prominent mostly broad rim, the base either with vertical sides or widening towards the base, the whole top resembling a puffed sleeve because the rim does not expand; **S** usually two, one in the operculum and one in the basal cup, rarely only one seed, this sometimes accompanied by remains of an ovule; **Ecol** often in disturbed places, also in saline soils, in tropical climates; **Distr** the majority of species known from Africa, but also in Asia, Australia, and with one species in Argentina.

*Note:* Of the 17 species distinguished in the subgenus, twelve species are found in Africa and the adjacent Arabian peninsula. They fall into a northern and a southern group, no species has been documented to occur in both parts of the area. Two species have been documented in Asia, two more in Australia, and one in South America. Relations in Asia remain unclear, due to lack of material, but so far no species has been found to occur on two continents.

*T. americana* = **Sesuvium parviflorum**

*T. anceps* ≡ **Acrosanthes anceps**

**T. argentina** Hunziker & Cocucci 1959: 17 subg. **Papularia** **T** Hunziker, Cocucchi & di Fulvo 13865 (CORD).

Annual herbs with oblique to erect branches; **I** sparsely papillate; **L** blades obovate to spatulate,



**Fig. 2** *Trianthema argentina* in habitat with a dense cover of big bladder cells, resembling conditions in *T. crystallina* and *T. sheilae* from NE Africa and Arabia (Copyright R. Kiesling)

covered densely with big globose bladder cells (Fig. 2), petioles 3–4.5 mm l, pseudostipules rectangular pergamentaceous wings ending in a short tooth, blades 11–13 mm l, 6–8.5 mm b; **Inf** in dense cymes; **Fl** the tiny bract and bracteoles narrowly acuminate, perigon lobes about as long as the tube, the tube smooth, the teeth with big globose bladder cells outside, 1 stamen, rarely 2–3; **Fr** obconical, operculum truncate with a wing-like margin surrounding the periphery, only a low ring of tissue below this ornamentation; **S** ovoid, the lower one sometimes lenticular, with some low almost circular ridges, black, 1.2–1.4 mm l; **Ecol** in fine loam in flats along the road in big colonies after rains; **Distr** Cordoba, Argentine.

*Note:* The species is remarkable in two aspects: it possesses mostly a single stamen only in the flower, and it occurs in a restricted area in South America, where few members of the genus have been found. Yet, the leaves with big globose bladder cells resemble those of **T. crystallina** and **T. sheilae** from N Africa and SW Arabia closely.

*T. australis* ≡ **Zaleyia galericulata** ssp. **australis**

*T. camillii* = **Zaleyia camillii**

**Key to the Species of *T. subg. Papularia***

1.	Operculum with a horizontal veil held by the outer rim of the wide central deepening; plants only found in Australia	<b>2</b>
–	Operculum without a veil, the concave base openly visible; plants found outside Australia	<b>3</b>
2.	Leaf blades ovoid with a rounded tip, operculum 1–1.5 mm wide	<b><i>T. clavata</i></b>
–	Leaf blade with a hyaline mucro, breaking off with age, operculum about 2 mm wide, resembling a ufo in shape	<b><i>T. ufoensis</i></b>
3.	Leaf blades and tepal teeth covered completely by big globose bladder cells	<b>4</b>
–	Leaf blades and tepal teeth smooth from inconspicuous bladder cells or acuminate bladder cells as short hairs in loose arrangement	<b>6</b>
4.	Inflorescence with a fimbriate bract and bracteoles, stamens five	<b>5</b>
–	Inflorescence with a tiny acute bract and similar bracteoles, a single stamen, rarely two; only in Argentina	<b><i>T. argentina</i></b>
5.	Tepals yellow inside, flowers 6 mm wide; reported from NE Africa, SW Arabia and Yemen	<b><i>T. sheilae</i></b>
–	Tepals green inside, about 4 mm wide; recorded only from SW Arabia and Yemen	<b><i>T. crystallina</i></b>
6.	Plants deciduous in the dry season, pedicels elongating during fruit ripening; only near the mouth of the Gariep River in South Africa and Namibia	<b><i>T. corymbosa</i></b>
–	Plants with leaves during the dry season	<b>7</b>
7.	Flowers basally embedded in the bottom of the inflorescence, the inflorescence breaking off as a whole; bases of tepal teeth forming prominent bulges on the otherwise straight erect long sides of the flower	<b>8</b>
–	Flowers basally free, breaking off individually; without or with inconspicuous bulges at the bases of the tepal teeth	<b>9</b>
8.	Two seeds per pyxidium, sometimes the basal one not fully developed; from S Zimbabwe through the old Transvaal Province and into KwaZulu/Natal, South Africa	<b><i>T. transvaalensis</i></b>
–	Only one seed inside the pyxidium; in a N–S band through the west of Kenya and Tanzania	<b><i>T. salsoloides</i></b>
9.	Internodes and leaf blades with elongate acuminate bladder cells like hairs visible to the naked eye; only along the southern coast of Somalia and the northern coast of Kenya	<b><i>T. corallicola</i></b>
–	Internodes with low and inconspicuous bladder cells, never eye-catching	<b>10</b>
10.	Pseudostipules along petioles narrowing gradually from the base to the blade	<b>11</b>
–	Pseudostipules along petioles broad and wide, separated distinctly and ending well below the blade	<b>12</b>
11.	Tepal teeth more or less smooth, connivent over the operculum; around the Gulf of Bengal	<b><i>T. triquetra</i></b>
–	Tepal teeth always with bladder cells; in Pakistan and adjacent parts of India	<b><i>T. pakistanensis</i></b>
12.	Pseudostipules to both sides of the petiole rounded, the pair forming a broad ellipse; tepal teeth as long as the basal tepal tube, erect; only known from sandy riverbeds in Namibia near the coast	<b><i>T. hereroensis</i></b>
–	Pseudostipules more or less angular, broad and spreading, usually ending in a short broad tooth	<b>13</b>
13.	Tepal teeth straight with distinct small finger-shape bladder cells	<b>14</b>
–	Tepal teeth curving over the pyxidium top to various degrees	<b>15</b>
14.	Operculum with a smooth broad rounded rim; only in SE Kenya and adjacent parts of Tanzania	<b><i>T. sanguinea</i></b>
–	Operculum shaped like a puffed-sleeve; only in the central plateau of South Africa	<b><i>T. vleiensis</i></b>
15.	Base of leaf persisting as a white sheath with several layers of pseudostipules along the stem; from Namibia to the Great Karoo in South Africa	<b><i>T. parvifolia</i></b>

*(continued)*

–	The pseudostipules at the base of the leaves short-lived and brittle, decaying soon	16
16.	Pseudostipules ending in a rectangle pointing outwards; only known from coastal southern Mozambique	<b>T. mozambicensis</b>
–	Pseudostipules with an oblique edge adorned with a short tooth more or less in its middle; from Morocco to SW Arabia and Yemen	<b>T. sedifolia</b>

**T. ceratosepala** Volkens & Irmischer In: Schellenberg 1913: 497 subg. **Trianthema** **T** Volkens 2219 (B!).

Shrubs to 50 cm h, branching profusely from the base, branches ± erect; **I** with scaly-warty papillae pointing backwards; **L** petioles c. 10 mm l, obovate, rounded, or acuminate, epidermis with papillae pointing downwards on both sides, blades up to 30 mm l, 4–15 mm b; **Fl** mostly 1, rarely few, perigon 10–12 mm l, Ø 4 mm, perigon lobes with broad, purple margins, middle vein hairy on the back, stamens 20–30; **Fr** ovate with a central apical dip and two short lobes, 8 mm l; **S** 6, thick, lentil-shaped, black, rough from many low crests, 2 mm l; **Ecol** near cultivated ground; **Distr** Masai, Kenya; Moshi, Tanzania.

*Note:* Jeffrey (1961: 25) reports the species also from Somalia and Ethiopia, but no such material has been found in the area in the preparation of the Flora of Ethiopia and Eritrea.

**T. clavata** (J.M.Black) H.E.K.Hartmann & Liede in Hartmann et al. 2011 ≡ *T. crystallina* (Forskål) Vahl var. *clavata* J.M.Black 1923 Transaction and Proceedings of the Royal Society of South Australia: 369 ≡ *T. triquetra* Willdenow ex Sprengel var. *clavata* (J.M.Black) H.Eichler 1965: 136 subg. **Papularia** **LT**, designated by Prescott 1984: 319, Cockburn s.n. (AD, seen as Scan).

Annual herbs with prostrate branches; **I** purple; **L** clavate, epidermis with some translucent cells, sometimes arranged in short lines on the upper leaf surface, 4–7 mm l, 2–3 mm t, some bigger bladder cells along the rounded margins, pseudostipules < petiole length, each flap ending in a short broad tooth pointing sideways; **Inf** with numerous flowers, bracts and bracteoles acuminate; **Fl** tepal teeth apically thickened, the outer ones with short protrusions fixed subapically, all connivent over the operculum, bladder cells most common at the tips; **Fr** operculum with a hyaline veil expanded over the interior, later either

splitting or sinking into the central deepening, forming a finely pleated layer there, the rim rather broad, the whole operculum turning reddish purple while ripening, sometimes only with red-purple dots; **S** 2, sides with curved crests; **Ecol** in heavy or shallow soil, in flood plains or at the edge of gravelly watercourses; **Distr** mainly in the centre of Australia: Northern Territory, South Australia, West Australia.

*Note:* The species shares the hyaline veil over the operculum with **T. ufoensis**, both species have been found in close proximity in some areas. **T. clavata** never shows a mucro like **T. ufoensis** does, and it has distinct clavate leaves with the occasional longitudinal line of translucent cells, a feature otherwise known as a regular feature along the entire leaf in **T. transvaalensis** and **T. vleiensis** from southern Africa.

**T. compacta** C.T.White 1919: 10 subg. **Trianthema** **T** Bailey s.n. (BRI).

Herbs with prostrate to ascending branches; **I** glabrous; **L** the bigger one of a pair with a well developed denticulate basal sheath on the petiole, the smaller consisting of blade and sheath only, blades oblong to nearly orbicular, 4–7 mm l, 4–7 mm b; **Fl** solitary, pedicels 2–4 mm l, the single bract ovate, perigon tube 1.5 mm l, lobes 2 mm l, pink inside, stamens 5–7, irregularly arranged, many ovules; **Fr** operculum subglobose, c. 2 mm l; **S** several, elongate ovate, shiny, black, smooth, 0.5 mm l; **Ecol** on shores; **Distr** Northern Territory, Queensland, Australia.

*Note:* The combination of smooth, small seeds with a nearly globose capsule permit an instant identification of this coastal species with almost round leaves.

**T. corallicola** H.E.K.Hartmann & Liede 2011: 195 subg. **Papularia** **T** Friis et al. 5029 (C!, IT B!, K!).





**Fig. 3** *Trianthema corymbosa* with thick ovoid leaves, withering later in the season, here visible as *dry dark shapes*, leaving the plant leafless in the dry season (Copyright H.E.K. Hartmann)

Prostrate annual to perennial plants; **I** usually longer than blades, with reflexed hairs to 0.5 mm l, thinning out towards the base and rubbed off with age; **L** about 18 mm l, 4 mm b, almost cylindrical to ovoid, apically ending in a group of elongate papillae sitting on a broad base, the normal epidermal cells with cuticular folds, petioles with very broad pseudostipules ending in a broadish awn or tooth clasping the stem; **Inf** dense in the axils of the leaves; **Fl** with a broadly acuminate bract with a row of long hairs along its centre, the bracteoles slender and pointed, tepal tube smooth but with a row of hairs along the central vein, teeth with long bladder cells along margins and keel, connivent over the flower, their tips with finger-shaped hairs just visible to the naked eye, stamens 2; **S** 2, completely smooth, round in side view, about 1 mm l and t; **Ecol** in sandy patches on coral reefs at the sea or on gypsum further inland; **Distr** NE Kenya, S Somalia.

*Note:* The species is morphologically unique in the subgenus and seems to be strictly adapted to the restricted ecological situations.

**T. corymbosa** (Sonder) H.E.K.Hartmann & Liede in Hartmann et al. 2011: 197 = *T. crystallina* (Forskål) Vahl var. *corymbosa* Sonder in Harvey & Sonder 1862: 598 ≡ *T. corymbosa* E.Meyer ex Drege 1843: 93 nomen nudum ≡ *T. parvifolia*

Sonder var. *corymbosa* (Sonder) Adamson 1962: 251 subg. **Papularia** **LT**, designated by Adamson 1962: 251, Drege s.n. S 04–457 (S!) = *T. rubens* E.Meyer ex Sonder in Harvey & Sonder 1862: 598 ≡ *T. rubens* E.Meyer ex Drege 1843: 92 nomen nudum ≡ *T. parvifolia* Sonder var. *rubens* (Sonder) Adamson 1962: 250 **LT**, designated by Adamson 1962: 251, Drege s.n. S 04–455 (S!).

Perennial plants of up to 1 m in diam., branches decumbent, hence only up to 20 cm tall, taproot to 10 cm l, apically to 5 mm diam., plants deciduous during the dry season, bearing ripe fruits then; **I** woody when dry, young ones purple, intermediate ones ochre to orange, smooth to finely papillate; **L** blades ovoid, with sparsely distributed dark dots in places where the outer tissue is lacking, leaving the assimilating tissue below visible (Fig. 3), no elevated cells on the surface, the two pseudostipules broadening towards the base over the whole length of the petiole, sometimes a low broad tooth visible, but usually not as broad as the blade; **Inf** dense when young, but pedicels elongating during the ripening phase of the fruit developing a long-stretched **Inf** separating the 6–9 **Fl** clearly, the pedicels with tiny acuminate bracts and two narrow pointed bracteoles, tepals completely smooth, green on both sides, erect and even spreading in the ripe fruit, each with a

subapical thickening but no horn or tooth discernible, stamens 5, purple or golden-orange; **Fr** with a prominent broad collar-shaped rim of big semiglobose cells, sharply separated from the base that widening towards its bottom, the central dip small, 1.2 mm in diam. and 0.6 mm h; **S** mostly 2, sometimes one abortive, black, sides and edge with crests in more or less semi-circular shapes, almost round in side view, about 9 mm in diam., 0.4 mm t; **Ecol** mostly in disturbed open places in sand, gravel, rock below quartz or granite, 240–560 m alt.; **Distr** on the lower slopes of the Gariep River in Lüderitz District, Karas, Namibia, and in Namaqualand, NC, S Africa.

*Note:* Most remarkable of this species is its deciduous condition, leaving the plants like mummies in habitat over the dry season. Further, it is the only species in the subgenus exhibiting a distinct growth during the ripening phase of the fruit. The plants share the dotted leaves with **T. parvifolia**, the distribution area of which touches the area of **T. corymbosa** at the latter's eastern border. No mixed populations have been found until now.

**T. crystallina** (Forskål) Vahl 1790: 32 ≡ *Papularia crystallina* Forskål 1775: 69 subg. **Papularia T** Forskål C III. 14 (C!) = *T. crystallina* (Forskål) Vahl forma *suberosa* Terraciano 1894: 108 **T** Terraciano 187 (FT) = *T. crystallina* (Forskål) Vahl forma *obscura* Armari 1904: 146 **LT**, designated by Hartmann 2001: 332, Terraciano 51 bis (FT).

Herbs when young, growing into shrubs with procumbent to erect woody branches; **I** papillate, terete, the whole plant looking crystalline when young, with age woody and smooth, turning white, usually > **L**; **L** blades circular to oval, covered densely by big globose papillae forming a secondary layer over the epidermis, the bladder cells drying into flat overlapping discs, 7–9 mm across when fresh, 4–5 when dry, the very broad pseudostipules usually with two very sharply pointed protrusions or teeth; **Inf** in dense cymes of mostly 5 **Fl**; **Fl** with a broad translucent bract and two fimbriate bracteoles disintegrating with age, perigon calyx-shaped, about 3 mm diam. when open, green inside, the tepal teeth

densely covered in big bladder cells like the leaf blades, bending over the operculum when the fruit is ripe, their bases smooth and not bulging at their contact points, stamens 5, anthers red, pollen pale yellow, the free teeth; **Fr** with a broad rugose rim around the sunken centre, inner and outer walls almost straight, about 2 mm in diam., 0.4 mm in height, almost globose when young; **S** 2 per capsule, with prominent crests around the outer edge and about 8 straight bulges, the sides smoother, 1–1.1 mm l, 0.9 mm b, 0.6 mm t; **Ecol** in disturbed open sandy to stony or gravelly places, in dry wadis (Fig. 4), mostly at or near the sea, 0–560 m alt.; **Distr** SW Arabia, Sudan, W Yemen.

*Note:* The species differs mainly from the partially sympatric **T. sheilae** in having small green flowers; both species may only represent subspecies or varieties of one species (Hartmann et al. 2013: 209–221). Similar to these two taxa is **T. sedifolia**, which, however, lacks the big bladder cell cover over the leaf blade.

*T. crystallina* forma *obscura* = **T. crystallina**

*T. crystallina* forma *suberosa* = **T. crystallina**

*T. crystallina* var. *clavata* ≡ **T. clavata**

*T. crystallina* var. *corymbosa* ≡ **T. corymbosa**

*T. crystallina* var. *rubens* = **T. corymbosa**

*T. crystallina* var. *sedifolia* ≡ **T. sedifolia**

**T. cussackiana** F.Mueller 1895: 207 subg. **Triantheme T** Cussack s.n. (K?, isotype MEL).

Prostrate to ascending herbs, **I** glabrous; **L** petiole dilated into a rectangular membranous denticulate sheath, which persists sometimes, terete, mucronate, channelled below, nearly glabrous, 5–40 mm l, 3 mm Ø; **Fl** 2 to several in a cyme, sessile to shortly pedicellate, pedicels 1 mm l, thick, bracts ovate, bracteoles lanceolate, perigon tube 2–3 mm l, lobes c. 3 mm l, purple inside, stamens 10, ovules 4–10; **Fr** operculum shaped like a jelly-bag, i.e. the stigma drawn out into a fine point from a round base; **S** reniform, black, aril hyaline, papillae shorter on both sides, c. 2 mm l; **Ecol** in the vicinity of a river; **Distr** West Australia, Australia.

*Note:* The species appears to occur in a restricted area only.





**Fig. 4** *Trianthema crystallina* in habitat in NE Sudan in a wadi mixed with other ephemeral vegetation after good rains (Copyright H.E.K. Hartmann)

**T. cypseloides** (Fenzl) Benth **1866**: 331 subg. *Trianthema*  $\equiv$  *Ancistrostigma cypseloides* Fenzl **1839**: 293 T Bauer s.n. (W?).

Perennial herbs with prostrate branches rooting distally; **I** filiform, glabrous, densely covered by the **L**; **L** petiolate, opposite and alternate, blades ovate to subrotund, up to 5 mm l, up to 2.5 mm b, ovary with 7–10 ovules; **Fl** solitary, perigon c. 2.5 mm l, green, stamens 7–9; **Fr** globose to ellipsoid, 4–8 seeds, stigma sigmoid, i.e. shaped like a  $\sigma$ ; **S** reniform, black, smooth; **Ecol** unknown; **Distr** New South Wales, Australia.

*Note*: The description in Prescott (**1984**: 54) follows Benth (**1866**: 331) differing in some points from the original description of Fenzl (**1839**: 293), the latter used here as the base of the text.

*T. debilis* Sprengel ex Turczaninow **1843**: 60 nomen nudum = **Adenocline ovalifolia** Turczaninow.

*Note*: The name *T. debilis* was only mentioned as a synonym in the original description of **Adenocline ovalifolia**.

*T. decandra*  $\equiv$  **Zaleya decandra**

*T. decandra* var. *flava* = **Zaleya govindia**

*T. decandra* var. *rubra* = **Zaleya govindia**

**T. diffusa** Miller **1768**: no.2 T ?

Diffuse branches, to 50 cm h; **L** petiolate, oval, less succulent than **T. portulacastrum**; **Fl** in clusters, sessile, perigon white inside; **Fr** with several seeds; **Ecol** unknown; **Distr** “East India”.

*Note*: Little attention has been paid to this species, as far as floras are concerned, and the identity cannot be established from the very general description.

*T. digyna* = **Zaleya pentandra**

*T. dinteri* = **Sesuvium sesuvioides**

*T. dubia* Sprengel ex Turczaninow **1852**: 179 nomen nudum = **Adenocline pauciflora** Turczaninow **1843**: 60. The name *T. dubia* is listed in Kew Index as given above, but there is no publication of Turczaninow in the cited Journal in 1852. Instead, the new name **Adenocline pauciflora** is published in Turczaninow **1843**: 60 without any indication of a synonym in *Trianthema*. But the species

**Adenocline ovalifolia** is described in that same paper (1843) with *T. debilis* as a synonym.

*T. flexuosa* = **T. portulacastrum**

*T. fruticosa* Vahl 1790: 32 ≡ *Gymnocarpon fruticosum* Persoon 1805: 262 nomen illeg. ≡ **Gymnocarpos decandrum** Forskål 1775: 65. A species of a genus in the family **Illecebraceae** R. Br. (e.g. Brummitt & Powell 1992: 192), sometimes also kept in the subfamily **Paronychioideae** (A.L. de Jussieu) Meisner of the family **Caryophyllaceae** A.L. de Jussieu, and even as a synonym under the genus **Paronychnia** Miller (Bittrich in Kubitzki 1993: 223).

*T. galericulata* ≡ **Zaleya galericulata**

*T. glandulosa* = **T. sedifolia**

**T. glaucifolia** F.Mueller 1859: 172 subg. **Papularia** T Mueller s.n. (K!).

Perennial herbs turning black when dry, branches prostrate, up to 30 cm l; **I** glabrous, on branchlets sparsely and minutely papillate; **L** petioles short, basally on both sides with dentate membranes, blades obtuse, linear to terete, glaucous; **Fl** solitary, with short pedicels, perigon with 5, rarely 6 lobes, green with white margins; **Fr** round, depressed, with 2 seeds; **S** lentil-shaped, black, almost smooth; **Ecol** in fertile basaltic soils; **Distr** Australia.

*Note:* Inspection of the type material at K permits a placement of the sheet in the subgenus **Papularia**, but the identification of the species is impossible. Remarkable are the unusually long slender nearly curved leaves. The material cannot be keyed out.

*T. glinoides* = **Zaleya decandra**

**T. glossostigma** F.Mueller 1884: 282 subg. **Trianthema** T Crossland (MEL).

Prostrate branches; **I** glabrous; **L** petioles 5–6 mm l, with small scarious wings, blades glabrous, 3–20 mm l; **Fl** 1–3, pedicels as long as the bracteoles, perigon tube very short, lobes 6 mm l, stamens 15–20, c. 10 ovules; **Fr** operculum shaped like an elongate helmet, c. 4 mm l, the stigma a little shifted to one side, recurved; **S** 4–8

per ripe fruit, black, pear-shaped, ornamented with ridges which appear as parallel walls in the dorsal part, c. 1 mm l; **Ecol** uncertain; **Distr** Western Australia, Northern Territory, Australia.

*Note:* The pear-shaped seeds ornamented with prominent ridges characterize this species well.

*T. govindia* ≡ **Zaleya govindia**

*T. govindia* var. *flava* ≡ **Zaleya govindia**

*T. grisea* = **Sesuvium portulacastrum**

**T. hecatandra** Wingfield & M.F.Newman 1994: 115; Hartmann 2008: 191; Guzman et al. 2011: 65–89 subg. **Trianthema** T Wingfield 14706 (CORO).

Perennial herbs with decumbent branches rooting finally near the edge of the mat, centre dying off with age, the rooting offsprings growing on forming a circle; **I** usually pink, 10–35 mm l; **L** opposite, anisophyllous, the broadened base of the petiole of the small leaf overlapping that of the bigger leaf, petioles 4–5 mm l, base and proximal half red, blades orbicular to ovate or rotund, glabrous, but rough to the touch when dry, 15–25 mm l, 10–25 mm b; **Fl** solitary, perigon 12.5–14.5 mm l, lobes 9.5–11 mm l, pale pink or mauvish inside, white in older flowers, stamens 81–100, filaments pink, anthers pale yellow in young **Fl**, c. 5 ovules per locule; **Fr** operculum 4-lobed, 2–4 seeds; **S** shiny black with shallow pits all over, aril pale brown, turning sticky when wetted; **Ecol** on bare, firm soil in coastal desert, 300 mm rainfall p.a.; **Distr** Miranda, Democracia, Falcon State, Venezuela.

*Note:* Similar in some aspects of the growth form and leaves to **T. portulacastrum**, this species differs in the peculiar formation of rings around a dead plant and the numerous stamens in the big flowers mainly. It is reported that it is not eaten by goats. Based on studies of the ecology, distribution, and ontogeny, it is suggested by Guzman et al. (2001) that all known material forms a single population which should be registered as being an endangered species.

**T. hereroensis** Schinz 1897: 76 subg. **Papularia** LT, designated by Hartmann et al. 2011: 200 (Z!), Stapf s.n. !Kuiseb 1866.

Low shrubs, developing a “dune-cushion” with age when blown over with sand; **I** inside the cushion woody, tough, much longer than the leaves; **L** petioles with broad semi-oval pseudostipules turning papery with age, always without teeth, blades elliptical to ovate, always acute, 3–5 mm l, 2–3 mm b; **Fl** 2–5 in  $\pm$  compact cymes, broadly based bracts and more slender bracteoles, perigon twice as long as broad, smooth, erect teeth about as long as the basal tube, stamens 5; **Fr** operculum basally coriaceous and thin, resembling a puffed sleeve in shape, with a collar-like apical rim spreading sideways; **Ecol** in sandy desert river beds near the sea; **Distr** Swakopmund, Erongo, Namibia.

*Note:* Friedrich (1970: 132) points out that most plants develop into an almost semi-globose cushion shape, the stems being very robust and continuing to grow when they are overblown by sand.

*T. humifusa*  $\equiv$  **Acrosanthes humifusa**

*T. humillima* = **Gigasperum repens** (Hook.) Lindb., a moss

*T. hydaspica* = **Sesuvium sesuvioides**

**T. kimberleyi** Bittrich & Jenssen in Bittrich 1990: 118 subg. **Trianthema T** Bittrich & Jenssen 18618 (HBG!).

Annual herbs with prostrate branches,  $\emptyset$  of plants c. 20 cm, 5 cm h, branching in the vegetative part monopodial, in the flowering region sympodial with the side branches differing in thickness, the thicker in the axil of the bigger leaf, **I** glabrous; **L** opposite, anisophyllous in the flowering region, petioles 1–2 mm l, broadening basally into a membranous sheath with 2 acuminate lobes, blades elliptical to obovate, epidermis weakly papillate, water storing tissue in epidermis and hypodermis; **Fl** solitary, smelling intensely of honey during anthesis, pedicels up to 2 mm, elongating to 5 mm when fruiting, bracteoles lanceolate and denticulate, perigon c. 5 mm  $\emptyset$ , tube 2 mm l, lobes whitish-pink inside, stamens 10, 5 alternate, 5 opposite, nectary disc whitish, 10–12 ovules; **Fr** operculum subovoid; **S** 6–8, broadly ovoid to pyriform, brownish to black, smooth, 1.1 mm l, 0.9 mm b; **Chr** 2n = 48;

**Ecol** on flat hills in schistose rocks; **Distr** Western Australia, Australia.

*Note:* The species is classified as rare by the authors.

**T. littoralis** J.Cordemoy 1895: 290 subg. **Trianthema T** Cordemoy s.n.? (P?).

Herbs with terete **I** with a line of hairs along them; **L** petioles sparsely hairy, basally with a broader membrane, blades ovate, obtuse, glabrous, 20–30 mm l; **Fl** solitary, perigon whitish-pink, 20 stamens, alternating short and long; **Fr** with few seeds, truncate; **S** black, striped, helmet-shaped; **Ecol** on the shore; **Distr** Réunion.

*Note:* In several features the description reads very similar to that of **T. portulacastrum**, but the line of hairs along the internodes seems to be a distinguishing character state not reported for other species.

*T. maidenii* = **Tetragonia implexicoma**

**T. megasperma** Prescott 1983: 183 subg. **Trianthema T** Lazarides 7990 (CANB).

Perennial herbs with prostrate branches to 100 cm l, **I** densely hirsute, hairs 2–3 mm l, branchlets regularly alternate; **L** petioles c. 6 mm l, on the bigger leaf of the pair basally broadened into a sheath, blades obovate to spatulate, acute or obtuse, pale green, covered with long hairs like the **I**, 3–30 mm l, 3–15 mm b; **Fl** solitary, pedicels 2–10 mm l, perigon tube very short, lobes spreading, hirsute outside, glabrous, white to pink with mauve tips inside, c. 6 mm l, stamens 5–15, 2 ovules; **Fr** a dry ovoid capsule, operculum semi-globose, with an undulating ridge near the top, tightly enclosing the single big seed, the stigma rolled up; **S** somewhat compressed pear-shaped, with small, distant papillae, black, c. 3 mm l; **Ecol** in sandy soil; **Distr** Northern Territory, Australia.

*Note:* The single big seed and the prominent pubescence of the entire plant permit an easy identification.

*T. monogyna*  $\equiv$  **T. portulacastrum**

**T. mozambiquensis** H.E.K.Hartmann & Liede in Hartmann et al. 2011: 202 subg. **Papularia T** Marques 2299 (WAG!).

Prostrate herb, **I** with almost globose bladder cells densely placed in the young state, distant later and finally rubbed off; **L** blades oblong-lanceolate, margins incurved, the lower leaf surface hardly visible, epidermis covered with big but low bladder cells, pseudostipules < petioles, rectangular, about as wide as the blade, ending in a short acuminate tooth; **Inf** with two flowers, dense; **Fl** with acuminate bracts and bracteoles, perigon smooth with short tepal teeth pushed back by the growing pyxidium; **Fr** with a prominent smooth broad rim around the operculum, 1.1 mm in Ø; **S** 2, black, with prominent sharp ridges in semi-circles around the outer edge, almost round in side view, about 0.9 mm in diam. **Ecol** unknown; **Distr** Mozambique.

*Note:* The species agrees in the possession of smooth broad rims on top of the operculum with **T. sedifolia** from N Africa, differing in this feature at the same time from all other known S African species (Hartmann et al.: 2013).

*T. multiflora* = **T. salsoloides**

*T. nigricans* = **T. sanguinea**

*T. nyasica* = **Sesuvium nyasicum**

*T. obcordata* = **T. portulacastrum**

**T. oxycalyptra** F.Mueller 1859: 173 ≡ *T. oxycalyptra* var. *pedunculata* F.Mueller 1859: 174 nomen illeg. subg. **Trianthema** LT, designated by Prescott 1984: 319, MEL 99967 (MEL) = *T. oxycalyptra* var. *sessiliflora* F.Mueller 1859: 174 NT, designated by Prescott 1984: 319, MEL 99968 (MEL).

Herbs with prostrate to ascending branches, **I** glabrous, sparsely hirsute when young; **L** petioles 3–8 mm l, blades obovate to spatulate, 3–25 mm l, 1–8 mm b; **Fl** mostly 3, rarely 1–2, pedicels 0–10 mm l, bracts linear-lanceolate, apiculate, perigon tube 2–3 mm l, lobes 5–6 mm l, stamens 10–20, ovules 10–12; **Fr** c. 6 mm l, operculum a short, low cone with a long, thin, terminal stigma, 6–9 seeds; **S** ovoid with the micropyle protruding, black, papillae prominent all over or only in the marginal parts, c. 2 mm l; **Ecol** in the desert; **Distr** Northern Western Australia, Australia.

*Note:* The taxonomy follows Prescott (1984: 57, 319), who made the lecto- and neotypifications.

*T. oxycalyptra* var. *pedunculata* ≡ **T. oxycalyptra**  
*T. oxycalyptra* var. *sessiliflora* = **T. oxycalyptra**

**T. pakistanensis** H.E.K.Hartmann & Liede in Hartmann et al. 2011: 203 subg. **Papularia** T Sultanul-Abedin 5681 (B!).

Prostrate annual herbs; **I** with finger-shaped bladder cells, dense on younger parts and distant on older ones, rubbing off eventually with age; **L** blades obovate, marginally distinctly incurved, hiding the lower leaf surface almost completely, the entire surface covered in low yet distinct bladder cells that dry into light coloured pointed tiny bodies, never flat, pseudostipules widening from the blade, but never exceeding the width of the flattish petiole, sometimes with a tooth; **Inf** with 5 and more flowers in dense aggregates, yet each **Fl** free, bracts and bracteoles acuminate; **Fl** with small bladder cells, especially on their erect teeth; **Fr** with a rugose operculum with a finely folded layer of tissue at the bottom of the central deepening, 1.1 to 1.4 mm wide; **S** 2, black, with prominent sharp ridges in semi-circular shape all over, rarely the ridges rounded. **Ecol** on saline soils, from sea level to 1,000 m elevation; **Distr** NW India and Pakistan.

*Note:* The vernacular name is reported as “alettie” and it is said to be used as fodder for goats and cattle in Pakistan (Nasir 1973). Study of fresh material is urgently needed in order to confirm the limits against **T. triquetra**.

**T. parvifolia** E.Meyer ex Sonder in Harvey & Sonder 1862: 598 ≡ *T. parvifolia* E.Meyer ex Drege 1843: 63, 226 nomen nudum ≡ *T. triquetra* Willdenow ex Sprengel ssp. *parvifolia* (Sonder) Jeffrey 1960: 237 subg. **Papularia** T Drege (S!) = *T. parvifolia* Sonder var. *annulata* Adamson 1962: 251 T Pearson 9231 (K!)

Perennial herbs with prostrate branches never rooting, but often with a distinctly thickened hypocotyl at the base, taproots to 10 cm l; **I** papillate or glabrous, shining, purple when young, straw-coloured to white with age, finely pleated;



**L** blades oblong to subrotund, nearly globose, rarely apically inconspicuously acuminate, covered with dark dots all over, derived from small translucent areas in the outer tissue (Fig. 5), the dots sometimes confluent, bladder cells only visible on young leaves, surface later smooth, the petiole with broad papery pseudostipules embracing the axis and remaining present on the plants for some months after the blades have broken off, mostly rectangular and ending in a tooth; **Inf** mostly with 5–6 flowers, but often much higher numbers, in very dense aggregates, but always basally free; **Fl** with a broadly acuminate bract and usually two more slender bracteoles, sometimes with 1–2 teeth, tepals completely smooth, the free teeth connivent over the pyxidium, subapically equipped with thick bright green protrusions not overtopping the actual tepal tip, perigon 1.5–2 mm l, green inside and outside, the 5 stamens purple, coccineus, orange-red or almost white, always in stark contrast to the green tepals; **Fr** operculum with a conical base distinctly separated from the rough collar on top, resembling in shape the collars of Hanseatic statesmen and ministers; **S** 2, black, with prominent crests along the edge and the sides, 0.9 mm l, 0.6 mm thick; **Ecol** in open disturbed areas with gravel, stones, and sand; **Distr** S Angola, Botswana, Namibia, central S Africa, never coastal.

*Note:* Examination of all available type material reveals that **T. hereroensis** must be excluded from this species, into which latter, however, *T. parvifolia* var. *annulata* belongs (see Hartmann et al. 2011 for details). Whether indeed material from N Namibia and Angola belongs in **T. parvifolia**, as assumed at this date, needs a re-examination of much more and fresh material.

*T. parvifolia* var. *annulata* = **T. parvifolia**  
*T. parvifolia* var. *corymbosa* ≡ **T. corymbosa**  
*T. parvifolia* var. *rubens* = **T. corymbosa**

**T. patellitecta** Prescott 1983: 185 subg. **Trianthema** T Perry 3067 (CANB).

Herbs with branches to 100 cm l, branchlets either one per node or one longer and the other shorter; **I** hirsute with spreading hairs; **L** petioles



**Fig. 5** *Trianthema parvifolia* in habitat near the type locality, the leaves with dark dots but without a distinct line, almost globose in shape (Copyright H.E.K. Hartmann)

c. 6 mm l, with a broad, membranous sheath, blades ovate to spatulate, covered with stiff, spreading hairs, 4–30 mm l, 3–15 mm b; **Fl** 1–2, sessile, perigon purple inside, c. 2.5 mm l, stamens 15–25, 2 locules; **Fr** globose, operculum dish-shaped with a fine hyaline cover over the apex, stigma persisting,  $\varnothing$  c. 4 mm, 1 seed in the operculum, 1 in the basal part; **S** pear-shaped, faintly reticulate, shiny black, c. 1.5 mm l; **Ecol** on sandy river banks; **Distr** Northern Territory, Western Australia, Australia.

*Note:* It appears that the operculum has the shape of a dish placed upside down on the basal part of the fruit.

*T. pentandra* ≡ **Zaleya pentandra**  
*T. pentandra* var. *flava* ≡ **Zaleya govindia**  
*T. pentandra* var. *hirtula* = **Zaleya pentandra**  
*T. pentandra* var. *rubra* ≡ **Zaleya govindia**

**T. pilosa** F.Mueller 1859: 174 subg. **Trianthema** T Mueller s.n. (isotype MEL!).

Herbs with procumbent, long main branches bearing short lateral branchlets; **I** densely hispid, especially when young; **L** petioles 1–15 mm l, basally broadening into an oval sheath, blades ovate to obovate, obtuse or acute, 3–30 mm l, 2–10 mm b; **Fl** 3–4 in a dense cluster, perigon tube c. 3 mm l, lobes 2–3 mm l, white, pinkish, or

red inside, stamens 15–20, 3–4 ovules; **Fr** operculum cylindrical, truncate, centre depressed, sides often reticulate to striate, 3–5 mm l, 1 seed in the operculum, 1 in the basal part; **S** disc-shaped, black, finely papillate all over, c. 1.7 mm l; **Ecol** in desert; **Distr** Northern Territory, Western Australia, Queensland, South Australia, Australia.

*Note:* The species occurs in a wide area, mainly in sand in dry habitats.

*T. polyandra* = **Sesuvium sesuvioides**

*T. polysperma* = **Sesuvium sesuvioides**

**T. portulacastrum** L. 1753: 223 ≡ *T. monogyna* L. 1767: 69 ≡ *T. procumbens* Miller 1768: no 1 subg. **Trianthema** LT, designated by Jeffrey 1960: 236, Hermann 1698 t. 213 = *Tetragonia chimajensis* Chiovenda 1932: 226 **T** Gorini 437 (FT?) = *T. flexuosa* Schumacher & Thonning 1827: 221 **T** Thonning s.n. (C?) = *T. obcordata* Roxburgh 1832: 445 **T** Roxburgh s.n. (after Wallich 1832: no 6837 A, K).

Herbs with procumbent branches to 60 cm l, rooting and developing mats over several square metres; **I** glabrous or sparsely hairy, especially when young; **L** petioles 5–25 mm l, leaves of a pair basally broadening and connate with the opposite leaf base, forming a cup-shaped sheath around the stem, blades elliptic to obovate, 4–50 mm l, 4–45 mm b; **Fl** solitary, sessile, almost hidden in the cup formed by the bracts (Fig. 6), perigon tube fused to leaf sheath, lobes 2.5–5 mm l, a few hairs outside, pink or white inside, stamens 10–20, ovules 10–15; **Fr** operculum turret-shaped, truncate with a thin flexible distal rim adorned with some short broad teeth, 2–3 mm l, of the 3–12 seeds 1–2 in the operculum; **S** reniform, black, with low crests, 1.5–2 mm l; **Ecol** in tropical climates as weeds in fields or gardens; **Distr** worldwide in the tropics.

*Note:* Since in his original description Linnaeus gave two stigmas for this species, some discussion has surrounded the decision of Jeffrey (1960: 235–236) who chose Hermann's text and figure (1698: 213 and t. 213) as the lectotype. Yet, this choice is in agreement with Linnaeus' later action (1767: 69), when he



**Fig. 6** *Trianthema portulacastrum* as a weed in the garden of a Mosque at Al-Ain, United Arab Emirates; note the solitary half-ripe purple fruits (Copyright H.E.K. Hartmann)

placed **T. portulacastrum** as a synonym with the new name *T. monogyna*. Note should be taken that in several cases the names **Sesuvium portulacastrum** and **Trianthema portulacastrum** have been used synonymously. When consulting floras it should therefore be checked whether either name is applied correctly.

Osbornová-Kosinová (1984: 279–285) stressed the occurrence of the species as a weed in Egypt comparing its frequency with that reported for other countries based on data from Holm et al. (1979) mainly.

*T. portulacastrum* var. *hillebrandii* = **Sesuvium portulacastrum**

*T. procumbens* ≡ **T. portulacastrum**

*T. redimita* = **Zaleya redimita**

**T. rhynchocalyptra** F.Mueller 1859: 174 subg. **Trianthema** T F.Mueller s.n. (isotype MEL).

Perennial herbs with prostrate branches from a woody rootstock, **I** densely hairy; **L** clustered, petioles c. 4 mm l, expanding basally into a denticulate sheath, blades lanceolate to obovate, acute, densely hairy or glabrous with ciliate margins, shiny above, pale below, 4–20 mm l, 2–8 mm b; **Fl** sessile, solitary, perigon tube c. 4 mm l, lobes c. 3 mm l, white, pink, or green inside, stamens 10, 4–6 ovules per ovary; **Fr**



operculum somewhat elongate semi-ovoid, the recurved stigma placed a little to the side of the apex; **S** nearly globose to pear-shaped, black, finely papillate, longer papillae along dorsal and basal sides, c. 2 mm l; **Ecol** on hills and in plains with rocky and sandy soil; **Distr** Northern Territory, Queensland, Australia.

*Note:* The long, persisting, beak-shaped stigma has given the species its name.

*T. rubens* = **T. corymbosa**

*T. salarium* = **Sesuvium sesuvioides**

**T. salsoloides** Fenzl ex Oliver 1871: 588 subg. **Papularia** **LT**, designated by Hartmann et al. 2011: 205, Kotschy 137 (K!) = *T. multiflora* Peter 1932: 29 (as “*T. multiflorum*”) **LT**, designated by Hartmann et al. 2011: 205, Peter 42471 a (B!)

Annual to perennial herbaceous plants with prostrate to ascending branches woody at base, taproot to 14 cm l; **I** hispid or papillate when young, the bladder cells broadest at their bases, glabrous and longer than **L** with age; **L** petioles with dentate wings (= pseudostipules) ending in an acuminate or acute tooth, blades linear to lanceolate, margins with hemispheric bladder cells, recurved, 15–30 mm l, 2–3 mm b; **Fl** in ± compact cymes composed of connate **Fl** forming a compact base into which the bases are sunken, the “consolidated” bases of Kotschy, falling off as a whole body when older, 10–15 **Fl** per axil, bracts and bracteoles reduced in size and included partially in the basal complex, perigon <5 mm l, bases of the erect perigon teeth with prominent protrusions, teeth and base about the same length, tepals green inside, stamens 1 in Kenyan material, 2 in Tanzanian material, “five or fewer (?)” according to Kotschy (137), only 2 found in the type material at K; **Fr** operculum with a prominent, thick rough erect ring over almost vertical sides; **S** one, 1.6 mm l, 1.2 mm wide, 0.9 mm t, the sides with up to six low bulges in semi-circular arrangement; **Ecol** in ruderal open places in alluvial loam or black cotton soil, rarely in sand; **Distr** Sudan, Kenya, Tanzania.

*Note:* The name **T. salsoloides** is restricted to populations from Sudan, Kenya, and Tanzania, based on the unique formation of a single seed in

the pyxidium and by the fact that the compact inflorescence forms a solid body always falling off as a unit, both features in clear contrast to **T. transvaalensis**.

*T. salsoloides* var. *transvaalensis*

= **T. transvaalensis**

*T. salsoloides* var. *stenophylla*

= **T. transvaalensis**

**T. sanguinea** Volkens & Irmischer in Schellenberg 1913: 498 ≡ *T. triquetra* Willdenow ex Sprengel ssp. *triquetra* var. *sanguinea* (Volkens & Irmischer) Jeffrey 1960: 237 subg. **Papularia** **T** Volkens 458 (B!) = *T. nigricans* Peter 1932: 30 **T** Peter 42741 c (B!).

Annual herbaceous plants with decumbent to erect branches, up to 25 cm tall; **I** with globose papillae when young, later smooth and the whole plant turning purple; **L** petioles with lanceolate wings over its length, blades linear, margins rolled backwards and papillate, blades 10–15 mm l, 2 mm b, the pseudostipules with 1–3 mostly rounded teeth, all bladder cells broadest at their bases; **Fl** in compact cymes, but each free, bracts broadly acuminate, bracteoles slender, small and acuminate, perigon 2–3 mm l, the bases of the teeth with protrusions or loops, the perigon teeth densely covered with finger shaped papillae outside, stamens 5; **Fr** truncate with a thick marginal ring around the operculum, often skewed, the apical rim base cylindrical, 2 seeds in the ovary; **S** black, with 3–5 semi circles of ridges of highly irregular shapes; **Ecol** in grassland with trees, steppe; **Distr** SE Kenya, NE Tanzania.

*Note:* The description suggests a similarity with **T. crystallina** from further north, but Jeffrey (1960: 237, 1961: 26) placed this species as a variety with **T. triquetra**. The small distribution area asks for more attention in the region to increase the number of available collections.

**T. sedifolia** Visiani 1836: 19 ≡ *T. crystallina* (Forskål) Vahl var. *sedifolia* (Visiani) Hiern 1898: 415 subg. **Papularia** **LT** designated by Hartmann 2001: 206, Visiani 1836: t. 3, f 1 = *T. sedifolia* Visiani var. *microphylla* Courbon 1862: 156 **T**

**Fig. 7** *Trianthema sedifolia* growing as a weed near the road near Kassala, Sudan, making use of temporary watered patches, now dried out (Copyright H.E.K. Hartmann)



Courbon s.n. (P) = *T. glandulosa* Peter 1932: 30 **T** Peter 42741 b (B!).

Annual herbs with prostrate branches up to 25 cm l; **I** conspicuously papillate; **L** petioles with broad basal wings clasping the stem, blades linear-oblong, to 12 mm l and about 2 mm wide, margins often recurved, the blade with prominent papillae turning into scales with age or the surface becoming almost smooth, pseudostipules widening from the blade base, each ending in a short broad tooth or without one; **Fl** 3–4 in cymes, perigon with 5 lobes bending over the ripe fruit, stamens 3; **Fr** operculum shaped like a cupula; **S** orbicular to reniform, black; **Ecol** in open disturbed places among pebbles or in loamy deposits (Fig. 7); **Distr** Kenya, Morocco, Mauritania, Saudi Arabia, Somalia, Sudan, Tanzania, Uganda, Yemen.

*Note:* The species has repeatedly been placed in synonymy with **T. crystallina**, from which it differs in the three stamens and possibly the number of four seeds. This item is doubtful because Visiani cited his colleague Brocchi mentioning four seeds but stated that the material he (Visiani) had examined had two seeds only. The species shares the big globose bladder cells on the internodes with **T. crystallina** and **T. sheilae**, but lacks the cover of densely placed big bladder cells on the leaf blades of the two latter species.

*T. sedifolia* var. *microphylla* = **T. sedifolia**  
*T. senniei* ≡ **Zaleyia senniei**

**T. sheilae** A.G.Miller & J.A.Nyberg in: Miller & Nyberg 1994: 33 subg. **Papularia** **T** Collenette 4718 (E!).

Annual herbs to perennial fruticose plants with decumbent to ascending branches forming shrubs to 35 cm tall and up to 75 cm in diam.; **I** terete, young ones with a touch of straw colour and with distant rather small bladder cells, bigger and denser near the uppermost nodes, turning woody and smooth with age, drying almost white; **L** ovate to almost circular, 4–8 mm l, 3–6 mm wide, thickish, covered completely by big bladder cells touching each other, the white dry rims overlapping in herbarium material, contrasting against the sometimes blackish background, tip of leaf usually rounded, rarely somewhat acuminate, petiole mostly below 5 mm long, adorned with two broad flaps on each side resembling stipules, each with a terminal tooth, pointing upwards or sideways, the flaps widening regularly towards the base of the blade, the widest point often adorned with a short broad tooth, the flap narrowing again at the base at the stem, teeth sometimes fimbriate, but not regularly so; **Inf** of 1–5 flowers, each flower with a fimbriate bract and two fimbriate bracteoles, all papery in consistence and broad, clasping the interior and conspicuous as whitish sheaths to the naked eye; **Fl** 5–6 mm Ø when fresh, when dry in the herbarium, 3.5–4.5 mm wide, up to 2 mm long, the free tepal teeth erect, sometimes apically recurved and drawn out acutely, usually 1.25 mm long,

subapically with a protrusion overtopping the papery margin of the tooth of c. 0.8–1 mm length; the bases of the tepal teeth at the points of joining the calyx tube with pronounced bulges (“sinuses” of the original description), epidermis covered densely with big bladder cells like those on the leaves; the tepal tube with erect but small bladder cells, smoothing with age because the bladder cells are rubbed off, stamens five, alternitepalous, the inside of the tepals yellow (Fig. 8), with yellow, scarlet, or orange anthers, pollen usually yellow; **Fr** almost globular when young, the operculum blown up like the upper half of a balloon with an indistinct upper rim reaching far into the centre where it leaves a small deepening from which the long stigma protrudes well between the stamens; the operculum surface smooth when young, unevenly shrinking with age, resulting in a wrinkling rim distinct from the wrinkled remaining operculum surface below, in which a seed is held; **S** two per capsule, the contact side flattened, but all sides equipped with narrow rows of bulges, c. nine more or less crescent-shaped ones per side, and 6–8 straight ones along the back of each seed; **S** almost orbicular, 1.1–1.2 mm l, 0.9–1 mm b, c. 0.7 mm thick; **Ecol** most often in sand near the sea, amongst lava rocks or coral remains, more rarely inland and in loam. 10–2,100 m. altitude; **Distr** SW of Saudi Arabia, SW Yemen, S of Egypt, E Sudan, and also reported but not confirmed from S Eritrea.

*Note:* The species is most similar to **T. crystallina** and might only be a taxon of lower rank in the earlier described species; both species share the dense big bladder cells cover of the leaves with **T. argentina** from S America.

**T. transvaalensis** Schinz 1915: 396 ≡ *T. salsoloides* var. *transvaalensis* (Schinz) Adamson 1962: 248 **T.** subg. **Papularia** **T** Schlechter 4876 (Z !; **IT** K!) = *T. salsoloides* Fenzl ex Oliver var. *stenophylla* Adamson 1962: 249 **T** van der Schijff & Marais 3734 (K!; **IT** PRE!).

Annual to shortly perennial herbaceous plants with decumbent to ascending branches to 30 cm long, most of them in dichasial branching; woody taproots to 12 cm long, apically to 5 mm in Ø; **I** often orange to reddish or purple coloured, rather



**Fig. 8** *Trianthema sheilae* in full flower in habitat in Saudi-Arabia, petals bright yellow and leaves glittering from big bladder cells (Copyright S. Collenette)

densely covered with globose bladder cells, in young plants shorter than leaves, in old plants distinctly longer than leaves, 15 mm long, up to 3 mm broad, narrowly spatulate, petioles basally with two translucent flaps, each ending in an acuminate tooth or rounded, margins and keel with fingertip shaped bladder cells, i.e. broadest at their bases and longer than thick, more prominent in young leaves, inconspicuous in old leaves, margins recurved; the upper leaf surface with a translucent line of tissue, due to the absence of chlorenchyma below the epidermis (Fig. 9); **Inf** dense and rather compact in the axils of leaves, 10–15 flowers on older branches, subtended by a broad-based acuminate bract with 0–1 teeth and two more slender bracteoles with a log tip and often a tooth; **Fl** with their bases often sunken with their lower parts into a solid basal tissue, the tepal tube visible for half to most of its length, the free, erect, acute tepal teeth forming prominent bulges at their bases and very long subapical tips overtopping the actual leaf tip widely, teeth about as long as the entire tepal tube, covered rather densely with bladder cells, longer ones erect on the teeth, which are smooth and white or greenish inside, with white lateral flaps, stamens five; **Fr** with straight sides in the basal part, the operculum forming a rounded lid with a central deepening on top, surrounded by the rim with a broad rough surface, the lid up to 1.2 mm Ø and ca 0.5 mm high; **S** in most cases two, but





**Fig. 9** *Trianthema transvaalensis* in habitat, note the dark line along each leaf (Copyright H.E.K. Hartmann)

sometimes the second one visible as an abortive small body at the base of the capsule only, 1.3 mm long and 1 mm broad and thick, covered completely by a thin aril disintegrating with age, the sides with irregular rounded crests in curved to semi-circular arrangement, the back with three prominent crests, black. **Ecol** in open places with grass to scrub cover, mostly in alluvial loamy or black cotton soil; **Distr** Botswana, the southern parts of Zimbabwe, Limpopo Province, Mpumalanga, KwaZulu/Natal, S Africa, Mozambique.

*Note:* Based on similarities in the possession of a single seed and flower bases sunken into the base of the inflorescence, this species has been united with *T. salsoloides*, which, however, occurs only in Kenya and Tanzania, being much more strictly one-seeded than *T. transvaalensis* (Hartmann et al. 2011, 2013). The longitudinal dark line on each leaf agrees with leaves of *T. vleiensis*. Remarkable is the fact that populations occur between about 100 and 1,600 m altitude, but only 11 populations were available for investigations.

**T. triquetra** Willdenow ex Sprengel 1825: 381  $\equiv$  *T. triquetra* Willdenow in Rottler 1803:

181 nomen nudum subg. **Papularia** T Rottler s.n. (B!) = *T. crystallina* var. *clavata* J.M.Black 1923: 369 = *T. gisekioides* Fenzl nomen nudum in schedis Renaud s.n. (B!) = *T. triquetra* Willdenow ex Sprengel var. *oblongifolia* Gamble 1919: 199 T Bourmes s.n. (K!).

Herbs with finely papillate or glabrous **I**; **L** petioles c. 2 mm l, the pseudostipules of nearly that length, narrow and rolling in with age, blades flat, obovate, ending in an acuminate tip, without prominent bladder cells; **Fl** 2–3 in cymes, sessile, bract and bracteoles acuminate, perigon tube and teeth lacking bladder cells completely, the short teeth bending over the operculum of ca 1.5 mm  $\varnothing$ , the gynoeceum surface surrounded by a broad rim sloping to the centre, 2 ovules; **Fr** operculum with a sunken centre from a broad outer rim, the bottom as if covered by finely pleated material; **S** two, black, one on top of the other, prominent ridges in semi-circular arrangement, especially around the outer edge; **Ecol** probably in disturbed places in tropical climates; **Distr** along the Coromandel Coast in India; probably on all coasts around the Gulf of Bengal.

*Note:* The history of the application of the name to plants superficially similar is summarized and explained in Hartmann et al. (2011, 2013); in those papers, it is also demonstrated that the supposed worldwide distribution was based on wrong applications of the name (compare maps in Hartmann et al. 2011). The present circumscription of the taxon and its distribution is based on only 11 collections in a wide region, and much more fresh material will be needed to reach reliable conclusions.

*T. triquetra* var. *oblongifolia* = **T. triquetra**

*T. triquetra* ssp. *parvifolia*  $\equiv$  **T. parvifolia**

*T. triquetra* ssp. *triquetra* var. *clavata*

$\equiv$  **T. clavata**

*T. triquetra* ssp. *triquetra* var. *sanguinea*

$\equiv$  **T. sanguinea**

**T. turgidifolia** F.Mueller 1876: 83 subg. **Trianthema** T Crouch s.n. (IT MEL!).

Perennial herbs or shrubs, branches semi-erect or sprawling, **I** glabrous, nodes often hairy; **L** petioles

with small scarious wings at their bases, blades semi-terete to almost clavate, obtuse, glabrous, 3–20 mm l, 3 mm b; **Fl** 1–3, pedicels hairy, 2–10 mm l, bracts dentate, bracteoles fringed, perigon tube 2–3 mm l, lobes 3–5 mm l, white or purple inside, stamens 10 in a ring, ovules 7 to many; **Fr** operculum semi-ovoid, papery, c. 2.5 mm l, 2–3 seeds; **S** flattish ovoid, dark brown, with parallel rows of papillae, c. 2 mm l; **Ecol** mainly in sand; **Distr** Western Australia, Australia.

*Note:* A widespread species in very dry areas of Australia.

**T. ufoensis** H.E.K.Hartmann & Liede 2011: 210 subg. **Papularia** T Short & Dunlop 4932 (DNA!).

Annual herbs with procumbent to ascending branches, up to 60 cm in diam.; internodes ochre to reddish, young ones with nearly globose bladder cells rather densely placed; **L** linear, with a hyaline mucro of 2–4 mm length at the tip, breaking off with age, blade covered densely by semiglobose bladder cells, petiole basally with two translucent pseudostipules, each ending in an short broad tooth pointing outwards, margins prominently recurved, blades 10–14 mm l, 1–2 mm wide in herbarium specimens, petioles ca 4 mm long; **Inf** with 1–3 flowers, very rarely more; the bract and the two bracteoles broadly acuminate; **Fl** with bladder cells higher than wide on the outside when young, older smooth; tepal teeth short and erect in the ripe capsule, surrounding the operculum as a ring and not incurved over it, equipped with subapical teeth overtopping the tepal tip and adorned with bladder cells, operculum very broad (2–2.5 mm  $\varnothing$ ) with a narrow rugose ring around the edge holding a translucent hyaline layer level with the top of the ring, hiding the sunken interior from sight, splitting and disintegrating with age, the inside of the ring wall concave, the whole operculum therefore more similar to a pastry crust than to the more common bowl or crater shape, with red-purple dots or completely suffused reddish-purple during the ripening process; **S** two, black, appressed to and on top of each other, their margins mostly with four crests, sides with very low irregular crests, surface covered by a thin aril, about

1.5 × 0.8 × 0.6 mm; **Ecol** in clayey soil, more rarely in sand and heavy dark brown soils; **Distr** northern and central parts of Australia.

*Note:* **T. ufoensis** differs from the adjacently growing **T. clavata** in its flatter leaves with a distinct mucro, which, however, can break off with age. The broad dark reddish-purple opercula form a striking character expression.

**T. vleiensis** H.E.K.Hartmann & Liede 2011: 211 subg. **Papularia** T Hartmann 31323 (HBG!).

Annual to perennial herbaceous plants with prostrate branches to 50 cm long from a hypocotyl that can broaden to a diameter of 8 cm, remaining flat on top; in young plants, short branches predominate, forming an almost compact habit; woody taproots to 12 cm long, apically to 3 mm in diam.; **I** ochre, young ones purplish suffused, in young plants shorter than leaves, on the procumbent branches distinctly longer than leaves, bladder cells finger-shaped and sparse; **L** 15 mm long, up to 3 mm broad, spindle-shaped, turning elongate-oval in the drying process, petiole basally with two broad and almost rectangular translucent pseudostipules, each ending in a short acuminate tooth often pointing sideways, usually half as long as the petiole, bladder cells inconspicuous, tip pointed and often with some short papillae; the upper leaf surface with a distinct straight translucent line of tissue, due to the absence of chlorenchyma below the epidermis (Fig. 10); **Inf** dense, comprised of 2–3 flowers in the axils of leaves, appearing more numerous in more compact young plants, due to the proximity of the nodes at which the inflorescences sit. **Fl** always with completely free bases, the tepal tube completely visible, the bract broadly acuminate with a small tooth or without one, the bracteoles slender and of the same shape, the acute tepal teeth erect at first and bending over the operculum while ripening, inconspicuous bulges at their bases and with only short subapical protrusions overtopping the actual tepal tip, tepals green all over and sometimes purplish at their tips, but not thickened, the inside a light yellowish green, teeth about as long as the entire tepal tube, each about 1 mm long, leaf tips with some longish bladder cells, stamens five, anthers light yellow or pink,

**Fig. 10** *Trianthema vleiensis* at the drier edge of a saline deepening; in the *centre* the short *white thick* persistent stem, all leaves with *dark longitudinal lines* (Copyright H.E.K. Hartmann)



the pollen purple or bright yellow, usually in contrast to the colour of the anther wall, in either case dominating the view in the open flower. **Fr** basally like a narrow cone, cut at the bottom, the operculum forming a rounded lid with a small central deepening on top, surrounded by a narrow shrivelled rim of more or less regularly arranged cells, forming a short puffed sleeve, the lid ca 0.5 mm high and up to 1 mm  $\varnothing$ ; **S** two, black, 1.4  $\times$  1  $\times$  1 mm, the sides with irregular crests in almost circular arrangement; **Ecol** at the upper edges of salt pans in grassland or open scrub, very often with limestones on top of fine soil, alt. 1,200–1,400 m; **Distr** SE North West Province, NW Free State, NE Northern Cape Province, S Africa.

*Note:* The species shares the spindle-shaped leaves with a dark green line along its middle over the upper leaf surface with **T. transvaalensis**, which differs in having long subapical teeth on the perigon teeth and prominent bulges at the bases of these teeth. Most typical is the adaptation to saline habitats with a changing water table.

## References

- Adamson R.S. (1962) The South African species of Aizoaceae XII. Sesuvium, Trianthema and Zaleya. JSAB 28: 243–253
- Adanson M. (1763) Familles des Plantes 2: 242–245. Vincent, Paris
- Armari B. (1904) Aizoaceae, Umbelliferae, Rubiaceae, Boraginaceae. In: Pirotta R. (ed.) Flora della Colonia Eritrea. Annuario del R. Istituto Botanico di Roma 8, 2: 144–162
- Bentham G. (1866) Flora Australiensis 3: 324–331. Reeve, London
- Bittrich V. (1990) A new species of Trianthema (Aizoaceae) from the Kimberley region and a note on *T. triquetra*. Nuytsia 7: 117–122
- Bittrich V. (1993) Caryophyllaceae. In: Kubitzki K. (ed.) The families and genera of vascular plants: 206–236. Springer, Berlin Heidelberg New York
- Bittrich V., Jansen K. (1990) In: Bittrich V. 1990: 118
- Black J.M. (1923) Additions to the flora of South Australia 21. Transactions and Proceedings of the Royal Society of South Australia 47: 367–370
- Brummitt R.K., Powell C.E. (1992) Authors of plant names. Royal Botanic Gardens, Kew London
- Candolle A.P. de (1828) Prodrôme systematis naturalis regni vegetabilis, sive . . . 3: 352, 415–456. Treuttel & Würtz, Paris
- Chiovenda E. (1932) Flora Somala 2: 225–228. The Author, Modena
- Cordemoy E.J. (1895) Flore de l'île de la Réunion: 290–291. Klincksieck, Paris (reprint 1972: Cramer, Lehre)
- Courbon A. (1862) Flore de l'île de Dissée (mer Rouge) Annales des Sciences Naturelles, sér. 4, 18: 156
- Drege J.F. (1843) Zwei Pflanzengeographische Documente. Besondere Beigabe zur Flora 1843, vol. 2: 63, 92, 93, 226, 227
- Eichler H.J. (1965) Supplement to J.M. Black's flora of South Australia (second edition 1943–1957): 134–136. Hawes, Government Printer, Adelaide
- Fenzl E. (1839) Monographie der Molluginen. Annalen des Wiener Museums der Naturgeschichte 2: 243–310
- Forskål P. (1775) Flora Aegytiaco-arabica sive descriptiones plantarum . . . : 25, 65–71, 95, CVIII, no. 200, t. 10. Möller, Copenhagen



- Friedrich H.-C. (1970) Aizoaceae. In: Merxmüller H. (ed) *Prodromus einer Flora von Südwestafrika* 27: 1–135
- Gamble J.S. (1919) *Flora of the Presidency of Madras* 3. London (not seen)
- George A.S. (ed) *Flora of Australia* 4.
- Guzmán-G. D., Lapp M., Torrecilla P., Wingfield R. (2011) Estudios de algunos aspectos de la biología y riesgo de extinción de *Trianthema hecatandra* R.Wingfield & M. F.Newman (Aizoaceae), especie endemica de la planicie xerofítica costera del estado Falcon (Venezuela). *Ernstia* 21: 65–89
- Hartmann H.E.K. (2001) *Illustrated Handbook of Succulent Plants: Aizoaceae F-Z*. Springer. Heidelberg
- Hartmann H.E.K. (2008) Aizoaceae. In: Hokche O., Berry O.P., Huber O. (2008) *Nuevo Catálogo de la Flora Vascular de Venezuela*: 191. Fundación Instituto Botánico de Venezuela Dr. Tobias Lasser. Caracas, Venezuela
- Hartmann H.E.K., Liede, S. (2011) In: Hartmann H.E.K., Meve U., Liede-Schumann, S. (2011): 177–213
- Hartmann H.E.K. Meve, U., Liede-Schumann, S. (2011) Towards a revision of *Trianthema*, the Cinderella of Aizoaceae. *Plant Ecology and Evolution* 144(2): 177–213.
- Hartmann, H.E.K. Meve, U., Liede-Schumann, S. (2013): *Trianthema* subg. *Papularia* (Aizoaceae) in Africa. In: Beau N., Dessein S., Robbrecht E. (eds) *African Plant Diversity, Systematics and Sustainable Development – Proceedings of the XIXth AETFAT Congress, held at Antananarivo, Madagascar, 26–30 April 2010*. Scripta Botanica Belgica: 50: 209–221. Meise, National Botanic Garden of Belgium.
- Harvey W.H., Sonder W. (1862) *Flora Capensis* 2: 386–478, 596–598, 616. Hodges, Smith & Co, Dublin
- Hassan, N.S., Hartmann, H.E.K., Liede-Schumann, S. (2005): *Conspectus of Aizoaceae, Gisekiaceae, and Molluginaceae of Egypt and the Sudan*. Feddes Repertorium 116, 1–2, 1–42.
- Hermann P. (1698) *Paradisus Batavus*: 166–168, 212–214, t. 155, 212. Elsevier, Leiden
- Hiern W.P. (1898) *Catalogue of the African plants collected by F. Welwitsch* 1,2: 411–415. Trustees of the British Museum, London
- Hokche O., Berry O.P., Huber O. (2008) *Nuevo Catálogo de la Flora Vascular de Venezuela*. Fundación Instituto Botánico de Venezuela Dr. Tobias Lasser. Caracas, Venezuela
- Holm L.G., Pancho J.V., Herberger J.P., Plucknett D.L. (1979) *A geographical atlas of world weeds*. Wiley, New York Chichester Brisbane Toronto
- Hunziker AT, Cocucci AE (1959) El genero *Trianthema* (Aizoaceae) en la Republica Argentina. *Boletín de la Academia Nacional de Ciencias Córdoba* 41: 17–28
- Jeffrey C. (1960) Notes on tropical African Aizoaceae. *KB* 14: 235–238
- Jeffrey C. (1961) Aizoaceae. In: Hubbard C.E., Milne-Redhead E. (eds) *Flora of tropical East Africa*: 1–37
- Kubitzki K. (ed.) (1993) *The families and genera of vascular plants*: 206–236. Springer, Berlin Heidelberg New York
- Linnaeus C. (1753) *Species plantarum*. Facs. 1957. Ray Society, London
- Linnaeus C. (1767) *Mantissa plantarum prima*: 69–70. Salvius, Stockholm
- Medikus F.K. (1789) *Philosophische Botanik mit kritischen Bemerkungen*: 99. Neue Hof- und Akademische Buchhandlung, Mannheim
- Merxmüller H. (ed) *Prodromus einer Flora von Südwestafrika* 27: 1–135
- Miller P. (1768) *Gardeners' dictionary* ed. 8: Mesembryanthemum: no. 1–32. *Trianthema*: no. 1–2. *Acrodon*: n 10. The author, London
- Miller A.G., Nyberg J.A. (1994) Studies in the Flora of Arabia: XXVII. Some new taxa from the Arabian Peninsula. *Edinburgh Journal of Botany*. 51: 33–47
- Mueller F. von (1859) *Fragmenta Phytographiae Australiae* 1: 172–175. Government Printer, Melbourne
- Mueller F. von (1876) *Fragmenta Phytographiae Australiae* 10: 72–83. Government Printer, Melbourne
- Mueller F. von (1884) Definitions of some new Australian plants. *Southern Science Record* 3: 282
- Mueller F. von (1895) Description of hitherto unknown plants from north-western Australia. *The Chemist and Druggist of Australia* 10: 207
- Nasir Y. (1973) Aizoaceae No.41. In: Nasir E., Ali S.I. (eds) *Flora of Pakistan*. Rawalpindi, Depot. Bot. Univ. Karachi and Stewart Herbarium, Gordon College
- Oliver D. (1871) *Flora of tropical Africa* 2: 582–588. Reeve & Co., London
- Osbornová-Kosinová J. (1984) Notes on the synanthropic plants of Egypt. 1. *Trianthema portulacastrum* L. (Aizoaceae). *Folia geobotanica et phytotaxonomica* 19: 279–285
- Persoon C.H. (1805) *Synopsis plantarum, seu enchiridium botanicum* ... 1: 262, 487. Cramer, Paris; Cotta, Tübingen
- Peter A. (1932) *Descriptiones plantarum novarum Africae orientalis*. *FR Beiheft* 40, 2: 29–30
- Pirotta R. (ed.) *Flora della Colonia Eritrea*. *Annuario del R. Istituto Botanico di Roma* 8, 2: 144–162
- Prescott A.A. (1983) Three new species of *Tetragonia* and *Trianthema* (Aizoaceae). *Journal of the Adelaide Botanical Garden* 6: 181–188
- Prescott A.A. (1984) *Trianthema*. In: Prescott A.A., Venning J. 1984: 52–60. In: George A.S. (ed) *Flora of Australia* 4. And: 319
- Rottler J.B. (1803) *Botanische Bemerkungen auf der Hin- und Rückreise von Trankenbar nach Madras von Herrn Missionar Rottler mit Anmerkungen von Herrn Prof. C.L. Willdenow*. *Neue Schriften der Gesellschaft Naturforschender Freunde zu Berlin* 4: 181
- Roxburgh W. (1832) *Flora indica* 2: 445. Thacker & Co. Calcutta; Parbury, Allen & Co., London
- Sauvages, F.B. de (1751) *Methodus foliorum, seu plantae Florae Monspelienis, juxta*... La Haye

- Schellenberg G. (1913) *Aizoaceae africanae* 2. BJS 48: 498–504
- Schinz H. (1897) Die Pflanzenwelt Deutsch-Südwest-Afrikas (mit Einschluß der westlichen Calahari). Bulletin de l'Herbier Boissier 5, Appendix 3: 5–101
- Schinz H. (1915) Mitteilungen aus dem botanischen Museum der Universität Zürich LXXI: *Aizoaceae*. Vierteljahresschrift der Naturforschenden Gesellschaft in Zürich 60: 396–397
- Schumacher F.C., Thonning E. (1827) Beskrivelse af Guineiske planter som . . . : 221. Preprint from: Det Kongelige Danske Videnskabernes Selskabs naturvedenskabelige og Mathematisk afhandlinger 3: 241–242 (print of 1828 seen)
- Sonder O.W. (1862) *Aizoon*. *Galenia*. *Mesembryaceae*. *Trianthema*. In: Harvey W.H., Sonder W. (eds) *Flora Capensis*
- Sprengel C. (1825) *Linnaei systema vegetabilium* ed. 16, 2: 381–382. Dieterich, Göttingen
- Terraciano A. (1894) Contribuzioni alla conoscenza della flora dell' Africa orientale II. Annuario del R. Istituto Botanico di Roma 5: 89–121
- Turczaninow N.S. (1843) *Decas generum plantarum huiusque non descriptorum*. Bulletin de la Société des naturalistes à Moscou 16: 51–62
- Vahl M. (1790) *Symbolae botanicae* 1: 32. Möller, Copenhagen
- Visiani R. de (1836) *Plantae quaedam Aegypti ac Nubiae* . . . : 19, t. 3, f 1. Minerva, Padova
- Volkens G., Irmscher G. (1913) In: Schellenberg G. 1913: 498–499
- White C.T. (1919) Contributions to the Queensland flora. Queensland's Department of Agriculture Botanical Bulletin 21: 10–12
- Willdenow C.L. (1803) In: Rottler J.B. 1803: 181
- Wingfield R., Newman M. (1994) A new species of *Trianthema* (*Aizoaceae*) from Venezuela. KB 47: 115–117