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A taxonomic study of the genus *Chamaesyce* S. F. Gray (Euphorbiaceae) in Taiwan

Shu-Chien Lin[1], Shu-Miaw Chaw[1,*] and Chang-Fu Hsieh[2]

[1]*Institute of Botany, Academia Sinica, Taipei, Taiwan 11529, Republic of China*

[2]*Department of Botany, National Taiwan University, Taipei, Taiwan 10764, Republic of China*

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Abstract. The genus *Chamaesyce* S. F. Gray (Euphorbiaceae) is usually separated from its closest relative *Euphorbia* L. by early exhaustion of the main stem meristem, interpetiolar stipules, opposite and basally oblique leaves with Kranz anatomy, cyathia commonly with four appendiculate glands, and ecarunculate seeds. It is represented in Taiwan by 14 widespread, endemic or naturalized weedy species, including one new species (*C. hsinchuensis* Lin & Chaw, *sp. nov.*), three new records (*C. maculata* (L.) Small, *C. serpens* (H. B. & K.) Small, *C. sparrmannii* (Boiss.) Hurusawa, and one nomenclatural correction (*C. hyssopifolia* (L.) Small). A brief taxonomic history of the genus in Taiwan, discussion of its useful taxonomic characters, a key to its taxa along with descriptions, illustrations, geographical distributions, classification notes, and specimens of each species examined are presented.

Key words: *Chamaesyce*; *C. atoto*; *C. garanbiensis*; *C. hirta*; *C. hsinchuensis*; *C. hyssopifolia*; *C. maculata*; *C. makinoi*; *C. prostrata*; *C. serpens*; *C. sparrmannii*; *C. taihsiensis*; *C. tashiroi*; *C. thymifolia*; *C. vachellii*; *Euphorbia*; Euphorbiaceae; Taxonomy; Taiwan.

Introduction

Chamaesyce S. F. Gray, a member of the tribe Euphorbieae Dumort. (Hurusawa, 1954; Webster, 1967, 1975) is a cosmopolitan genus of some 250 species with at least three-fourths of the species centering in America (Webster, 1967). The genus is represented in Taiwan by 14 widespread, endemic or naturalized weedy species. The present study is focused on the taxonomy of these 14 taxa. The most recent full treatment of *Chamaesyce* in Taiwan was made by Hsieh (1977), who recognized eight species and attributed all of them to the genus *Euphorbia* L.

"The name *Chamaesyce* was first used by S. F. Gray at the generic rank in 1821, but it is actually older and can be traced at least to the time of Dioscorides (Koutnik, 1984)." *Chamaesyce* is rooted from *chamae* which means on the ground, lowly, or creeping (Stern, 1983), and *syce* which, stemmed from *sycon*, denotes fig (Brown, 1956). The genus is typified by *C. maritima* S. F. Gray (Koutnik, 1984, 1987), an illegitimate substitution for *Euphorbia peplis* L. (now *C. peplis* (L.) Prokh.). Historically, *Chamaesyce* has frequently been placed in the genus *Euphorbia* L., primarily based on their common possession of cyathia, but many floristic treatments (e.g. Small, 1903, 1933; Millspaugh, 1909, 1916; Rydberg, 1932; Degener and Croizat, 1936 - 1938; Hara, 1935, 1938; Hurusawa, 1954; Burch, 1966; Webster, 1967; Webster and Burch, 1967; Kartesz and Kartesz, 1980; Koutnik, 1984, 1987) considered it as a separate genus. Webster (1967) has reviewed the generic circumscription and infrageneric taxonomy of *Chamaesyce* in some length. He pointed out that it was sufficiently expedient to recognize such a widespread and large genus by one characteristic habit - the main stem abortive just above the level of the cotyledons. Recently, Koutnik (1984, 1987) suggested that a combination of the follow-

*To whom correspondence should be addressed.

ing characteristics can definitively distinguish *Chamaesyce* from *Euphorbia*: apical abortion on main stem (as a result forming sympodial growth); alternate branching; opposite, basally oblique leaves with Kranz anatomy (Welkie and Caldwell, 1970); presence of interpetiolar stipules; cyathia commonly with four (or five) appendiculate glands; ecarunculate seeds; and the possession of C_4 metabolism.

The repeated statement that the epicotylar apical meristem of *Chamaesyce* aborts (e.g. Hurusawa, 1954; Webster, 1967; Webster and Burch, 1967; Koutnik, 1987) prior to initiation of lateral branches has been disputed by Rosengarten and Hayden (1983) and Hayden (1988) from ontogenetic studies of the cotyledonary region. Hayden (1988) elucidated that the epicotyl apical meristem is actually consumed by development of the paired leaves inserted directly above the cotyledons, leaving no residue to abort.

Taxonomic History of *Chamaesyce* in Taiwan

Forbes and Hemsley (1889) are the first to document five *Chamaesyce* species from Taiwan and referred all of them to the genus *Euphorbia* (i.e. *E. atoto* = *C. atoto*; *E. pilulifera* = *C. hirta*; *E. humifusa* = *C. tashiroi*; *E. thymifolia* = *C. thymifolia* and *E. serrulata* = *C. vachellii*). Later, Hayata described three new species. They are *C. makinoi* (Hayata, 1911), *C. garanbiensis* (Hayata, 1920), and *C. tashiroi* (Hayata, 1920); these three new species were originally attributed to the genus *Euphorbia*. Hara (1938) is the first to list all *Chamaesyce* species of Taiwan within a separate genus. Until Hsieh's (1977) revision there had not been any change in the census of the taxa except for some specific synonymous corrections made by Keng (1951a, b, 1955), Masamune (1954), and Hurusawa (1954). In general, prior to the most recent full revision of Hsieh (1977), publications of Henry (1896), Matsumura and Hayata (1906), Kawakami (1910), Hayata (1917), Sasaki (1928), Suzuki (1936) and Masamune (1954) are mostly limited only to the enumeration of species. Notable exceptions can be found in the studies of Hayata (1904) where six species were monographed, Keng (1951a, b) where one new record was reported and comprehensive revisions of the genus (as *Euphorbia*) were made, and Hurusawa (1954) where the generic position of *Chamaesyce* was recovered, important characteristics of each species were illustrated and the species of Taiwan were classified into three sections, sect. *Sclerophyllae* (Boiss.) Hurusawa, sect. *Hypericifoliae* (Boiss.) Hurusawa and sect. *Chamaesyce*. Hurusawa's division stems from Boissier's (1862) subsectional classification of the section *Anisophyllum* Roeper (a synonym of *Chamaesyce*) of *Euphorbia*. Recently, in reporting the American species *C. maculata* as naturalized in Taiwan, Kao and Chaw (1987) provided a key to 9 species of *Chamaesyce* in Taiwan.

In the areas covered by the present study (including Taiwan, Penghu Islands, Hsiaoliuchiu, Lutao and Lanyu), the genus *Chamaesyce* consists of 14 species in three sections, including one new species and three new records reported for the first time from Taiwan. For each species a detailed description, geographical distribution, citation of all examined specimens, and discussion pertaining to affinity and delimitation are provided, based on the collections from the herbaria of: Institute of Botany, Academia Sinica (HAST); Department of Botany, Faculty of Science, Kyoto University (KYO); National Chiayi Institute of Agriculture (NCAI); Department of Forestry, National Taiwan University (NTUF); National Pingtung Institute of Agriculture (PAI); Department of Botany, National Taiwan University (TAI); Taiwan Forestry Research Institute (TAIF); Department of Forestry, National Chunghsing University (TCF); The Laboratory of Plant Biology, University of Tokyo (TI); Department of Biology, Tunghai University (THAI).

Taxonomic Characters

Stem. Hayden (1988) has recently clarified that the epicotyl apical meristem is early consumed by a pair of developing leaves rather than abortive as repeatedly stated by many previous workers (Hurusawa, 1954; Webster, 1967; Webster and Burch, 1967; Koutnik, 1987). He described that "further shoot development is limited to the lateral branches that develop sequentially from cotyledonary axially buds, and then from the new buds which arise at bases of previously developed lateral branches." Consequently, species of the genus usually form dense mat of branches. All species of the genus in Taiwan are herbaceous. The growth habit varies from prostrate to ascending, sometimes even erect. *Chamaesyce makinoi* and *C. serpens* have adventitious roots arising from the nodes of branches.

Stipules. The interpetiolar stipules are mainly membraneous and varies from free to fused. Within the same species such stipules are similar, but sometimes the pair above the stem is different from the pair below. The margin, inside and outside of the stipules can be glabrous or pubescent. Stipular traits are rarely used in differentiating the taxa of Taiwan. Nevertheless, they are useful when combined with other characteristics.

Leaves. The simple, petiolate leaves of *Chamaesyce* are opposite, distichous and oblique at the base. Leaves of the taxa of Taiwan display wide variations in their shape, size, marginal serration and pubescence. These characteristics are important in delimitation of the species in Taiwan. We have observed stomata on both surfaces of the leaves of *C. hsinchuensis* (Fig. 1K), *C. maculata, C. serpens, C. taihsiensis* and *C. thymifolia.* They are uniformly anomocytic.

Venation. The veins of *Chamaesyce* possess a sheath of cells, which contain large chloroplasts, around the vascular bundle (Welkie and Caldwell, 1970). Welkie and Caldwell (1970) reported that this specialized leaf structure perfectly correlates with the correlative physiological characteristics of C_4 metabolism. All *Chamaesyce* species in Taiwan also consistently show the presence of the distinctive bundle sheath (e.g. *C. tashiroi*, Fig. 1J). In the majority of the species examined, the veins at the leaf edge form a more or less continuous, thickened marginal vein (by Melville's terminology, 1976). This is especially clear in *C. hsinchuensis* and *C. thymifolia* (Fig. 1F). While in *C. atoto, C. garanbiensis* (Fig. 1E), *C. prostrata* and *C. serpens* the marginal veins are incomplete, linking some of the excurrent veins but leaving others free.

Sehgal and Paliwal (1974, 1975) classified the venation of *Euphorbia* (including *Chamaesyce* which was considered as section *Anisophyllum* of *Euphorbia*) into four categories. The *Chamaesyce* species of Taiwan can be readily assigned to Sehgal and Paliwal's group 1.3.1 of the category 1.3, which is characterized by the possession of bundle sheaths (Fig. 1J) and three strands of veins entering the petiole. Sehgal and Paliwal further divided their group 1.3.1 into three types. Our species show only their Type 1.3.1.2 (or *E. hirta* type) and Type 1.3.1.3 (or *E. granulata* type) on the basis of course of the vascular strands within the lamina. These two types are defined as follows: in the *E. hirta* type (Fig. 1A), the three strands entering the petiole follow in-

Table 1. *Venation pattern of* ***Chamaesyce*** *species in Taiwan. The type follows the Seghal and Paliwal's (1974, 1975) categorization, see text for explanation*

Species	Marginal vein	Isolated veins[a]	Type[b]
C. atoto	Nearly continuous	+ (many)	3
C. garanbiensis	Discontinuous	+ (few)	2, 2-3
C. hirta	Nearly continuous	−	2, 3, 2-3
C. hsinchuensis	Continuous	+ (few)	3
C. hyssopifolia	Nearly continuous	−	2-3
C. maculata	Continuous	−	3, 2-3
C. makinoi	Continuous	−	2, 3, 2-3
C. prostrata	Discontinuous	−	3, 2-3
C. serpens	Mostly continuous	−	2, 3, 2-3
C. sparrmannii	Continuous	+ (few)	3
C. taihsiensis	Continuous	−	3, 2-3
C. tashiroi	Continuous	−	3, 2-3
C. thymifolia	Continuous	−	2, 3, 2-3
C. vachellii	Continuous	+ (few)	3

[a] + : present; − : absent.
[b] 2-3 represents the intermediate pattern between the type 2 and 3.

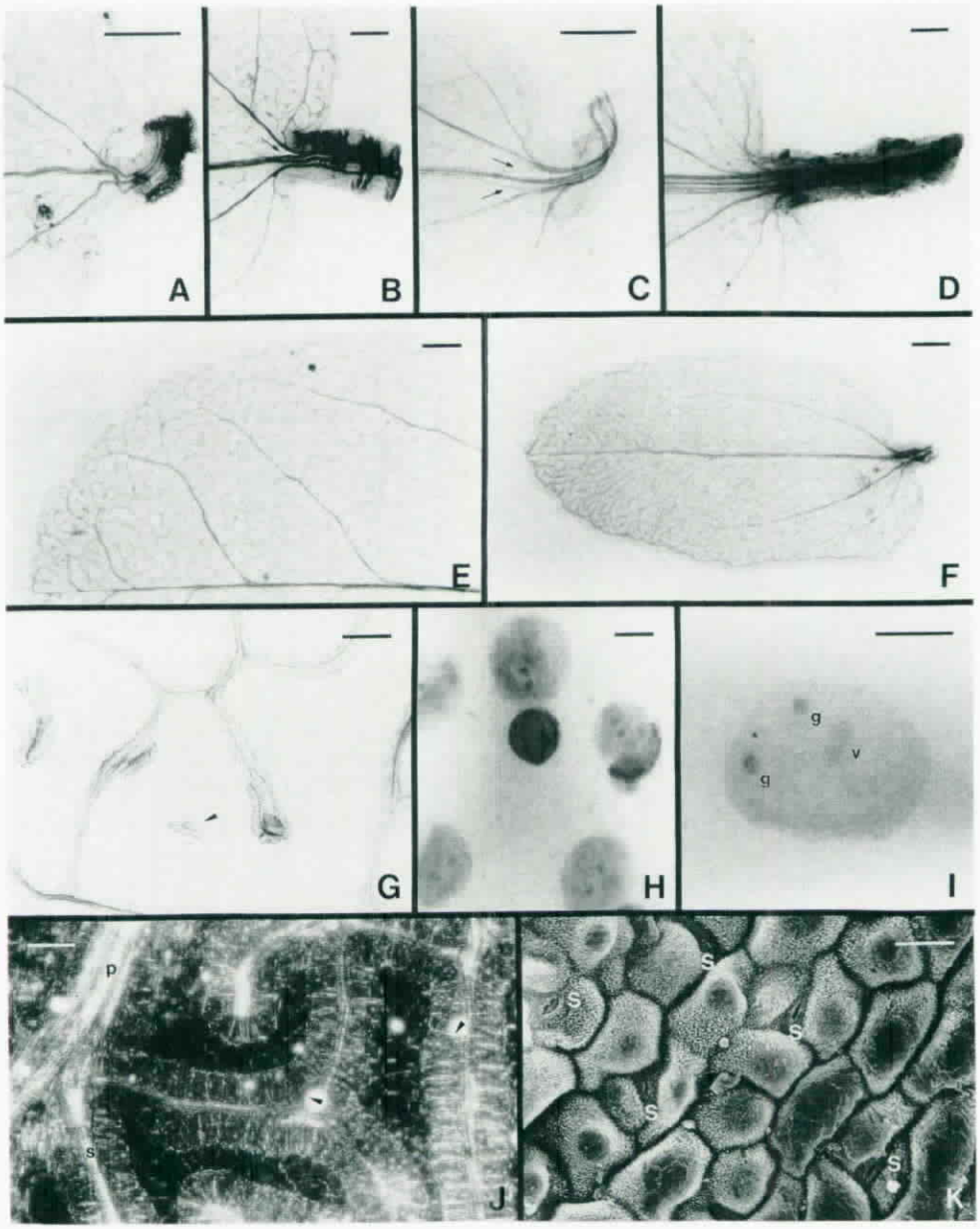

Fig. 1. A-G & J, leaves from selected species of *Chamaesyce* cleared with 5% KOH, following O'Brien's method (1974), then stained with Safranin O. A - D, venation type, showing three vascular strands of vein entering the petiole. A, *C. makinoi* (*Lin 197*), three strands run independently, the median forming the midrib and the two laterals supplying the sides; B, *C. garanbiensis* (*Lin 437*), showing one of the laterals joining the formation of midrib with a branch (arrow); C, *C. prostrata* (*Lin 279*), showing the median along with branches (arrow) from the two laterals forming the midrib; D, *C. atoto* (*Lin 438*), showing two laterals contributing comparatively large proportions of branches to support the midrib. E & F, marginal vein. E, *C. garanbiensis* (*Lin 437*), showing discontinuous marginal vein; F, *C. thymifolia* (*Lin 119*), showing continuous marginal vein; G, *C. garanbiensis* (*Lin 437*), showing disjunct vein (arrow); J, *C. tashiroi* (*Lin 409*), showing bundle sheath (arrow), primary vein (p) and secondary vein (s), observed under a Nikon Biophot microscope with Nomarski prim. H & I, trinucleate pollen of *Chamaesyce*, stained with FLP orcein (Jackson, 1973). H, *C. garanbiensis* (*Hsiao s. n.* 25 Jan 1987), showing each ruptured pollen with two generative nuclei (vegetative cell frequently degraded); I, *C. sparrmannii* (*Lin 789*), showing two generative nuclei (g) and one vegetative nuclei (v) in a ruptured pollen; K, scanning electron micrograph of *C. hsinchuensis* (*Chaw et al. 483*), showing anomocytic stomata (s). Scale bars of A - F equal 200 μm, of G & J 50 μm, and of H, I & K 20 μm.

dependent courses, the median forms the midrib and the laterals supply the sides; in the *E. granulata* type (Fig. 1C) three strands enter the petiole of the leaf, the median along with branches of the laterals form the midrib. We found that leaves of *C. hirta, C. makinoi, C. serpens* and *C. thymifolia* (see Table 1) show not only the *E. hirta* type and the *E. granulata* type, but also exhibit an intermediate pattern between the two types. In the intermediate pattern (e.g. C. *garanbiensis*, Fig. 1B), one of the laterals supplies the side and the other joins the formation of the midrib with a branch. Usually the latter lateral is located in the abaxial side of the lamina. *Chamaesyce maculata, C. prostrata, C. taihsiensis* and *C. tashiroi* exhibit the *E. granulata* type and the intermediate pattern. *Chamaesyce garanbiensis* exhibits the *E. hirta* type and the intermediate pattern. Leaves of *C. atoto* (Fig. 1D) and *C. vachellii* have the *E. granulata* type venation, but the two laterals contribute comparatively large proportions of branches to support the midrib, a condition which is uncommon.

In *Chamaesyce* of Taiwan, *C. atoto, C. garanbiensis* (Fig. 1G), *C. hsinchuensis, C. sparrmannii,* and *C. vachellii* are unusual in having isolated segments of veins (or disjunct veins). The disjunct veins are single or small clusters of tracheary elements, or small portions of the intersecondary reticulum independent of the foliar vascular system (Herbst, 1972). Among the five species mentioned above, *C. atoto* has the highest number of disjunct veins. Ontogenetically, "the disjunct veinlets are isolated early in the histogenesis of the intersecondary veins when certain procambial cells fail to differentiate into vascular tissue" (Herbst, 1972). Herbst (1971) studied the disjunct veins of the Hawaiian *Chamaesyce* (as *Euphorbia*) species and found that they are common in the species native to mesic and wet areas. He suggested that the disjunct tracheid strand could be an adaptation to an increased laminar volume or a response to a wetter environment. According to our field observations, the above five Taiwan species also tend to inhabit moister habitats such as coastal areas or shady places.

Inflorescence (the arrangement of cyathia). From the specimens we have examined, we assume the ancestral inflorescence of *Chamaesyce* to be a cyme with leaf -like bracts (Fig. 2A; e.g. *C. atoto, C. hyssopifolia, C. sparrmannii*). From such inflorescence two different modified phyletic lines can be hypothesized. In one line,

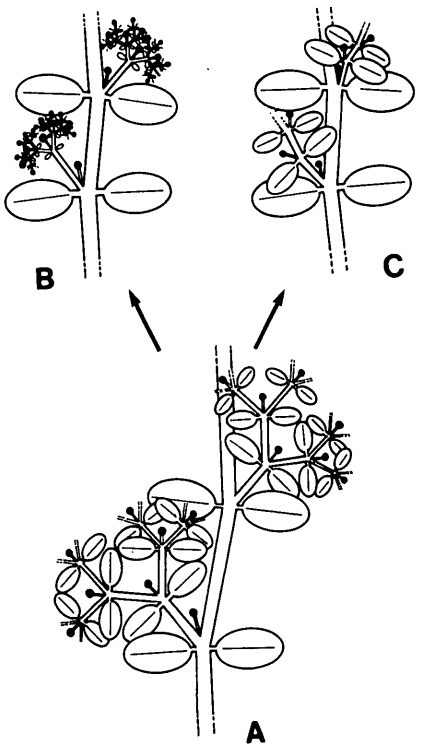

Fig. 2. Two hypothesized phyletic lines of cyathial arrangement in *Chamaesyce*. A, cyathia in cyme, each with leaf -like bracts; B, a solitary cyathium and a glomerule -like cyme at each node; C, cyathia solitary at nodes with normal leaves or diminutive leaves.

due to diminution of inflorescence branches and of leaf -like bracts, the above-said cyme becomes glomerule -like (Fig. 2B, e.g. *C. tashiroi*), or a typical glomerule (e.g. *C. hirta*) born alternatively at succeeding nodes. The second line can be hypothesized as a result of not only a reduction of one of lateral inflorescence branches, but also further elimination and contraction of branchlets within the remaining lateral inflorescence branch. Consequently, the cyathia appear to be solitary in the apparent axils of normal or bract-like leaves (Fig. 2C, e.g. *C. makinoi, C. prostarta*).

Cyathium. The cyathium, a basic character of the tribe Euphorbieae, is defined by Dressler (1957) as an inflorescence composed of fused involucral bracts surrounding a single, terminal female flower and usually composed of five clusters of male flowers. The basic shape of a cyathium is campanulate. All *Chamaesyce* species of Taiwan possess petaloid glandular appen-

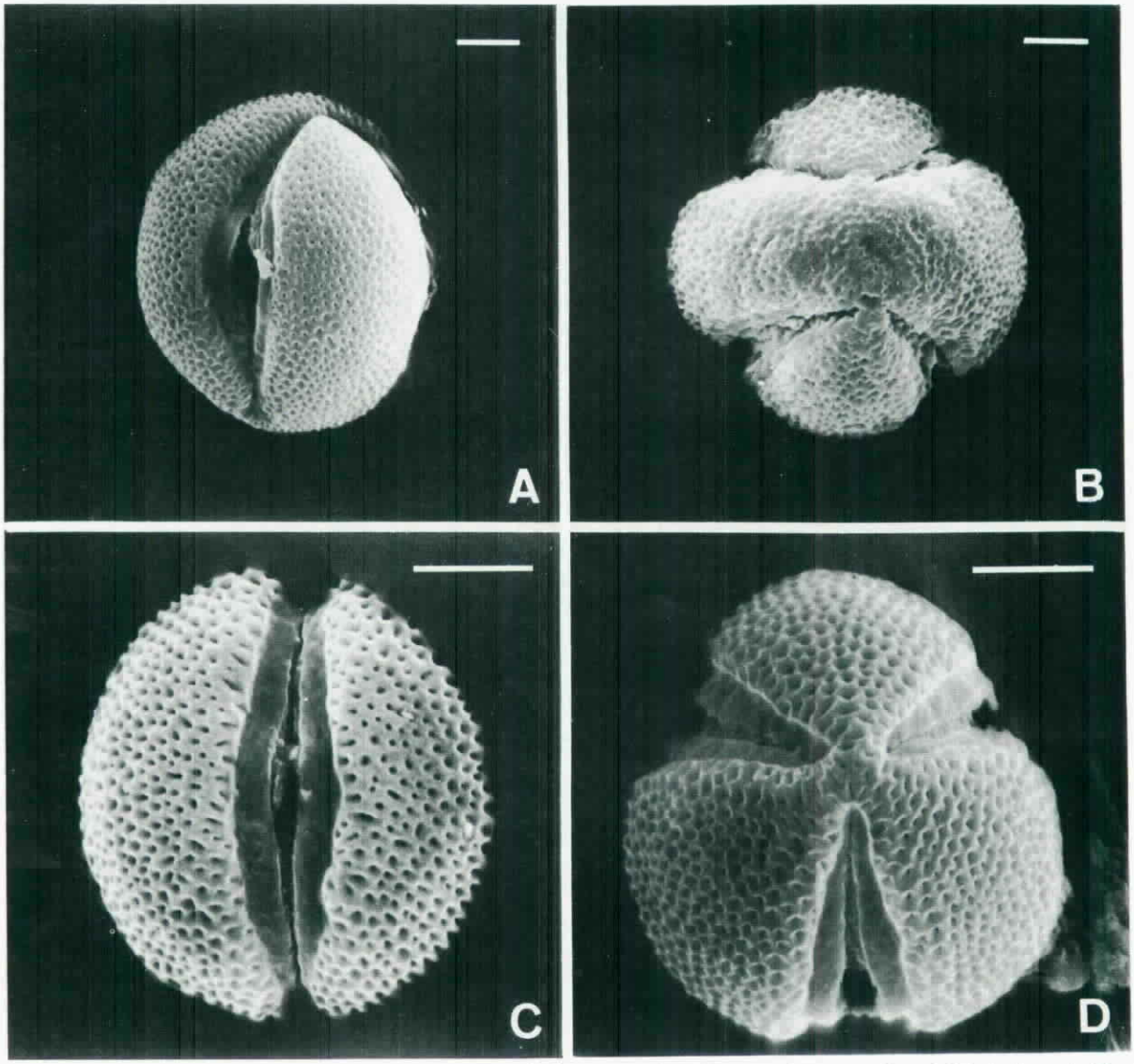

Fig. 3. Scanning electron micrographs of acetolyzed pollen of *Chamaesyce*. A & B, tetracolporate pollen of *C. hsinchuensis (Lin 851)*. A, equatorial view; B, polar view; C & D, tricolporate pollen of *C. makinoi* (*Lin 855*). C, equatorial view; D, polar view. Scale bars equal 5 μm.

dages, which is an useful character in separating the genus from the rest of Euphorbieae, and sometimes in delimiting species within the genus.

Other than *C. serpens* and *C. taihsiensis*, which usually have a rudimentary perianth, the female flower of *Chamaesyce* is naked (without a perianth). The male flower is naked, monandrous and exserted beyond the top of the cyathium when mature. The base of the male flower pedicel usually has several small bracteoles. In the genus in Taiwan, the number of male flowers is more than five, but in some weedy species such as *C. hirta, C. maculata, C. makinoi, C. prostrata, C. serpens* and *C. thymifolia* it is usually five or less.

Pollen. Webster and Rupert (1973) and Webster *et al.* (1982) reported pollen of *Chamaesyce* species as trinucleate. The majority of the taxa they examined are American natives. Our observations on three endemic species, *C. garanbiensis* (Fig. 1H), *C. hsinchuensis* and *C. tashiroi*, and a local population of *C. sparrmannii* (Fig. 1I) also show the same pattern. Pollen grains of the genus have been generally described as tricolporate

(Fig. 3, C & D), prolate or subprolate, with reticulate exine and long tapering colpi almost reaching the poles (Selling, 1947; Huang and Wong, 1968, as *Euphorbia*). Pollen of all *Chamaesyce* in Taiwan is consistent with the above descriptions except for *C. garabiensins* and *C. hsinchuensis,* whose exine seems to be perforate rather than reticulate. Furthermore, we found that our new species *C. hsinchuensis* is unique in having tetracolporate pollen in two nearly syncolporate pairs (Fig. 3, A & B). Among our local taxa the largest pollen belongs to *C. sparrmannii* (30 - 36 × 24 - 28 μm), and the smallest to *C. hirta* (20 - 22 × 16 - 18 μm) and *C. thymifolia* (18 - 22 × 16 - 20 μm).

Fruits and seeds. Fruits of *Chamaesyce* are capsular and 3-celled with one seed in each cell. Webster (1967) reported that "the elastic dehiscence of the fruit is characteristic, and seeds may be hurled to a considerable distance." The fruit size ranges from 1 mm (*C. thymifolia*) to 3 mm (*C. atoto*) in length. The pubescence of the capsule is an important character to identify species. The pedicel of the capsule is longer than the involucre except in *C. thymifolia*. In *C. hirta, C. hsinchuensis* and *C. maculata* the pedicels of the capsules are short and the capsules nutant slightly above the involucres or to the side. While in other species, the pedicels are much longer so that the capsules nutant distinctly to the side of involucres. The ecarunculate seeds of *Chamaesyce* are generally tetragonal in cross section. The testa usually becomes mucilaginous when wetted.

Chamaesyce S. F. Gray, Nat. Arr. Brit. Pl. 2: 260. 1821.

Anisophyllum Haw. Syn. Pl. Succ. 159. 1812, *non* Jacq.

地錦草屬

Monoecieous, herbaceous, with tap-root, main axis meristem of stem consumed above the cotyledons, apparent main axes actually sympodial, latex whitish; stipules usually membranous, free or fused. Leaves simple, opposite, distichous, oblique at base, entire or serrulate at margin, petiolate. Cyathia solitary, in cymes with leaf-like bracts, in pedunculate cymes or in glomerules; involucre with 5 lobes, which alternate at the tips with 4 (rarely 5) glands, the glands with appendages; bracteoles acicular or linear to oblanceolate, laciniate-lacerate at margin. Flowers naked, perianth usually absent, pedicellate; male flowers, monandrous, in 5 monochasia (usually each with 1 to several flowers); female flowers solitary, ovary glabrous or not, 3-celled, 1-ovuled per cell; style 3, free or connate at base, bifid at apex. Fruits capsular, style and stigma persistent; seeds tetragonal, slightly rugulose or transversely rugose, ecarunculate.

Distribution: In Taiwan, *Chamaesyce* species grow in habitats such as roadsides, yards, wilderness, cultivated fields and seashores, and range from sea level to an elevation of approximately 1700 meters. Section *Sclerophyllae (C. atoto, C. garanbiensis* and *C. sparrmannii), C. hsinchuensis* and *C. taihsiensis* are confined to coastal habitats. *Chamaesyce hirta, C. prostrata* and *C. thymifolia* are more widespread, commonly found in and around human habitations.

Chamaesyce garanbiensis, C. hsinchuensis, C. taihsiensis and *C. tashiroi* are endemic to the island, while the remainder are widespread in temperate and tropical regions of the world. *Chamaesyce hyssopifolia, C. maculata* and *C. serpens* are of American origin, and recent naturalizers.

Classification notes: Boissier (1862) divided the genus *Euphorbia* into 27 sections, of which the section *Anisophyllum* (a synonymous of *Chamaesyce*) was further subdivided into 8 subsections. In his treatment, Hurusawa (1954) elevated three Boissier subsections, *Sclerophyllae, Hypericifoliae* and *Chamaesyce* to the rank of section. Webster (1967) in treating the New World species of *Chamaesyce* considered Hurusawa's section *Hypericifoliae* a subsection of the section *Chamaesyce*. However, in their more recent study on the pollen of Euphorbiaceae, Webster *et al.* (1982) maintained *Hypericifoliae* as a distinct section without comment.

Until the present, no comprehensive sectional classification of *Chamaesyce* has been proposed. Therefore, in this report we follow Hurusawa's definition, and assign its Taiwanese species into three sections (Table 2). Section *Sclerophyllae* (Boiss.) Hurusawa is a pantropical group of about 30 insular or maritime species (Webster, 1967), characterized by the subshrubby habit, the articulate stems which are woody at base, the subcoriaceous, entire to sometimes serrate leaves, and the glandular appendages which are small and sometimes reduced. As shown in the Table 2 we include not only *C. atoto* and *C. sparrmannii* but also *C. garan-*

Table 2. *Comparison of Hurusawa's (1954) and the authors' classifications of the genus* ***Chamaesyce*** *in Taiwan*

Hurusawa's classification			Lin *et al.*'s classification	
Section	Subsection	Species	Section	Species
Sclerophyllae		*C. atoto* (Forst. *f.*) Croizat	*Sclerophyllae*	*C. atoto* (Forst. *f.*) Croizat 濱大戟 *C. garanbiensis* (Hayata) Hara 鵝鑾鼻大戟 *C. sparrmannii* (Boiss.) Hurusawa 心葉地錦
Hypericifoliae	*Hirtae*	*C. hirta* (L.) Millsp.	*Hypericifoliae*	*C. hirta* (L.) Millsp. 飛揚草
	Hyssopifoliae	*C. vachellii* (Hook. & Arn.) Hurusawa		*C. hyssopifolia* (L.) Small 紫斑大戟 *C. tashiroi* (Hayata) Hara 田代氏大戟 *C. vachellii* (Hook. & Arn.) Hurusawa 華南大戟
Chamaesyce		*C. garanbiensis* (Hayata) Hara *C. hypericifolia* (L.) Millsp. var. *tashiroi* (Hayata) Hurusawa *C. makinoi* (Hayata) Hara *C. prostrata* (Ait.) Small *C. thymifolia* (L.) Millsp.	*Chamaesyce*	*C. hsinchuensis* Lin & Chaw 新竹地錦 *C. maculata* (L.) Small 斑地錦 *C. makinoi* (Hayata) Hara 小葉大戟 *C. prostrata* (Ait.) Small 伏生大戟 *C. serpens* (H. B. & K.) Small 匍根地錦 *C. taihsiensis* Chaw & Koutnik 臺西地錦 *C. thymifolia* (L.) Millsp. 千根草

biensis in the section *Sclerophyllae*, since the latter species possesses all the characters that pertain to section *Sclerophyllae* rather than to section *Chamaesyce* as proposed by Hurusawa (1954).

The differences between section *Hypericifoliae* and section *Chamaesyce* as keyed out in Hurusawa's work are that the former has ascending to suberect rather than prostrate stem and branch, cymulose rather than solitary cyathia, and large rather than small leaves. *Chamaesyce tashiroi* is presently placed under section *Hypericifoliae* because of its ascending stem, cymulose cyathia and the comparatively large leaves.

Webster (1967) pointed out that within section *Chamaesyce* it is difficult to demarcate infrasectional groups. As no clear cut infrasectional system could be followed, and we have not as yet obtained a broad understanding of character variations among *Chamaesyce*, we do not attempt further classification within this section.

Key to the Species of the Genus *Chamaesyce* of Taiwan

1. Capsule glabrous.
   2. Plant erect, seldom prostrate; leaves more than two times as long as wide.
      3. Leaves linear to linear-oblong; cyathia in pedunculate cymes. . . . . 7. *C. vachellii*
      3. Leaves oblong-lanceolate to elliptic; cyathia in cymes with leaf-like bracts. . . . . 5. *C. hyssopifolia*

2. Plant prostrate to ascending, seldom erect; leaves less than two times as long as wide.
   4. Leaf-margin serrulate at least at the apex.
      5. Leaf-apex obtuse to rounded; glandular appendages conspicuous, wider than glands. . . . . 2. *C. garanbiensis*
      5. Leaf-apex emarginate; glandular appendages not obvious, narrower than glands. . 13. *C .taihsiensis*
   4. Leaf-margin entire.
      6. Stem rooting at nodes; leaves 2 - 5 mm long; cyathia solitary at nodes.
         7. Glandular appendages reniform, margin entire or not; ovary and capsule with 1 - 3 minute, triangular, perianth segments . . . . . 12. *C. serpens*
         7. Glandular appendages narrowly elliptic, margin distinctly undulate; ovary and capsule not as above. . . . . 10. *C. makinoi*
      6. Stem not rooting at nodes; leaves 10 - 30 mm long; cyathia in cymes with leaf-like bracts.
         8. Leaves elliptic to ovate-oblong, obtuse to rounded at apex; glandular appendages narrowly elliptic, obscure . . . . . 1. *C. atoto*
         8. Leaves ovate, acute at apex; glandular appendages obovate to reniform, conspicuous . . . . . 3. *C. sparrmannii*

1. Capsule pubescent.
   9. Cyathia in pedunclulate cymes or glomerules.
      10. Stem yellowish hirsute; leaf-apex acute; glandular appendages narrowly obdeltoid . 4. *C. hirta*
      10. Stem not as above; leaf-apex rounded; glandular appendages broadly reniform . . . . . 6. *C. tashiroi*
   9. Cyathia solitary at nodes, clustered if on congested lateral branches.
      11. Stem puberulent; ovary and capsule hirtellous mainly along their angles; capsular pedicel ca. 3 times as long as the involucre . . . . . 11. *C. prostrata*
      11. Stem sericeous or sparsely pilose; ovary and capsule pubescent all over; capsular pedicel up to 1.5 times as long as the involucre.
         12. Capsule ca. 1mm long, not completely exserted at maturity. . . . . 14. *C. thymifolia*
         12. Capsule ca. 2 mm long, completely exserted at maturity.
            13. Stem sericeous; stipules free below; leaves elliptic or oblong to falcate, 6-13 mm long, usually with an elongate purple spot centrally above; male flowers 4-5; pollen tricolporate . . . . . 9. *C. maculata*
            13. Stem glabrous to sparsely pilose; stipules fused below; leaves ovate- to obovate-oblong, 2-7 mm long, with several scattered small purple spots above; male flowers 5-15; pollen tetracolporate . . . . . 8. *C. hsinchuensis*

Chamaesyce sect. Sclerophyllae (Boiss.) Hurusawa in J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 275. 1954; Koutnik in Allertonia 4(6): 338. 1987. Type: *Chamaesyce atoto* (Forst. *f*.) Croizat. 革葉組

1. **C. atoto** (Forst. *f*.) Croizat *In* Degener, Fl. Hawaii. Fam. 190. 1936; Hara in J. Jap. Bot. 14: 355. 1938; Hurusawa in. J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 275. f. 33. 1954; Kao & Chaw in J. Taiwan Mus. 40(2): 43. 1987. 濱大戟 Fig. 4, 5.

Euphorbia atoto Forst. *f*., Fl. Ins. Austr. Prodr. 36. 1786; Boiss. *In* DC. Prodr. 15(2): 12. 1862; Forbes & Hemsley in J. Linn. Soc. Bot. 26: 411. 1889; Henry, List. Pl. Form. 81. 1896; Matsumura & Hayata in J. Coll. Sci. Univ. Tokyo 22: 367. 1906; Kawakami, List Pl. Form. 100. 1910; Hayata in J. Coll. Sci. Univ. Tokyo 30: 261. 1911; Hayata, Gen. Ind. Fl. Form. 66. 1917; Sasaki, List Pl. Form. 260. 1928; Suzuki *In* Masamune, Short Fl. Form. 119. 1936; Keng in Quart. J. Taiwan Mus. 4: 254. 1951; Masamune, List Vasc. Pl. Taiwan 46. 1954; Keng in Taiwania 6: 43. 1955; Hsieh *In* Li *et al*., Fl. Taiwan 3: 460. 1977.

E. atoto var. *minor* Boiss. in *l. c.* 15(2): 13. 1862.

E. sparrmanni sensu Hayata in J. Coll. Sci. Univ. Tokyo 20: 73. 1904; Matsumura & Hayata in J. Coll. Sci. Univ. Tokyo 22: 367. 1906; Kawakami, List Pl. Form. 100. 1910, *non* Boiss.

C. atoto forma *minor* (Boiss.) Hurusawa in *l. c.* 276.

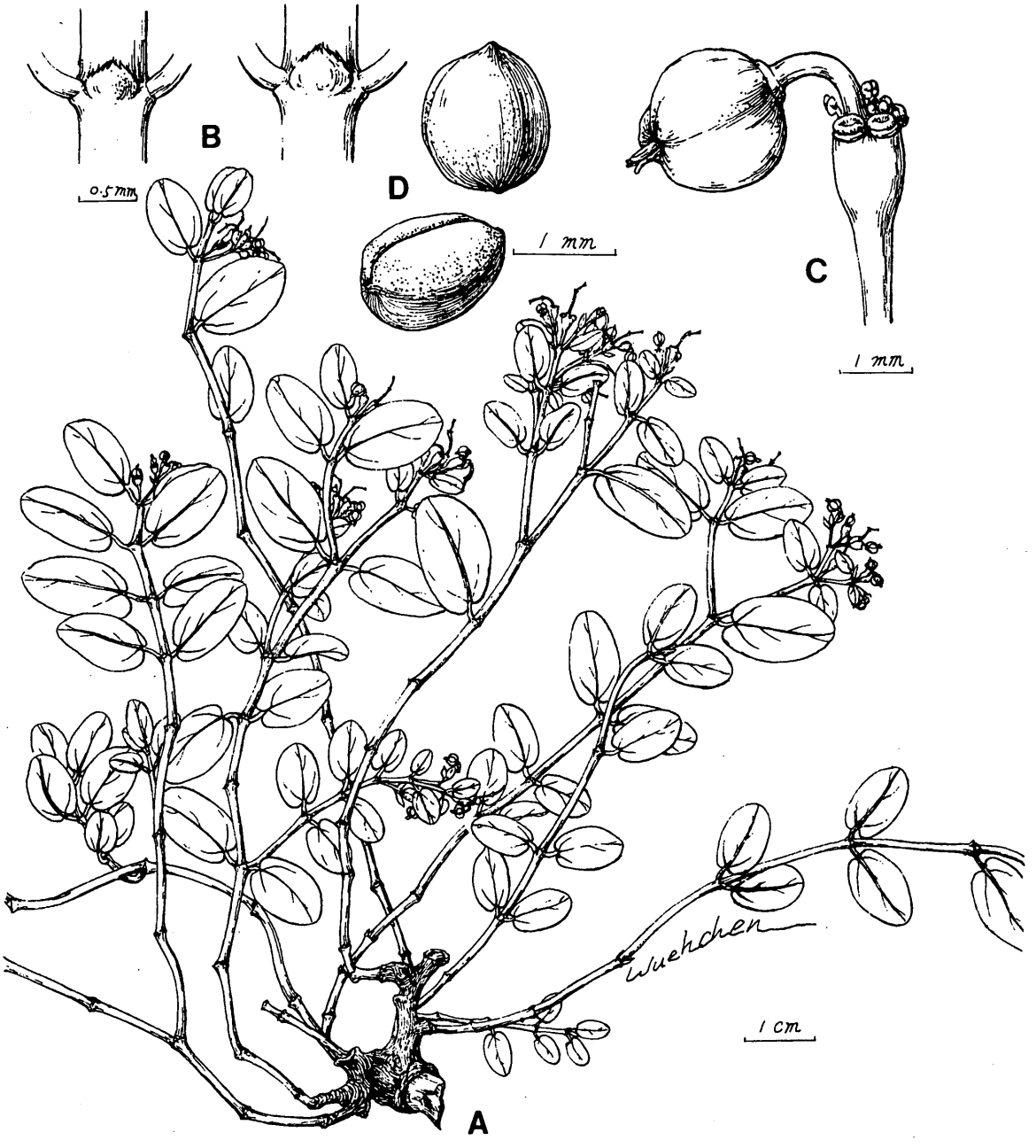

Fig. 4. *C. atoto* (*Lin 438*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, cyathium; D, seeds (*Lin 789*).

1954.

Perennial herb; stem prostrate to ascending, seldom erect, glabrous; stipules usually fused at upper and lower side of stem, sometimes free at upper side, ovate -deltoid to ovate, 0.4 - 1.2 mm long, incised at margin, sericeous adaxially. Leaves subcoriaceous, elliptic to ovate-oblong, 12 - 30 mm long, 7 - 14 mm wide, obtuse to rounded at apex, obliquely subcordate at base, entire at margin, glabrous on both surfaces; petioles 1.5 - 2.5 mm long, glabrous. Cyathia in cymes with leaf-like bracts; involucres turbinate, 1 - 1.4 mm long, glabrous

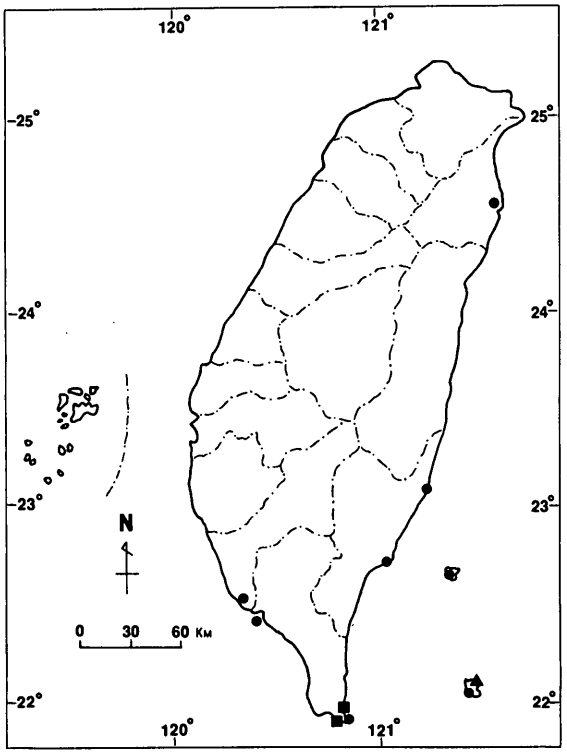

Fig. 5. Distribution of *C. atoto* (solid circle), *C. garanbiensis* (solid square) and *C. sparrmannii* (solid triangle) in Taiwan.

outside, velutinous inside; stalks 0.5 - 5.6 mm long; glands 4, yellow, transversely elliptic or oblong, 0.3 - 0.7 mm long; appendages white, narrowly elliptic and obscure; bracteoles linear, laciniate-lacerate at margin. Male flowers 10 - 25; anthers yellow. Female flower with glabrous pedicel and ovary; style and stigma 0.4 - 0.6 mm long. Capsules ca. 3 mm long, 2.3 mm diam., exserted, nutant, glabrous, the pedicels to 6 mm long; seeds brownish, tetragonal, ovoid to rounded -ovoid, 1 - 1.5 mm long, 0.8 - 1.3 mm diam, smooth or slightly rugulose.

Distribution: This species is widely distributed in India, southern China, Malaysia, Java, Australia, the Philippines, the Ryukyus, Japan and Polynesia (Keng, 1951b; Hsieh, 1977). Local populations occur in coral reefs and sandy coastal areas in the southern and eastern parts.

Specimens examined: ILAN CO.: Suao, *Kawakami s. n.* 28 Feb 1914 (TAIF). KAOHSIUNG CITY: *Kawakami, Hayata & Shimada s. n.* 15 Aug 1908 (TAIF), *Hayata 115* (TI). PINGTUNG CO.: Hsiaoliuchiu, Taliao, *Hosokawa 1948* (TAI); Tientai, *Hosokawa 1949* (TAI); Oluanpi, *Kawakami & Sasaki s.n.* Feb 1911 (TAIF), *Morilani 1926* (TAI), *Matuda 161* (TAI), *Shimizu s. n.* 14 Apr 1961 (TI), *Nagasawa (A)616* (KYO), *Nagasawa s. n.* 5 Dec 1906 (TI); Ohwi *s. n.* 30 Mar 1933 (KYO), *T. I. Chang & Kao 3007* (HAST); Fengtsueishah, *Peng 7209* (HAST); Longkeng, *Lin 438* (HAST, THAI). PENGHU CO.: Chiyuyu, *Hsu s. n.* 26 Jun 1985 (TAIF). TAITUNG CO.: Taitung City, *Kobayashi s. n.* Sep 1908 (TAIF), *Sauseudai 2078, 2471* (TAI); Sanhsientai, *Lu 19328* (TAIF), *Lin 646* (THAI); Lanyu: Tungching, *C. E. Chang 8403, 14998* (PAI); Yehyin, *C. E. Chang 8490* (PAI), *Lin 789* (THAI); Shuangshihyen, *Lin 787* (TAI, THAI); Lanyu, without further locality, *Miyake s. n.* 29 Nov 1899 (TI), *Mori 2480* (TAIF), *Wu 1630* (TAI), *C. E. Chang 7665, 8414, 9633, 9663* (PAI); Lutao, Haisenping, *Peng 7604* (HAST), *Chaw & Lin 906* (HAST); Lutao, without further locality, *Huang 7012*(TAI), *C. E. Chang 15825* (PAI), *Ho 341* (NTUF).

Classification notes: This species was mistaken as *Chamaesyce chamissonis* (Boiss.) Ho by Ho (1981). The populations in Ryukyu Islands and Japan were also attributed to *Euphorbia chamissonis* Boiss. by Hatusima (1971), Walker (1976) and Hurusawa (1982). We have not seen the type of either *C. atoto* or *C. chamissonis*, but Boissier's descriptions of both species (1862) are helpful in identifing both identities. Boissier (1862) originally described *C. chamissonis* as having obovate leaves and wider glandular appendages, while *C. atoto* having elliptic to ovate-oblong leaves and narrower glandular appendages.

Chamaesyce atoto forma *minor* (Boiss.) Hurusawa is a combination with new rank based on *E. atoto* var. *minor* Boiss. Boissier described the variety on the account of its size and pustulate seeds. Hurusawa (1954) mentioned the leaf size in the key to this variety. The ranges of leaf length vary from 1 to 2 cm in *C. atoto* var. *minor*, 2 - 3 cm in *C. atoto* var. *C. atoto*. Hurusawa (1954) assinged *Miyake s. n.* 29 Nov 1899 and *Nagasawa s. n.* 1907 to be *C. atoto* forma *minor*. We have not seen the latter specimen, but we have found another Nagasawa's specimen of the same place, which was collected in 1906. The leaves of *Nagasawa s. n.*

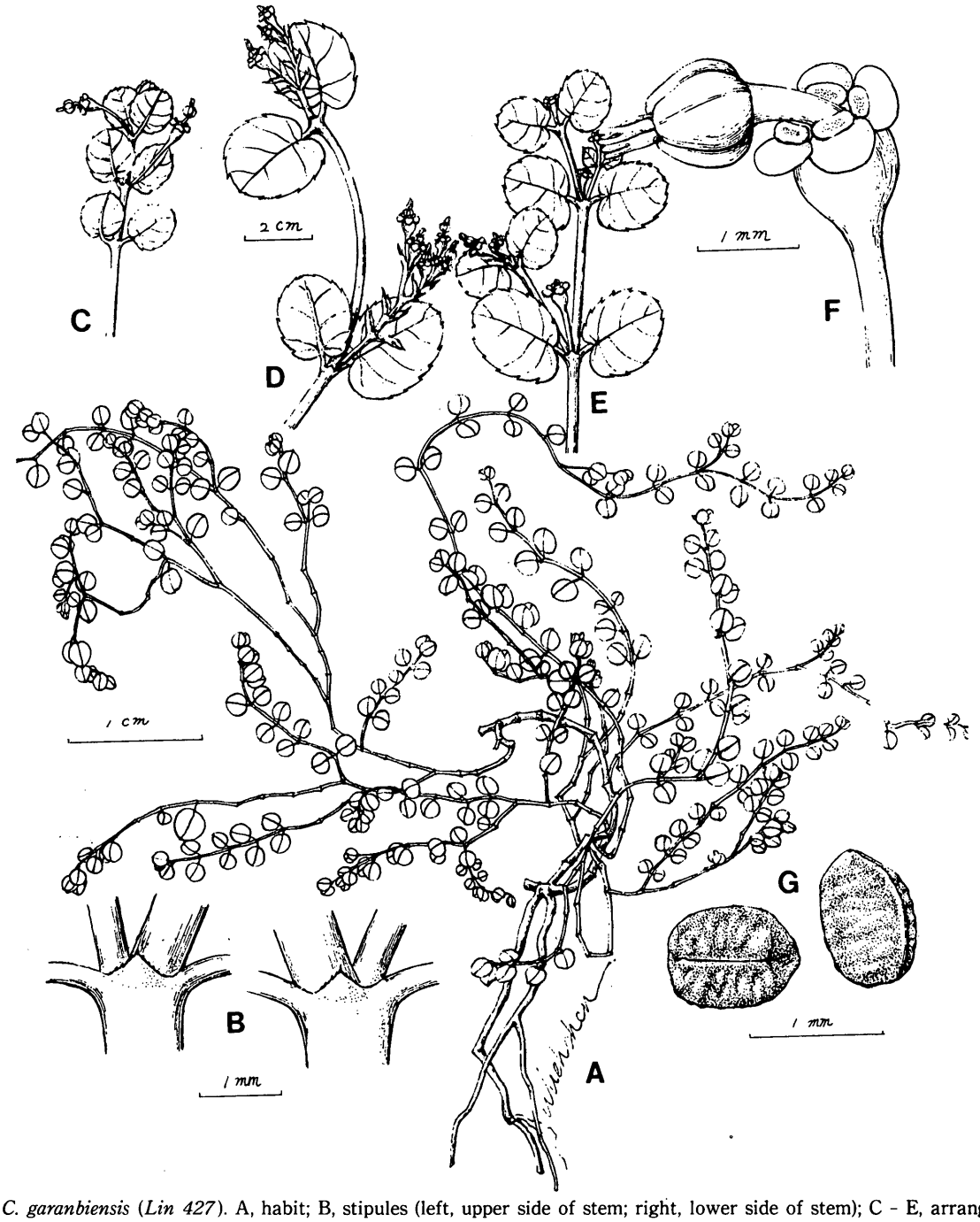

Fig. 6. *C. garanbiensis* (*Lin 427*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C - E, arrangement of cyathia. C, cyathia solitary at nodes; D, cyathia in pedunculate cymes at nodes (*Hsiao s. n.* 25 Jan 1987); E, cyathia in cyme with leaf-like bracts (*Lin 437*); F, cyathium; G, seeds (*Lin 428*).

1906 and Miyake 1899 varies from 1 to 2 cm long, which is within the range of the specimens gathered in Taiwan. The seed coats of all specimens examined appear smooth with naked eyes, but slightly rugulous under dissected microscope. We have not seen both type of *C. atoto* and Boissier's variety, therefore, at present, we do not make further classification within species.

The present species is closely allied with *C. sparrmannii*, under which their differences are discussed.

2. **C. garanbiensis** (Hayata) Hara in J. Jap. Bot. 14: 355. 1938; Hurusawa in. J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 291. f. 40. 1954.
鵝鑾鼻大戟 Fig. 5, 6.

Euphorbia garanbiensis Hayata, Icon. Pl. Form. 9: 103. 1920; Sasaki, List Pl. Form. 260. 1928; Suzuki *In* Masamune, Short Fl. Form. 119. 1936; Keng in Quart. J. Taiwan Mus. 4: 259. 1951. *excl. sp.*; Masamune, List Vasc. Pl. Taiwan 46. 1954; Keng in Taiwania 6: 43. 1955; Hsieh *In* Li *et al.*, Fl. Taiwan 3: 462. 1977. (Holotype, *Hayata s. n.* Jun 1, 1912, TI!)

Perennial herb; stem prostrate to ascending, glabrous; stipules triangular-cuspidate, 0.2 - 0.5 mm long, glabrous. Leaves subcoriaceous, rounded-ovate to obovate, 3 - 11 mm long, 3 - 9 mm wide, obtuse to rounded at apex, obliquely subcordate at base, serrulate at margin or only near apex, glabrous on both surfaces; petioles 1 - 1.7 mm long, glabrous. Cyathia solitary or together with a pedunculate cyme at a node, or sometimes in cyme with leaf-like bracts; involucres urceolate-turbinate, 0.7 - 1.1 mm long, glabrous outside and inside; stalks 1.6 - 7.4 mm long; glands 4, yellow-green, transversely elliptic or oblong, 0.3 - 0.7 mm long; appendages white, reniform, entire to subundulate, 0.4 - 0.8 mm long, 0.2 - 0.5 mm wide; bracteoles acicular or linear to linear-oblong, laciniate-lacerate at margin. Male flowers 20 - 30, anthers yellow. Female flower with glabrous pedicel and ovary; style and stigma 0.3 - 0.7 mm long. Capsules 1.6 - 2.2 mm long, 1.7 - 2.3 mm diam., exserted, nutant, glabrous, the pedicels to 3.7 mm long; seeds grayish, brownish or reddish, tetragonal, ovoid, 1 - 1.2 mm long, 0.8 - 1 mm diam, transversely rugose.

Distribution: This species is endemic to the Oluanpi Peninsula, the southernmost tip of Taiwan. It grows on coral reefs, sandy areas and grasslands along the coast.

Specimens examined: PINGTUNG CO.: Oluanpi, *Hayata s. n.* 1 Jun 1912 (Type of *Euphorbia garanbiensis*, TI!), *Yamamoto s. n.* 25 Aug 1925 (TI), *Koyama & Kao 8928* (TAI), *Ou & Kao 9015* (TAI); Nanshan, *Huang 7888* (TAI); Fengchuisha, *Lin et al. 124* (THAI), *Lin 427, 428* (HAST, THAI); Longkeng, *Lin 434, 437* (TAI, THAI); *Lin & Wang 624, 625* (THAI), *Hsiao s. n.* 25 Jan 1987 (THAI).

Classification notes: *Chamaesyce garanbiensis* is characterized by its glabrous appearence, subcoriaceous and serrulate leaves, as well as conspicuous glandular appendages. The cyathial arrangement of this species has three types: solitary, in a cyme with leaf-like bracts, or in a pedunculate cyme accompanied by a single cyathium at node.

3. **C. sparrmannii** (Boiss.) Hurusawa in J. Fac. Sci Univ. Tokyo, sect. 3, Bot. 6(6): 277. 1954, '*C. sparrmanni*'.
心葉大戟 Fig. 5, 7.

Euphorbia sparrmannii Boiss., Cent. Euphorb. 5. 1860, '*E. sparmanni*'; Bentham, Fl. Austral. 6: 46. 1873, '*E. sparrmanni*'; Hatusima, Fl. Ryukyu 362. 1971, '*E. sparrmanni*'.

Perennial herb; stem ascending, glabrous; stipules ovate-deltoid to ovate, 1 to 2 mm long, incised at margin, sericeous adaxially. Leaves subcoriaceous, ovate, 10 - 18 mm long, 6 - 13 mm wide, acute at apex, obliquely cordate at base, entire at margin, glabrous on both surfaces; petioles 1 - 1.8 mm long, glabrous. Cyathia in cymes with leaf-like bracts; involucres turbinate, 1.2 - 1.8 mm long, glabrous outside, velutinous inside, stalks 0.5 - 4 mm long; glands 4, yellow, rounded to transversely elliptic, ca. 0.2 mm long; appendages white, obovate to reniform, entire, 0.5 - 0.9 mm long, 0.3 - 0.7 mm wide; bracteoles linear, laciniate-lacerate at margin. Male flowers 15 - 20, anthers yellow. Female flower with glabrous pedicel and ovary; style and stigma 0.4 - 0.6 mm long. Capsules to 2.5 mm long, 2.5 mm diam., exserted, nutant, glabrous, the pedicels to 4 mm long; seeds grayish to brownish, tetragonal, oblong-ovoid, to 1.3 mm long, 1 mm diam, smooth or slightly rugulose.

Distribution: This species occurs in eastern India (Boissier, 1860), Australia (Bentham, 1873) and the Ryukyu Islands (Hatusima, 1971). Locally it has been collected only in Lanyu, and is commonly found in coral reefs along the coastal areas.

Specimens examined: TAITUNG CO.: Lanyu: Hungtou, *S. F. Huang 2725* (TAI); Lungmen, *Lu et al. 8973*(NCAI); Shuangshihyen, *Chang 14750* (PAI), *Lin 786* (HAST, TAI, THAI), *Yang et al. 3924* (TAI,

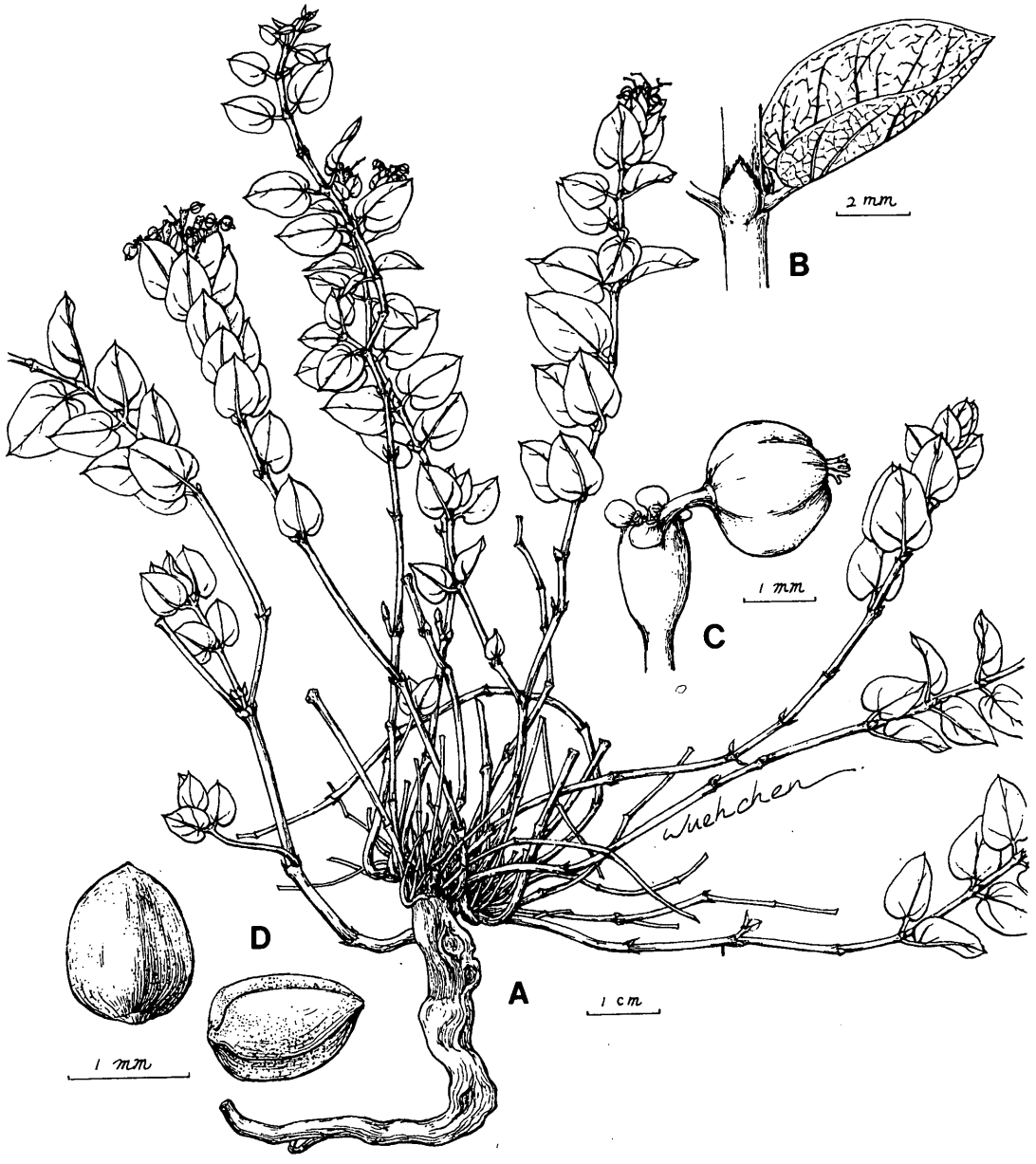

Fig. 7. *C. sparrmannii* (*Lin 786*). A, habit; B, leaf and stipules, viewing from the upper side of stem; C, cyathium; D, seeds.

THAI), *Chaw & Lin 932* (HAST); Tungching, *Chang 11729* (PAI); Kaishi, *T. C. Huang et al. 10548* (TAI); Lanyu, without further locality, *Chang 14542* (PAI); *Hsu s. n.* 28 Feb 1981 (TAI).

Classification notes: Though the original epithet '*sparrmanni*' of the present species, commemorating Anders Sparrman, was misspelled by Boissier, it is not to be altered according to the code 73.3 of ICBN. However, the wrong use of the epithetic termination is here corrected as *Chamaesyce sparrmannii*.

The present species (as *Euphorbia sparrmannii*) was reported by Hayata in 1904, based on the specimen of *Miyake s. n.* (collected from Ang-than-su [an old Taiwanese name for Lanyu, or Hung-tou-yu] in 1897), as a taxon occurring in Taiwan, and he was followed by Matsumura and Hayata (1906), and probably Kawakami (1910), too. In 1917, Hayata considered *E. sparrmannii* of Lanyu to be *E. atoto* (now *C. atoto*). We have

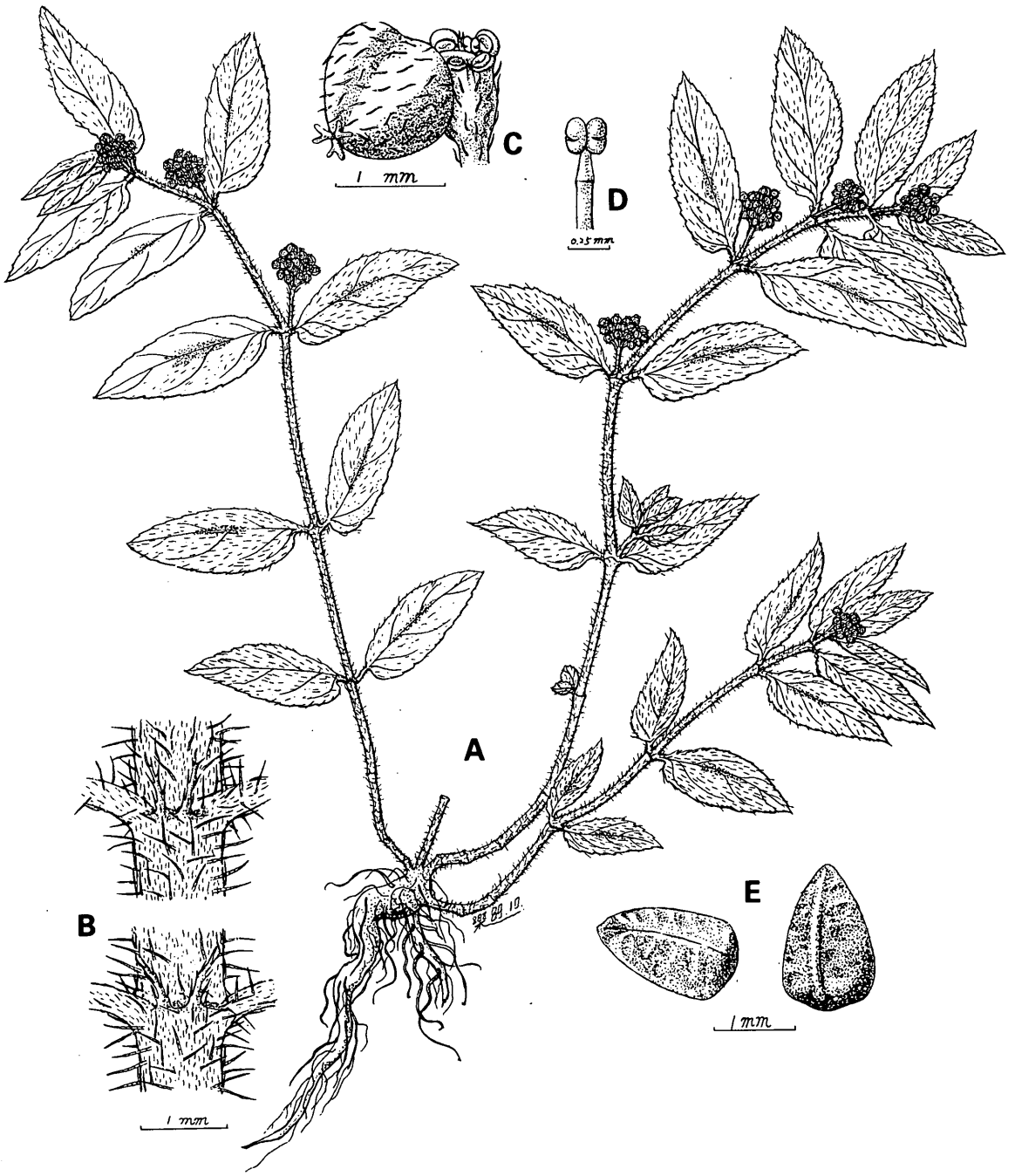

Fig. 8. *C. hirta* (*Lin et al. 489*). A, habit; B, stipules (above, upper side of stem; below, lower side of stem); C, cyathium; D, male flower; E, seeds.

been unable to locate the Miyake collection cited by Hayata, but we did find another Miyake specimen (dated 1899, at TI!) collected in Lanyu, which was annotated as *E. sparrmannii* but actually represents *C. atoto*. Therefore, *C. sparrmannii* is here reported for the first time from Lanyu.

Chamaesyce sparrmannii is very similar to *C. atoto* by its glabrous appearance and subcoriaceous leaves. However, the ovate and acute rather than elliptic to oblong-ovate and obtuse leaves are distinctively differ-

ent from those of the latter. Furthermore, in the present species the glands of cyathia are smaller (0.1 - 0.2 mm long), and the glandular appendages are obovate and conspicuous, while in *C. atoto* the glands are larger (0.3 - 0.7 mm long) and the glandular appendages are narrowly elliptic and obscure.

Both *Chamaesyce sparrmannii* and *C. atoto* have disjunct veins and the venation of the *Euphorbia granulata* type in laminas. In the former, only small proportions of the two laterals join with the median to form the midrib. While in the latter, the two laterals contribute comparatively large proportions of the branches to support the midrib (Fig. 1D).

Chamaesyce sect. Hypericifoliae (Boiss.) Hurusawa in J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 277. 1954. Type: *Chamaesyce hyperifolia* (L.) Millsp. 擬金絲桃組

4. **C. hirta** (L.) Millsp. in Publ. Field Columbian Mus., Bot. ser. 2: 303. 1909; Hurusawa in J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 277. f. 34, A - J. 1954; Kao & Chaw in J. Taiwan Mus. 40(2): 43. 1987.

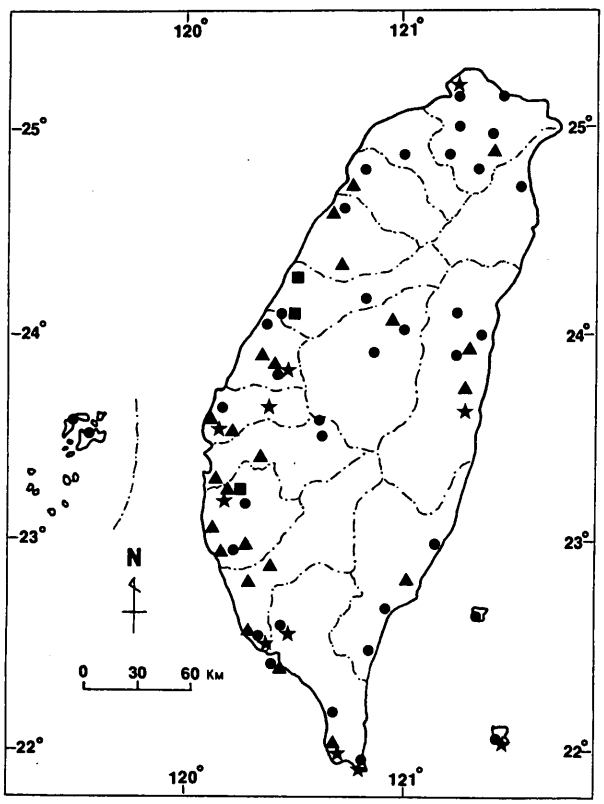

Fig. 9. Distribution of *C. hirta* (solid circle), *C. hyssopifolia* (solid square), *C. tashiroi* (solid star) and *C. vachellii* (solid triangle) in Taiwan.

飛揚草 Fig. 8, 9.

Euphorbia hirta L., Sp. Pl. 454. 1753; Sasaki, List Pl. Form. 260. 1928; Suzuki *In* Masamune, Short Fl. Form. 119. 1936; Keng in Quart. J. Taiwan Mus. 4: 254. 1951; Masamune, List Vasc. Pl. Taiwan 46. 1954; Keng in Taiwania 6: 43. 1955; Hsieh *In* Li *et al.*, Fl. Taiwan 3: 462. 1977.

Euphorbia pilulifera L., Sp. Pl. 454. 1753; Forbes & Hemsley in J. Linn. Soc. Bot. 26: 416. 1889; Henry, List. Pl. Form. 81. 1896; Hayata in J. Coll. Sci. Univ. Tokyo 20: 74. 1904; Matsumura & Hayata in J. Coll. Sci. Univ. Tokyo 22: 368. 1906; Kawakami, List Pl. Form. 100. 1910; Hayata, Gen. Ind. Fl. Form. 66. 1917.

Herb; prostrate, ascending or erect; stem pale green or red, sericeous-strigose and yellowish hirsute; stipules free, narrowly triangular to linear-lanceolate, 0.8 - 1.7 mm long, sericeous-strigose. Leaves green to red, sometimes with an elongate purple spot centrally, ovate-rhomboid to oblong-lanceolate, 15 - 50 mm long, 7 - 16 mm wide, acute at apex, obliquely cuneate to rounded at base, serrulate at margin, sericeous-strigose on both surface; petioles 1 - 3.5 mm long, sericeous-strigose and hirsute. Cyathia in glomerules with peduncle to 25 mm long; involurces campanulate, 0.5 - 1 mm long, sericeous outside, pilose inside; stalks 0.5 - 1 mm long; glands 4, red, rounded to transversely elliptic, 0.1 - 0.2 mm long; appendages white to reddish, narrowly elliptic to obdeltoid, entire to undulate at margin, less than 0.3 mm long, less than 0.2 mm wide; bracteoles acicular or linear to oblanceolate, laciniate -lacerate at margin. Male flowers 4 or 5, anthers red. Female flower with sericeous pedicel and ovary; style and stigma 0.2 - 0.3 mm long. Capsules ca. 1.1 mm long, ca. 1.4 mm diam., exserted, slightly nutant, sericeous, the pedicels to 1.5 mm long; seeds reddish, tetragonal, oblong-ovoid, 0.7- 0.9 mm long, 0.4 - 0.5 mm diam, transversely rugose.

Distribution: *Chamaesyce hirta* is widely distributed in Japan, the Ryukyus and all tropical regions (Hsieh, 1977). It is common in grasslands, roadsides, yards, cultivated fields and seashores.

Specimens examined: TAIPEI CITY: Kungkuan, *Yamamoto s. n.* 12 Jan 1928 (TAI), *Tanaka & Shimada 11114* (TAI); NTU Campus, *Jeng s. n.* 17 Aug 1980

(TAI); Chishanyen, *Kawakami & Hayata s. n.* 25 Jul 1928 (TI); Shihchiao, *Shimada s. n.* 12 Dec 1914 (TAIF); Peitou, *Shimada s. n.* Aug 1916 (TAIF); Taipei City, without further locality, *Makino s. n.* 10 Nov 1896 (TI), *S. Sasaki s. n.* Oct 1921 (TAIF), *S. Sasaki s. n.* Mar 1924 (TAI). TAIPEI CO.: Keelung City, *Makino s. n.* 8 Nov 1896 (TI), *Kawakami s. n.* 21 Jul 1908 (TAIF); Hsintien, Wantan, *Shimizu 2370* (TAI); Kueishan to Huoshawchang, *C. C. Hsu & R. Hsu 3472* (TAI); Shinmen, *Chuang 2354* (TAI); Chichu to Kueishan, *Chuang 3100* (TAI); Wulai, *Suzuki 11663* (TAI); Tanshui, *Kawakami et al. s. n.* 25 Jul 1908 (TAIF); *Hayata s. n.* 23 Aug 1900 (TI); Kuangyinshan, *I. Sasaki 235* (TI), *Fukuyama & Miuda 215* (TAI); Palifen, *S. Sasaki s. n.* 21 Nov 1910 (TAIF). ILAN CO.: Ilan, *Ichizuka s. n.* 24 Jul 1910 (TAIF); *Kudo & Sasaki 15444* (TAI); Tuchang, *Suzuki s.n.* 29 Jul 1929 (TAI); Tahu, *Miyake s. n.* 5 Nov 1899 (TI); Taipingshan, *Suzuki s. n.* 29 Jul 1929 (TAI); Meihuahu, *Lin et al. 470, 475* (THAI); Houhou, *Lin et al. 489* (THAI); Kueishan Island, *Masamune & Suzuki s. n.* 3 Jul 1922 (TAI). TAOYUAN CO.: Shulin, *Kawakami & S. Sasaki s. n.* 24 Nov 1910 (TAI); Jenmei, *C. M. Kuo 6288* (TAI). HSINCHU CO.: Hsinchu City, Chiukang, *Lin et al. 447* (THAI); Hsinchu City, without further locality, *Shimada 1734C* (TAI). Shihpachienshan, *C. M. Kuo 5764* (TAI). MIAOLI CO.: Chiting, *Tang 540, 545* (TAI); Yuanli, *Lin et al. 249* (THAI); Tonghsiao, *Lin & Chou 263* (THAI). TAICHUNG CO.: Taichung City, THAI Campus, *Lin 6, 22, 25, 703* (THAI); NCHU campus, *Lin 294, 298* (THAI); Shuikutou, *T. Y. Yang 821* (TAI); Liuchuan, *Lin 61, 63* (THAI). Shihpiken, *Suzuki s. n.* 16 Dec 1932 (TAI); Chenkunglin, *C. M. Kuo 6001* (TAI); Kukuan, *Ando et al. 273* (TI); Tachia, *Lin & Chou 257* (THAI); Taan River, *Kawakami & S. Sasaki s. n.* 3 May 1909 (TAIF). NANTOU CO.: Wushe, *Masamune & Nakamura 1959* (TAI); Yuechih, Lienhuachih, *Lin 231* (THAI); Shuangtung, *Lin et al. 465* (THAI). CHANGHUA CO.: Wanhsing, *C. C. Hsu 4718* (TAI); Shenkang, Tatu River, *Lin & Li 46, 55* (THAI); Peitou to Chichou, *Lin 145* (THAI); Peitou, *Lin 203, 206* (THAI); Tienwei, *Lin 545* (THAI); Tienchung, *Lin 543* (THAI). YUNLIN CO.: Houan, *T. Y. Yang 491* (TAI); Taishi, *T. Y. Yang 502* (TAI); Hsutsoliao, *W. S. Tang 697* (TAI); Taishi to Santialun, *Lin & Li 130, 132* (THAI); Santialun, *Lin & Li 142* (THAI). CHIAYI CO.: Mt. Arishan, *S. Sasaki 1929* (TAI). TAINAN CO.: Tainan City, *C. C. Hsu 9600* (TAI), *Lin 244* (THAI). Kuangtien, *Lin et al. 387* (THAI); Chiali, *Morimoto 105* (TAI). KAOHSIUNG CITY: *Ou & K. C. Lu 6024* (TCF); *S. Sasaki s. n.* 17 Mar 1910 (TAIF). KAOHSIUNG CO.: Yuehshihchieh, *Jang 1173* (NCAI); Niaosung, *Okada s. n.* 29 Jul 1940 (TAI); Chiehting, *Lin et al. 246* (THAI). PINGTUNG CO.: Pingtung, NPTAC campus, *J. H. Lee s. n.* 29 Sep 1971 (PAI), *Yang 003946* (PAI); *S. J. Yang & C. C. Ho 111* (PAI); Sehmen, *Kao 7124* (TAI); Hengchun, *Tashiro s. n.* 16 Mar 1898 (TI); Hengchun to Maopitou, *Lin et al. 116* (THAI); Nanwan to Oluanpi, *Lin 403* (THAI); Maopitou, *Lin 416* (THAI); Nanjenshan, *Lin et al. 593* (THAI); Suchunchi, *Hsieh 100* (TAI); Fangshan, *Yamamoto s. n.* 23 Aug 1925 (TI); Wutai to Ali, *Namba et al. 1278* (TI); Paoli Forest Farm, *Y. I. Chung 004* (NCAI); *S. J. Yang 755, 756* (PAI); *Tsai 1965* (NCAI); Hsiehkou, *C. H. Chen C10056* (PAI); Hsiaoliuchiu, *Hosokawa 1944, 1945, 1946, 1947* (TAI); *Lin et al. 69, 96* (THAI). PENGHU CO.: Penghu, *C. C. Chen 282* (PAI); *Y. L. Chung 22* (PAI); Tungliang, *C. S. Cheng s. n.* 5 Aug 1933 (TAI); Hsiyu, *C. S. Kuo 1083* (TAI); Chunghsi, *Y. L. Chung 434* (NCAI); Chihtung, *C. C. Chen 243* (PAI); Hsiaomen, *C. C. Chen 242* (NCAI); Huchi, *C. C. Chen 203* (PAI); Lintou, *C. C. Chen s. n.* 24 Aug 1983 (NCAI); Shihli, *C. C. Chen s. n.* 24 Aug 1983 (PAI). HUALIEN CO.: Hualien, *Lin 383* (THAI); Tongmen to Wumao, *Suzuki 1347* (TAI); Tien to Hsieng, *C. S. Kuo et al. 6977* (TAI); Shoufeng, *Yamamoto 2756* (TAI); Wenshan to Yuehwangting, *Lin 360, 362* (THAI). TAITUNG CO.: Taitung, *Kobayashi s. n.* Sep 1907 (TAIF); Taitung to Pahsientung, *Lin 649* (THAI); Milun, *Kawakami & Kobayashi 1518* (TAIF); Tawu, *Kawakami & Kobayashi 5144* (TAIF); Takangkou, *Miyake s. n.* 18 Dec 1899 (TI); Lanyu: Dantou, *Huang & Kao 6386* (TAI); Tungching, *Chang 8362* (NCAI); Hungtou to Yehyin, *Lin 746* (THAI); Yehyin, *Chang 10183* (NCAI); Lanyu, without further locality, *Chang 7819* (NCAI), *Kao 8705* (TAI); *Ikeda 2093* (TI); Lutao, *Huang & Kao 6942* (TAI), *Kao 3902* (TAI), *Chang 15885* (PAI), *C. C. Chen 42* (PAI, TI); *Chang 15826* (PAI); *C. C. Chen 42* (TI).

Classification notes: *Chamaesyce hirta* is readily distinguishable from its congeners in Taiwan by the yellowish hirsute stem and the cyathia in pedunculate glomerules. This species has a red and a green form, the former is more common.

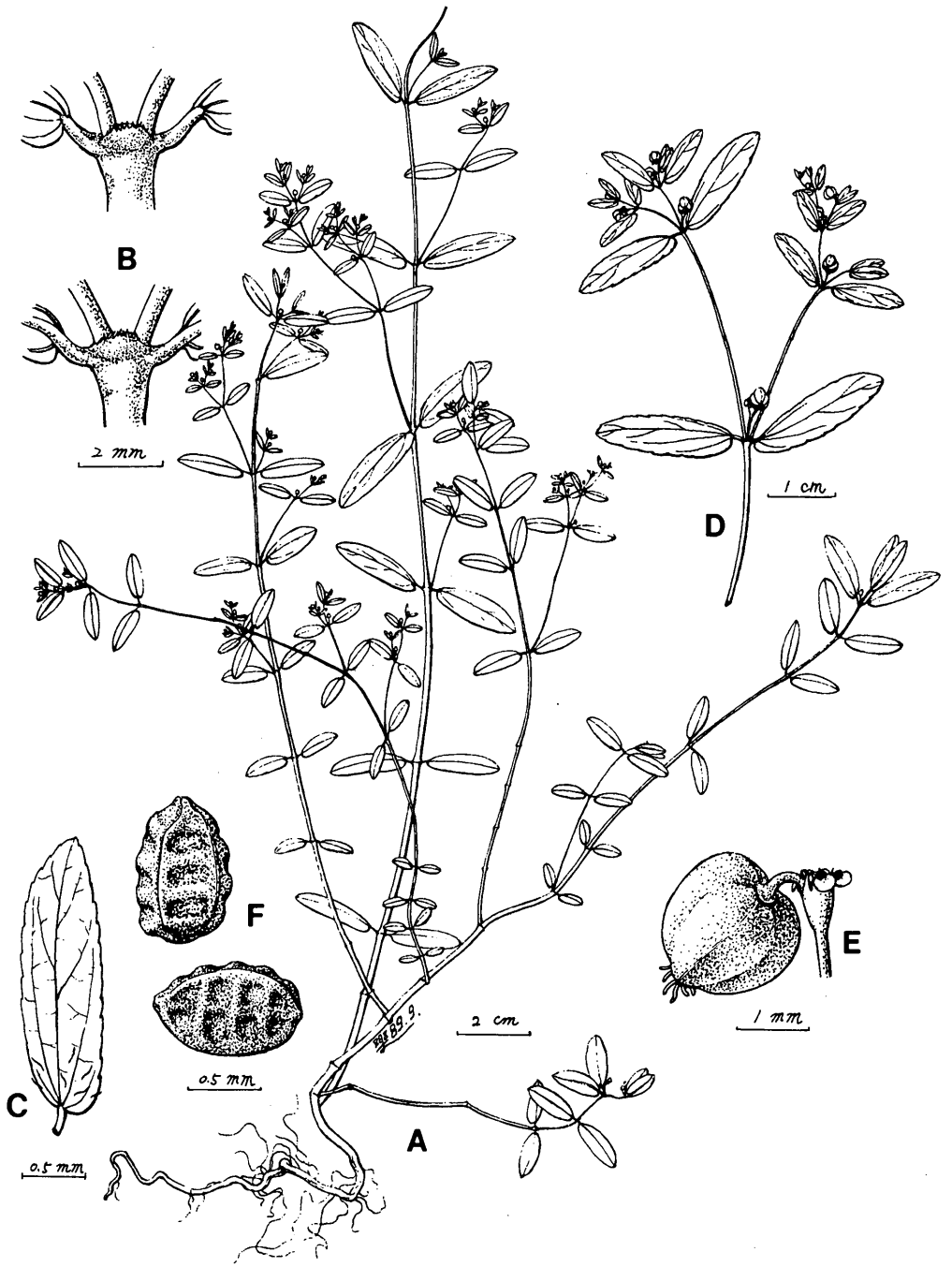

Fig. 10. *C. hyssopifolia* (*Kao 10510*). A, habit; B, stipules (above, upper side of stem; below, lower side of stem); C, leaf, abaxial view; D, cyathia in cyme with leaf-like bracts; E, cyathium; F, seeds.

5. **C. hyssopifolia** (L.) Small in J. New York Bot. Gard. 3: 429. 1905; Burch in Ann. Missouri Bot. Gard. 53: 91. 1966; Webster & Burch in Ann. Missouri Bot. Gard. 54: 345. 1967. 紫斑大戟 Fig. 9, 10.

Euphorbia hyssopifolia L., Syst. Nat. ed. 10. 2: 1048. 1759. *C. maculata sensu* Kao & Chaw in J. Taiwan Mus. 40(2): 43. 1987, *non* (L.) Small.

Annual herb; stem ascending to erect, rarely pros-

trate, glabrous (somtimes, sparsely pubescent on the upper side when young); stipules deltoid, 0.7 - 0.9 mm long, incised, glabrous or sparsely sericeous inside. Leaves often with several small purple spots, chartaceous, oblong-lanceolate to elliptic, 7 - 30 mm long, 3 - 12 mm wide, acute to obtuse at apex, oblique at base, serrulate at margin, usually glabrous on both surfaces, sometimes sparsely pilose at base; petioles to 2 mm long, 0.5 mm wide, glabrous. Cyathia in cymes with leaf -like bracts; involucres to 0.8 mm long, glabrous outside, pilose inside; stalks to 4mm long; glands 4, yellowish green, rounded to transversely elliptic, to 0.3 mm long; appendages white and blotched with pink at margin, reniform, entire to subundulate, to 0.7 mm long, 0.5 mm wide; bracteoles linear, in 5 bundles. Male flowers 5 - 15, anthers red. Female flower with glabrous pedicel and ovary; style and stigma to 0.5 mm long. Capsules trigonal-ovoid, ca. 2.5 mm diam., exserted, nutant, glabrous, the pedicels to 2 mm long; seeds blackish, tetragonal, oblong-ovoid, ca. 1.1 mm long, 0.8 mm diam, transversely rugose.

Distribution: This species is widely distributed in the New World tropics and subtropics and is an adventive in the Old World (Webster & Burch, 1967). It is naturalized in the central and southern parts of Taiwan. Populations of this species occur along railways, tarred roads, wilderness, and recently harvested crop fields.

Specimens examined: TAICHUNG CO: Taichung City, *Kao 10648* (TAI). CHIAYI CO.: Chungpu, *Kao 10506* (HAST), *Lin et al. 282* (HAST, TAI, THAI). TAINAN CO.: Shuehchia, *Kao 10649* (TAI). KAOHSIUNG CITY: Hsiaokang, *Kao 10510* (HAST). KAOHSIUNG CO.: Hunei, *Kao 10469* (HAST).

Classification notes: The misidentification of *Chamaesyce hyssopifolia* as *C. maculata* and a newly naturalized species in Taiwan by Kao and Chaw (1987) is here corrected. This species is characterized by its leaves which are chartaceous and oblong-lanceolate to elliptic, and cyathia which are cymose with leaf-like bracts.

6. **C. tashiroi** Hara in J. Jap. Bot. 14: 356. 1938; Kao & Chaw in J. Taiwan Mus. 40(2): 43. 1987.
田代氏大戟 Fig. 9, 11.

Euphorbia humifusa sensu Henry, List. Pl. Form. 81. 1896; Hayata in J. Coll. Sci. Univ. Tokyo 20: 73. 1904; Kawakami, List Pl. Form. 100. 1910; Hayata, Gen. Ind. Fl. Form. 66. 1917; Sasaki, List Pl. Form. 260. 1928; Suzuki *In* Masamune, Short Fl. Form. 119. 1936, *non* Willd.

E. hyperifolia sensu Hayata in J. Coll. Sci. Univ. Tokyo 20: 75. 1904; Matsumura & Hayata in J. Coll. Sci. Univ. Tokyo 22: 368. 1906; Kawakami, List Pl. Form. 100. 1910; Hayata, Gen. Ind. Fl. Form. 66. 1917; Sasaki, List Pl. Form. 260. 1928, *non* Hayata.

E. tashiroi Hayata, Icon. Pl. Form. 9: 104. 1920; Sasaki, List Pl. Form. 261. 1928; Suzuki *In* Masamune, Short Fl. Form. 120. 1936; Keng in Quart. J. Taiwan Mus. 4: 255. 1951; Masamune, List Vasc. Pl. Taiwan 47. 1954; Keng in Taiwania 6: 44. 1955; Hsieh *In* Li *et al.*, Fl. Taiwan 3: 465. 1977. (Holotype, *Tashiro s. n.* Apr. 1895, TI!)

C. hyperifolia (L.) Millsp. var. *tashiroi* (Hayata) Hurusawa in J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 285. f. 36. 1954.

Herb; stem ascending, rarely prostrate, reddish, sparsely to densely sericeous; stipules free or fused at base, triangular, 0.4 - 0.6 mm long, puberulent at margin. Leaves green or reddish, sometimes with several small purple spots, obovate- to ovate- oblong or elliptic, 5 -15 mm long, 3 - 8 mm wide, acute to rounded at apex, obliquely truncate, rounded to subcordate at base, serrulate at margin, subglabrous above and sericeous below; petioles 0.8 - 1.3 mm long, sericeous abaxially. Cyathia in loosely or densely peduculate cyme together with a solitary cyathium at nodes; involucres turbinate to campanulate, 0.5 - 0.9 mm long, pilose inside; stalks 0.5 - 1.4 mm long; glands 4, red, rounded to transversely elliptic, 0.1 - 0.5 mm long; appendages white, reniform, entire to undulate, 0.3 - 0.6 mm long, 0.1 - 0.5 mm wide; bracteoles linear to linear-oblanceolate, laciniate-larcerate at margin. Male flowers 5 - 15, anthers red. Female flower with sericeous pedicel and ovary; style and stigma 0.3 - 0.5 mm long. Capsules exserted, nutant, sericeous, the pedicels to 3 mm long; seeds brownish or grayish, tetragonal, oblong-ovoid, 0.8 - 1 mm long, 0.6 - 0.8 mm wide, smooth or slightly rugulose.

Distribution: *Chamaesyce tashiori* is endemic to Taiwan. It can be found in cultivated fields and on

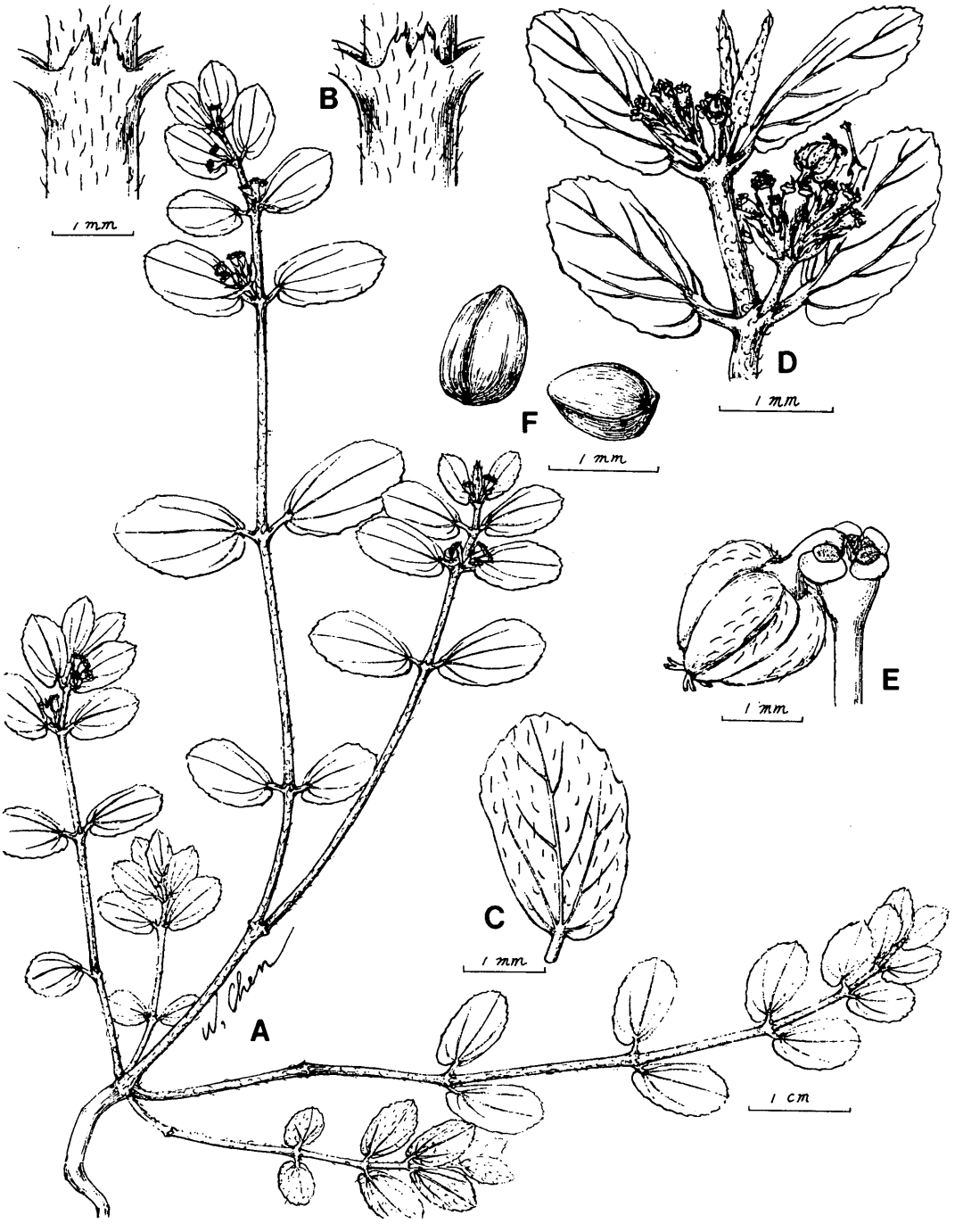

Fig. 11. *C. tashiroi* (*Lin et al. 280*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, leaf, abaxial view; D, a pedunculate cyme accompanied by a single cyathium at top node; E, cyathium; F, seeds.

coral reefs, but is not common.

Specimens examined: TAIPEI CO.: Tanshui, *Tashiro s. n.* Sep. 1895. CHANGHUA CO: Tienwei, *Chaw & Lin 1204* (HAST). YUNLIN CO.: Thalibukoe, *Tashiro s. n.* Apr 1895 (Type of *Euphorbia tashiroi*, TI!); Huwei, *Ashikaga 141* (TAI), *Yamamoto et al. 1145* (TAI); Kouhu, Shunhsing, *Lin et al. 280* (HAST,

THAI); Shuilin, *Lin & Tang 635, 636* (THAI). TAINAN CO: Matou, *Morilani 104* (TAI); Shitiliao, *Morilani 528* (TAI). KAOHSIUNG CO.: Hsiaokang, *Shimada 6025C* (TAI); Linyuan, *Hsieh et al.* 326 (THAI). PINGTUNG CO.: Pingtung, *Shimada s. n.* 7 May 1915 (TI), *Matuda s. n.* 1 May 1917 (TAIF); Chuanfanshih, *Lu & Ou 1560* (TCF); Lungluantan, *Lin et al. 113* (THAI); Tropical Coastal Forest, *Lin 406* (THAI); Hsiangchiaowan to Shatao, *Lin 409* (THAI); Hengchun, Sheting park, *Yang 3189* (PAI). HUALIEN CO.: Hotien, *Yashikawa s. n.* 24 Feb 1923 (TAIF). TAITUNG CO.: Lanyu, Hungtou, *Huang & Kao 5181* (TAI).

Classification Notes: A combination of the pubescent state, elliptic and serrulate leaves, pedunculate cyme, and petaloid glandular appendages all distinguish *Chamaesyce tashiroi* from the remainder of *Chamaesyce.*

7. **C. vachellii** (Hook. & Arn.) Hurusawa in J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 283. f. 34, K & L. 1954. 華南大戟 Fig. 9, 12.

Euphorbia serrulata Reinw. *ex* Blume, Bijdr. 635. 1826; Forbes & Hemsley in J. Linn. Soc. Bot. 26: 417. 1889; Henry, List. Pl. Form. 81. 1896; Hayata in J. Coll. Sci. Univ. Tokyo 20: 76. 1904; Matsumura & Hayata in J. Coll. Sci. Univ. Tokyo 22: 368. 1906; Hayata, Gen. Ind. Fl. Form. 66. 1917; Sasaki, List Pl. Form. 261. 1928; Suzuki *In* Masamune, Short Fl. Form. 120. 1936; Keng in Quart. J. Taiwan Mus. 4: 254. 1951, *non* Thuill. 1790, *nec* Vell. 1825.

E. vachellii Hook. & Arn., Bot. Capt. Beechey Voy. 5: 212. 1836; Keng in Taiwania 6: 45. 1955; Hsieh *In* Li *et al.*, Fl. Taiwan 3: 467. 1977.

E. parannaquensis Blanco, Fl. Filip. 286. 1837; Masamune, List Vasc. Pl. Taiwan 47. 1954.

C. parannaquensis (Blanco) Hara in J. Jap. Bot. 14: 356. 1938.

Herb; ascending to erect, sparsely puberulent when young; stipules free, triangular, 0.3 - 0.5 mm long, incised, glabrous. Leaves green, linear to linear-oblong, 20 - 60 mm long, 2 - 7 mm wide, acute to obtuse at apex, obliquely rounded at base, serrulate at margin, subglabrous above, puberulent-sericeous below; petioles 1.5 - 2.5 mm long, puberulent-sericeous abaxially. Cyathia in a densely pedunculate cyme together with a solitary cythium at node; involucres turbinate to campanulate, 0.5 - 1 mm long, glabrous or nearly so outside, pilose inside; stalks 0.5 - 2.3 mm long; glands 4, rounded to transversely elliptic, 0.1 - 0.3 mm long; appendages white to reddish, reniform to orbicular, entire to subundulate, 0.2 - 0.8 mm long, 0.1 - 0.6 mm wide; bracteoles linear to linear-oblanceolate, lacerate -laciniate at margin. Male flowers 5 - 20, anthers red. Female flower with glabrous pedicel and ovary; style and stigma 0.2 - 0.4 mm long. Capsules 1.5 - 2 mm long, 1.9 - 2 mm diam., exserted, nutant, glabrous, the pedicels to 3 mm long; seeds blackish, tetragonal, elliptic-ovoid, 1.1 - 1.3 mm long, 0.8 - 1 mm diam, transversely rugose.

Distribution: *Chamaesyce vachellii* is widespread in southern China, Malaysia, from the Philippines to Polynesia, Australia, the Ryukyus and Japan (Keng, 1955; Hsieh, 1977). It is frequently associated with farm crops and weeds in Taiwan.

Specimens examined: TAIPEI CO.: Fanshuliao, *Mori 3881* (TAIF). HSINCHU CO.: without further locality, *Makino s. n.* 24 Nov 1896 (TI). MIAOLI CO.: Tahu, *Kawakami & Mori 7123* (TAIF); Tsaochiao, *Shimada 3152C* (TAI); Taan River, *S. Sasaki s. n.* 2 May 1910 (TAIF). NANTOU CO.: Tanan, *Hayata s. n.* 13 May 1916 (TI). CHANGHUA: Hsihu, *Sakida s. n.* 14 Aug 1936 (TAI); Peitou, *Shimada s. n.* 17 Mar 1909 (TAIF); Hsichou, *Takeoito s. n.* 13 Jul 1922 (KYO); Houliao, *Hsu 4736* (TAI). YUNLIN CO.: Taihsi, *Chaw 473* (HAST); Santiaolun, *Ou 6071* (TCF); Santialun to Chinhu, *Ou 5331* (TCF); Iwu, *H. N. Yang 3774* (TAI); Wuchientso, *Kawakami s. n.* 6 Feb 1908 (TAIF); Shuilin, Tuchientso, *Lin & Tang 633, 634* (TAI, THAI). CHIAYI CO.: Chiayi City, *Kao 7893* (TAI); Putai to Ichu, *Lin et al. 281* (TAI, THAI); Ichu, *Hsieh,* 200 (THAI). TAINAN CO.: Tainan City, Anpin, *Kodawa s. n.* 27 Dec 1966 (KYO); Chiali, *Morimoto 106* (TAI); Hsinying, *Shimada 740* (TAI); Hsinhua, *Peng 3161* (TAI), *Kao 9289* (TAI); KAOHSIUNG CO.: Kangshan, *Tik s. n.* Oct 1913 (TAIF); Matou, *Kao 10144* (TAI); Chishan, *Suzuki 6754* (TAI); *Okamoto s. n.* 22 Jul 1938 (KYO); Hakuhyo, *Suzuki 7130* (TAI). PINGTUNG CO.: Pingtung, NPTAC Campus, *Choug s. n.* 14 Dec 1978 (PAI); *S. Y. Yang & Ho 88* (PAI); Pingtung, without further locality, *Matuda s. n.* Mar 1918 (TAIF); Hsiaoliuchiu, *Hosokawa 1943* (TAI).

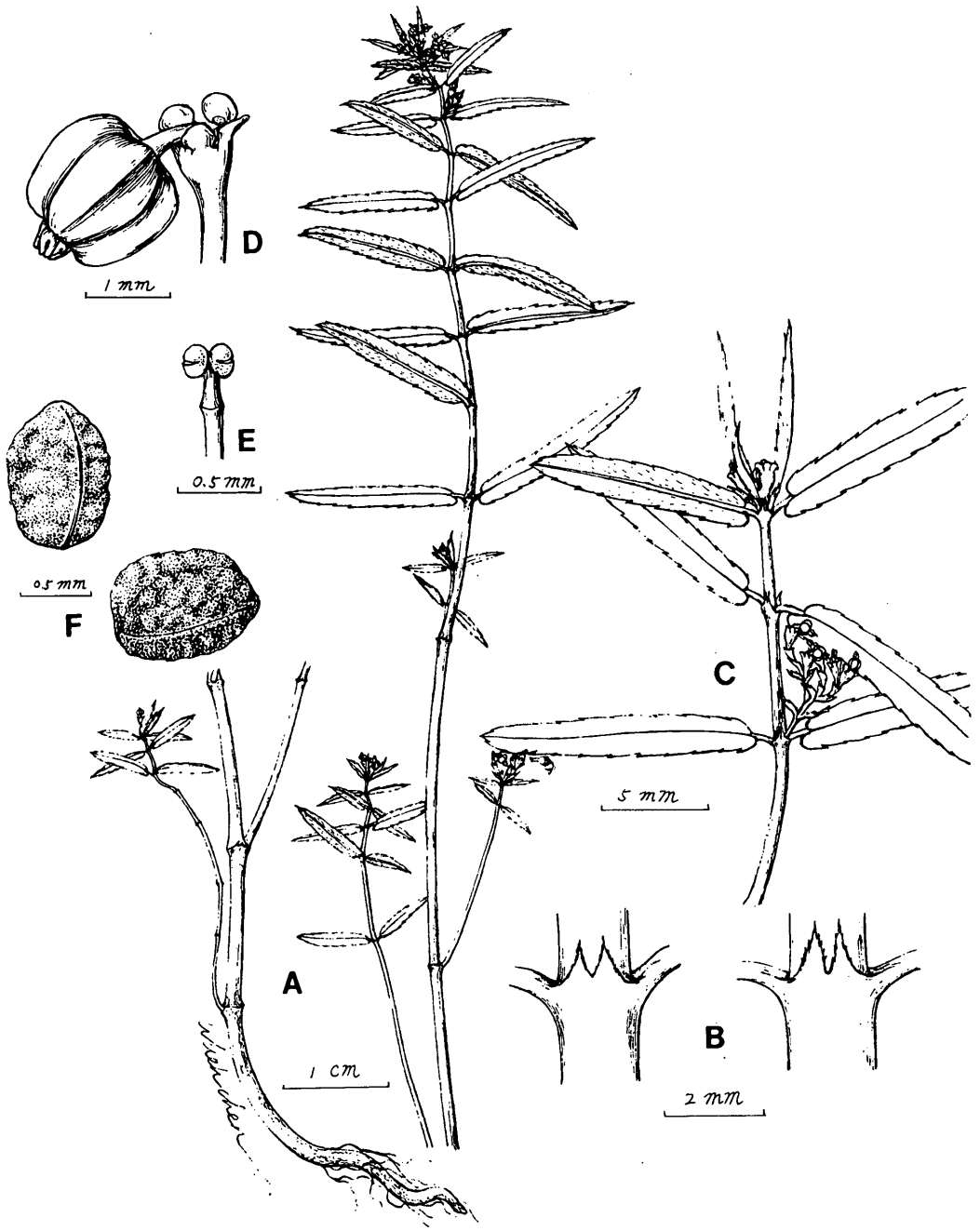

Fig. 12. *C. vachellii* (*Lin & Tang 633*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, cyathium in a pedunculate cyme at node; D, cyathium; E, male flower; F, seeds.

HUALIEN CO.: Fenglin, *Lu 8501* (NCAI); Wuchuangcheng, *Kawakami s.n.* 18 Nov 1909 (TAIF). TAITUNG CO.: Peinan, *Kobayashi 1594* (TAIF); Chinpen, *Koyama et al. 6726* (TAI).

Classification notes: Though Blume's *Euphorbia serrulata* predates Hooker and Arnold's *E. vachellii,* it is a later homonym of *E. serrulata* Vellero and therefore invalidated. Hurusawa (1954) and Keng (1955) have considered Vellero's binomial a synomym of *E.*

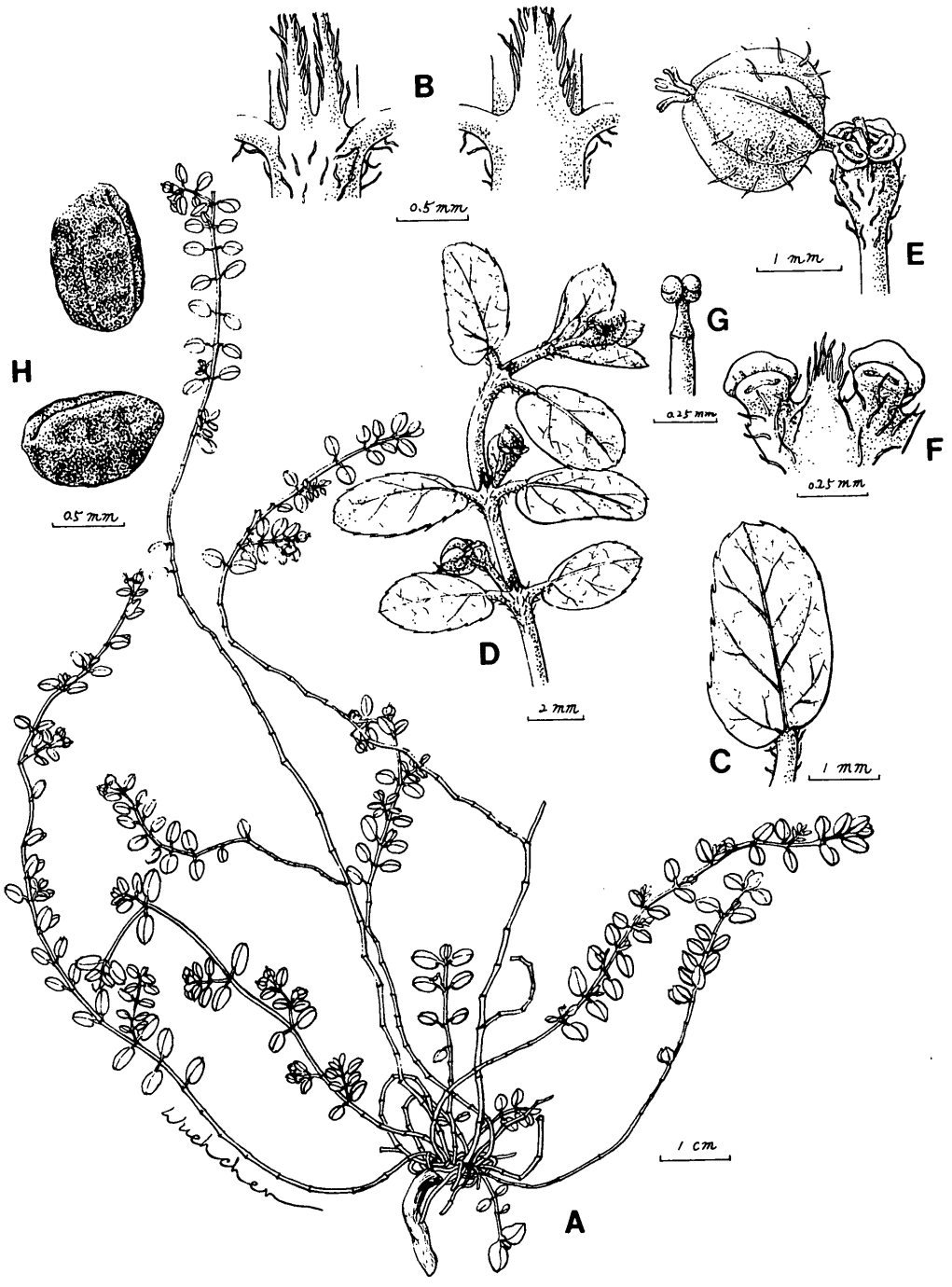

Fig. 13. *C. hsinchuensis* (*Lin et al. 444*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, leaf, adaxial view; D, cyathia solitary at nodes; E, cyathium; F, portion of a dissected involucre, adaxial view; G, male flower; H, seeds.

brasiliensis Lam.

Chamaesyce vachellii is readily separated from its congeners in Taiwan by its linear and serrulate leaves. Disjunct veins are found in cleared leaves of this species. In its petiole the two lateral strands contribute comparatively large proportions of branches to support

the midrib.

Chamaesyce sect. Chamaesyce. Type: *Chamaesyce peplis* (L.) Prokh.

Chamaesyce sect. *Chamaesyce* (Reichb. *sensu* Boiss.) Hurusawa in J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 283. 1954. Type: *Chamaesyce chamaesyce* (L.) Hurusawa = *Euphorbia chamaesyce* Linn. = *C. vulgare* Prokh. 地錦草組

8. **C. hsinchuensis** Lin & Chaw *sp. nov.* - Type: Taiwan, Hsinchu City, Kangnanli, scattered on sandy beaches, elev. 0 m, 14 Sep 1987, *Lin, Chaw & Chou 444* (Holotype: HAST; isotypes: A, TAI, THAI, TI; paratypes: same locality *Chaw, Lin & Chou 483*, HAST). 新竹地錦 Fig. 13, 14.

Species insignis quadricolporis polline, serrulatis foliis, et sparse pilosis capsulis, a speciebus nobis notis bene distincta; differt a C. thymifolia pedicellis capsularibus longioribus; differt C. prostrata pedicellis brevioribus et aequato indumento in capsulis; differt a C. maculata formam et longitudinem foliorum, et distributionis purpureo-macularum in foliis.

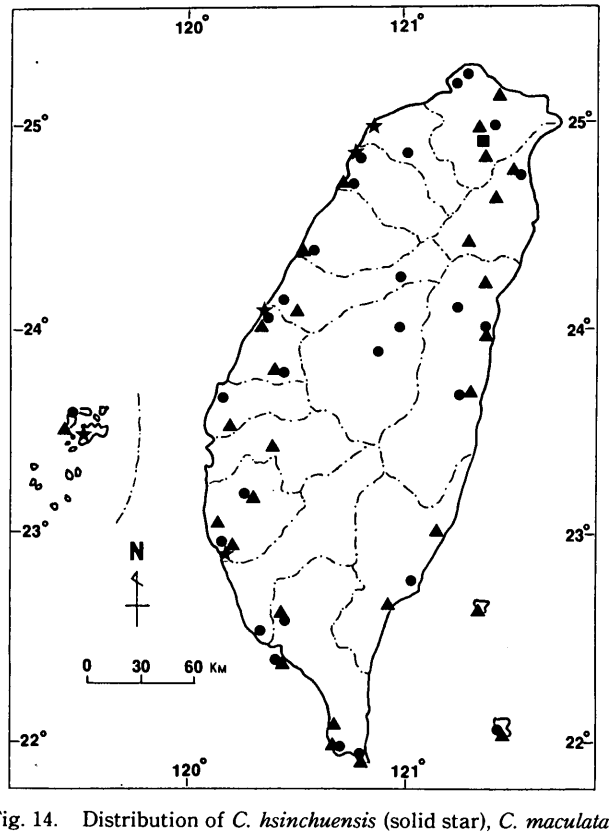

Fig. 14. Distribution of *C. hsinchuensis* (solid star), *C. maculata* (solid square), *C. prostrata* (solid circle) and *C. thymifolia* (solid triangle) in Taiwan.

Herb; stem prostrate to ascending, reddish, glabrous to sparsely pilose on the upper side; stipules laciniate and sparsely pilose abaxially, the upper free, linear-lanceolate, 0.6 - 1.3 mm long, the lower fused, triangular or bifid at apex. Leaves ovate- to obovate-oblong, 2 - 7 mm long, 1 - 3.5 mm wide, obtuse to rounded at apex, obliquely obtuse to rounded at base, serrulate at the lower margin and/or apex, glabrous and with several scattered small purple spots above, sparsely pilose below; petioles reddish, 0.5 - 0.8 mm long, pilose. Cyathia solitary at nodes; involucres campanulate, to 1 mm long, pilose outside and inside; stalks 0.3 - 0.8 mm long; glands 4, red, rounded to transversely elliptic or oblong, slightly concave, 0.1 - 0.3 mm long; appendages white to reddish, depressed obovate, entire to undulate, to 0.5 mm long, 0.3 mm wide; bracteoles acicular to linear. Male flowers 5 - 15, anthers red. Female flower with sparsely pilose pedicel; ovary pilose; style and stigma to 0.5 mm long. Capsules 1.4 -1.8 mm long, 1.5 - 1.8 mm diam., exserted, slightly nutant, sparsely pilose, the pedicels 0.8 - 1.3 mm long; seeds reddish, tetragonal, oblong-ovoid, ca. 1 mm long, 0.7 mm diam, transversely rugose.

Distribution: This endemic species is found only on sandy beaches and riversides of the western region.

Specimens examined: TAOYUAN CO.: Yungan Port, *Peng 12768* (HAST). HSINCHU CO.: Hsinchu City, Chiukang, *Shimada 1736B, 1736C, 3211A* (TAI), *3211B* (NTUF); Nanliao, *Mori 1739* (TAI), *Sasaki 1741* (TAI), *Shimada s. n.* 23 Jul 1925 (TAI). CHANGHUA CO.: Minjyh Ditch, *Guo et al. 90* (TAI); Shenkang, Changpin 1st Industrial District, *Lin et al. 550, 551* (HAST, TAI, THAI), *Lin 851* (HAST, TAI, THAI), *Chaw & Lin 1188* (HAST); Changpin 2nd Industrial District, *Wang & Ke s. n.* May 1988 (THAI). TAINAN CO.: Tainan City, Aping, *Tanaka 10385* (NTUF). PENGHU CO.: Penghu, *Chen 255* (PAI); *Fengkuei, Hsu & Kuo 14018* (TAI); Penghu Co., without further locality, *Huang & Kao 6904* (TAI).

Classification notes: *Chamaesyce hsinchuensis* is

quite distinct from the species known to us by its tetracolporate pollen. The four colpae converge by pairs near the poles (Fig. 3, A & B). The serrulate leaves (mainly at the lower side and apex), and the sparsely pilose capsules can also be used to identify *C. hsinchuensis*.

Most of the specimens examined were assigned to *Chamaesyce thymifolia* or *C. prostrata*. In the present species the capsular pedicel is slightly longer than the involucres, while in *C. thymifolia* the pedicel is shorter than the involucres. In *C. prostrata* the capsular pedicel is the longest of the three, and so long that it becomes disinctively nutant when the capsules are still young.

Dr. Wunderlin (pers. comm.) of University of South Florida suggested the present new species be attributed to *Chamaesyce maculata*, which is similar to *C. hsinchuensis* in cyathial morphology. However, in this new species, the stem is sparsely pilose rather than sericeous; the leaf-blades are shorter and ovate- to obovate- oblong rather than elliptic to oblong or falcate, and without an elongate spot centrally; and the male flowers are 5 - 15 rather than 5 or less per cyathium. In addition, populations of *C. hsinchuensis* have been well collected in the coastal regions and riversides of western Taiwan since 1924, while *C. maculata* was only recently found to be naturalized in Taipei City. A comparison of different characteristics among this new species, *C. maculata*, *C. prostata*, and *C. thymifolia* are shown in Table 3.

9. **C. maculata** (L.) Small, Fl. SE. U. S. 713. 1903; Burch in Ann. Missouri Bot. Gard. 53: 94. 1966.
斑地錦 Fig. 14, 15.

E. maculata L. Sp. Pl. 455. 1753; Boiss. *In* DC., Prodr. 15(2): 46. 1862; Richardson in Univ. Kansas Sci. Bull. 48(3): 85. f. 14. 1968.

Herb; stem prostrate to ascending, sericeous on the upper side; stipules free, linear-lanceolate, ca. 1 mm long, sparsely sericeous. Leaves green, usually with an elongate purple spot centrally, elliptic or oblong to falcate, 6 - 13 mm long, to 3 mm wide, acute to obtuse at apex, obliquely rounded at base, serrulate or rarely entire, sparsely sericeous to glabrous above, sericeous below; petiole ca. 1 mm long, sparsely sericeous abaxially. Cyathia solitary at nodes, usually on short, congested lateral branches; involucres 0.7 - 1 mm long, sericeous outside, pilose inside; stalks 0.5 - 1.2 mm long, lobes deltoid to linear-lanceolate, ciliate at margin; glands 4, yellowish green, rounded to transversely elliptic or oblong, ca. 0.3 mm long; appendages white to reddish, depressed obovate, entire or undulate, up to 0.5

Table 3. *A comparison of characteristics among* ***Chamaesyce hsinchuensis, C. maculata, C. prostrata*** *and* ***C. thymifolia***

Character	*C. hsinchuensis*	*C. maculata*	*C. prostrata*	*C. thymifolia*
Pubescence of stem	Sparsely pilose	Sericeous	Puberulent	Sericeous
Stipules of lower stem	Fused	Free	Fused	Free (sometimes fused)
Spots of leaves	Small, purple, scattered	Elongate, purple, centrally	None	Small, purple, scattered
Length of leaves	2 - 7 mm	6 - 13 mm	2 - 7 mm	3 - 8 mm
Number of male flowers	5 - 15	4 - 5	3 - 5	3 - 5
Pollen	Tetracolporate	Tricolporate	Tricolporate	Tricolporate
Pubescence of capsules	Sparsely pilose	Sparsely sericeous	Hirtellous only along angles	Sparsely sericeous
Length of capsules	1.4 - 1.8 mm	1.4 - 1.8 mm	1.3 - 1.6 mm	0.9 - 1 mm
Length of capsular pedicels	0.8 - 1.3 mm	0.9 - 1.4 mm	1.6 - 2.4 mm	0.2 - 0.6 mm
Length of capsular pedicel/involucre	ca. 1.5	ca. 1.5	ca. 3	ca. 0.5
Length of seeds	0.9 - 1 mm	0.9 - 1.2 mm	0.7 - 0.9 mm	0.6 - 0.7 mm

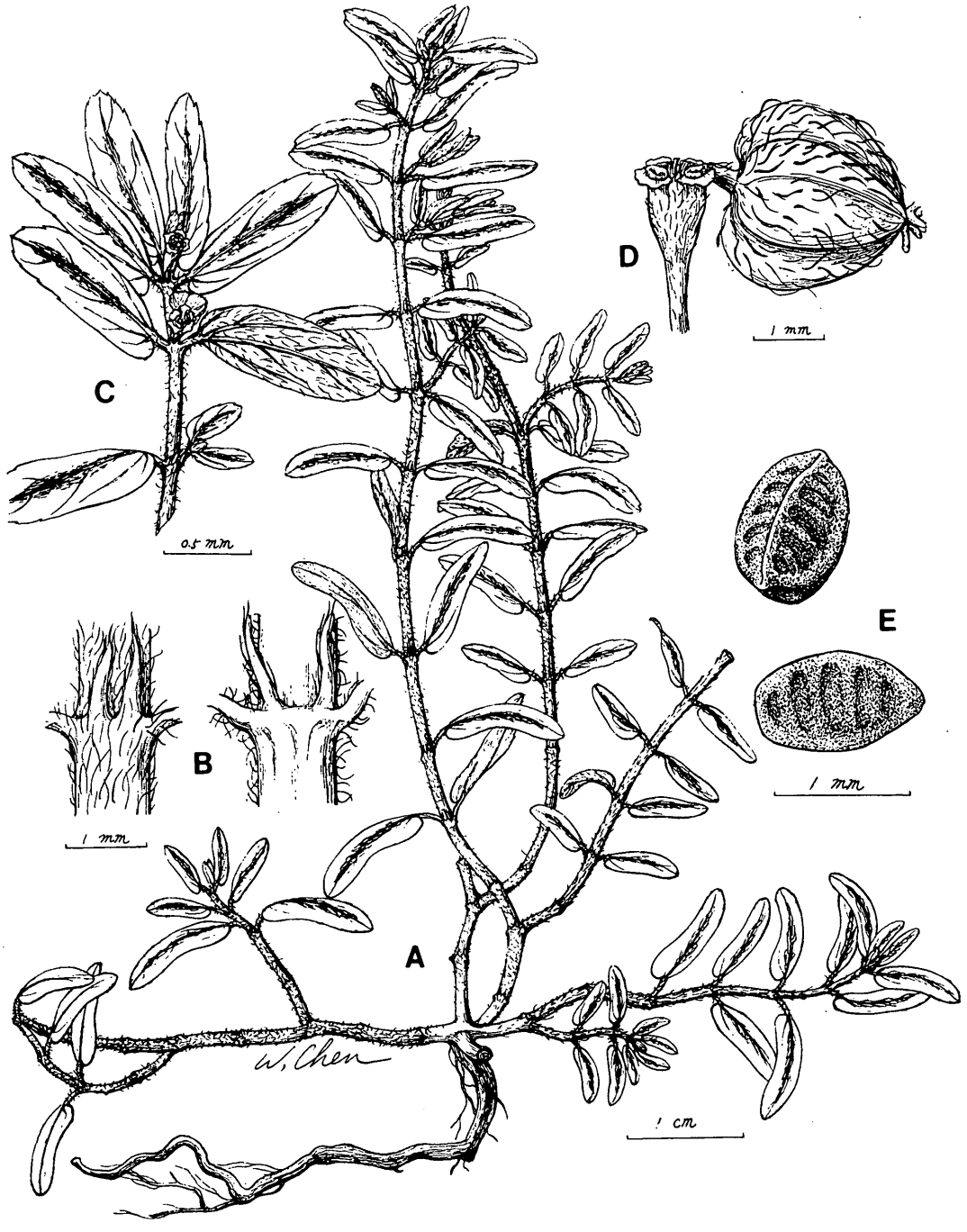

Fig. 15. *C. maculata* (*Lin et al. 687*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, cyathia solitary at nodes; D, cyathium; E, seeds (*Chaw & Lin 997*).

mm long, 0.3 mm wide; bracteoles acicular to linear. Male flowers 4 - 5, anthers red. Female flower with sericeous pedicel and ovary; style and stigma to 0.3 mm long. Capsules trigonal-ovoid, to 2 mm long, 2 mm diam., exserted, slightly nutant, sericeous, the pedicels to 1.2 mm long; seeds grayish to reddish, tetragonal, oblong-ovoid, ca. 1.1 mm long, 0.7 mm diam., transversely rugose.

Distribution: This species is distributed throughout North America except the extreme north (Small, 1903), and naturalized in Taipei City, Taiwan. Locally, the species grows along street sides, median strip of street, and crevices of tile-paved roads.

Specimens examined: TAIPEI CITY: Neihu, *Kao 10660* (HAST, THAI), *Chaw 608* (HAST), *Lin et al. 687* (TAI, THAI), *Chaw & Lin 997* (HAST); Nankang, *Chaw & Lin 995, 998* (HAST).

Classification notes: The correct application of *Chamaesyce maculata* was clarifed by Burch in 1966, but *C. supina*, a later synonym of *C. maculata*, had been widely used by many authors (Koutnik, 1985). Kao and Chaw (1987) misapplied the name of present species for *C. hyssopifolia* when reporting the naturalization of the latter species.

Locally, *Chamaesyce maculata* was first collected by Mr. Muh-Tsuen Kao by the Neihu freeway entrance in Taipei City in 1988. Later, more populations were found in the neighboring Nankang District. The present species is readily distinguishable by its sericeous vestiture on all parts, and its oblong to falcate leaf which is blotted with an elongate purple spot at the center.

10. **C. makinoi** (Hayata) Hara in J. Jap. Bot. 14: 356. 1938; Croizat & Hara in J. Jap. Bot. 16: 383. 1940; Hurusawa in. J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 291. f. 39. 1954; Kao & Chaw in J. Taiwan Mus. 40 (2): 43. 1987. 小葉大戟 Fig. 16, 17.

Euphorbia microphylla sensu Hayata in J. Coll. Sci. Univ. Tokyo 20: 79. 1904; Matsumura & Hayata in J. Coll. Sci. Univ. Tokyo 22: 368. 1906; Kawakami, List Pl. Form. 100. 1910, *non* Heyne.

E. makinoi Hayata in Coll. Sci. Univ. Tokyo 30: 262. 1911; Hayata, Gen. Ind. Fl. Form. 66. 1917; Sasaki, List Pl. Form. 260. 1928; Suzuki *In* Masamune, Short Fl. Form. 119. 1936; Keng in Quart. J. Taiwan Mus. 4: 256. 1951; Masamune, List Vasc. Pl. Taiwan 47. 1954; Keng in Taiwania 6: 44. 1955; Hsieh *In* Li *et al.*, Fl. Taiwan 3: 463. 1977. (Holotype, *Makino s. n.* 19 Nov 1896, TI!)

Herb; stem rooting at nodes, reddish, glabrous; stipules pale to reddish, deltoid, 0.3 - 0.5 mm long, incised at apex, glabrous. Leaves rounded-ovate to ovate -elliptic, 2 - 5 mm long, 1 - 4 mm wide, retuse to rounded at apex, obliquely rounded to cordate at base, entire at margin, glabrous on both surfaces; petioles reddish, 0.3 - 1.5 mm long, glabrous. Cyathia solitary at nodes; involucres turbinate-campanulate, 0.3 - 0.6 mm long, glabrous outside, pilose inside under glands; stalks 0.5 -1.5 mm long; glands 4, red, rounded to transversely narrowly elliptic or oblong, 0.2 - 0.3 mm long; appendages white to reddish, narrowly elliptic, distinctly undulate at margin; bracteoles acicular, sublaciniate. Male flowers 2 - 4, anthers red. Female flower with glabrous pedicel and ovary; style and stigma 0.2 - 0.3 mm long. Capsules 1.1 - 1.3 mm long, 1.4 - 1.6 mm diam., exserted, nutant, glabrous, the pedicels to 2 mm long; seeds grayish or brownish, tetragonal, oblong -ovoid, 0.8 - 1 mm long, 0.5 - 0.7 mm diam., smooth or slightly rugulose.

Distribution: This species is found in yards, crevices of tile-paved roads and cement ground, and sandy seashores throughout the islands. It also occurs in the Philippines (Merrill, 1923) and the Ryukyus (Walker, 1976).

Specimens examined: TAIPEI CITY: Kuting, *Nakahara s. n.* Oct. 1913 (TAIF); Kungkuan, *Tanaka & Shimada s. n.* 15 Jun 1932 (TAI); Taipei City, without further locality, *Sasaki s. n.* Oct 1913 (TAIF); *Sasaki s. n.* 22 Jul 1927 (TAI). TAIPEI CO.: Tanshui, *Makino s. n.* 19 Nov 1896 (Type of *Euphorbia makinoi*, TI!). HSINCHU CO.: Hsinchu City, *Sakada 25* (TAI). MIAOLI CO.: Lungkang, *Chuang 2581* (HAST). TAICHUNG CO.: Taichung City, THAI Campus, *Lin 150, 154, 233*; Kukuan, *Ou & Kao 8858* (TAI). CHANGHUA CO.: Tienwei, *Lin 197, 198, 200, 467* (THAI); Peitou, *Lin 201, 204* (THAI); Shenkang, Changpin 2nd Industrial District, *Lin 855* (THAI). TAINAN CO.: Kuantien, *Morimoto s. n.* 3 Nov 1943 (TAI). PINGTUNG CO.: Nanwan, *Lin 397* (THAI); Tantzuwan, *Lin 399* (THAI); Fanchanshih, *Lin 404* (THAI); Fengchuisha to Kengtzunei, *Lin 429* (THAI); Oluanpi, *Lin 430* (THAI); Kenting to Nanwan, *Lin et al. 562* (THAI). PENGHU CO.: Penghu, *Huang & Kao 6836* (TAI); Chiyu, *Hsu s. n.* 26 Jun 1985 (TAIF). HUALIEN CO.: Wenshan to Yuehwangting, *Lin 357, 361* (THAI).

Classification notes: *Chamaesyce makinoi* is char-

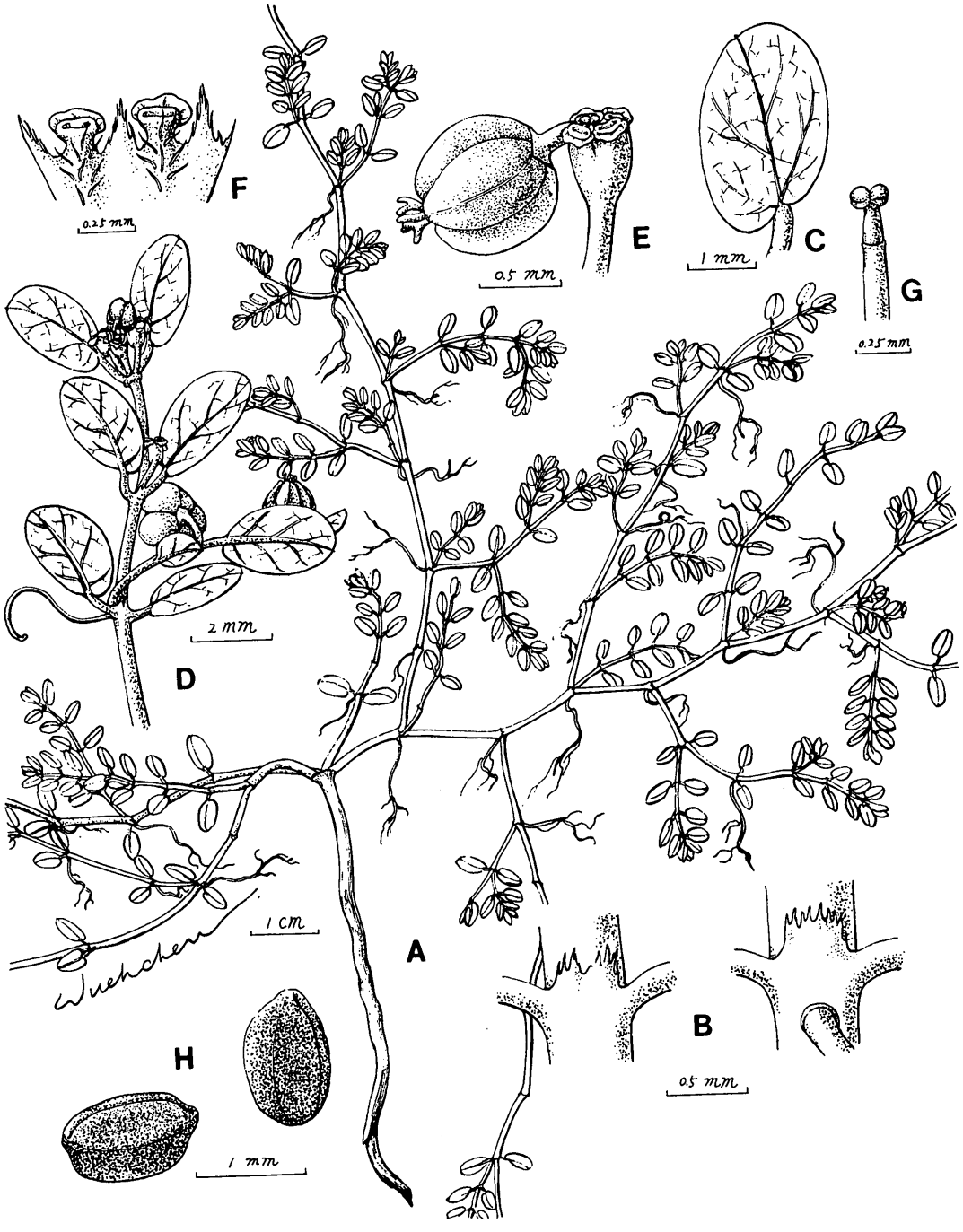

Fig. 16. *C. makinoi* (*Lin 201*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, leaf, abaxial view; D, cyathia solitary at nodes; E, cyathium; F, portion of a dissected involucre, adaxial view; G, male flower; H, seeds.

acterized by the rooting stem, the entire leaves and the glabrous appearance (except the involucres). It is very similar to *C. serpens*, which is reported in this paper as a recent naturalized species in Taiwan. Their differences are discussed under *C. serpens*. The present species sometimes cohabits with populations of *C. pros-*

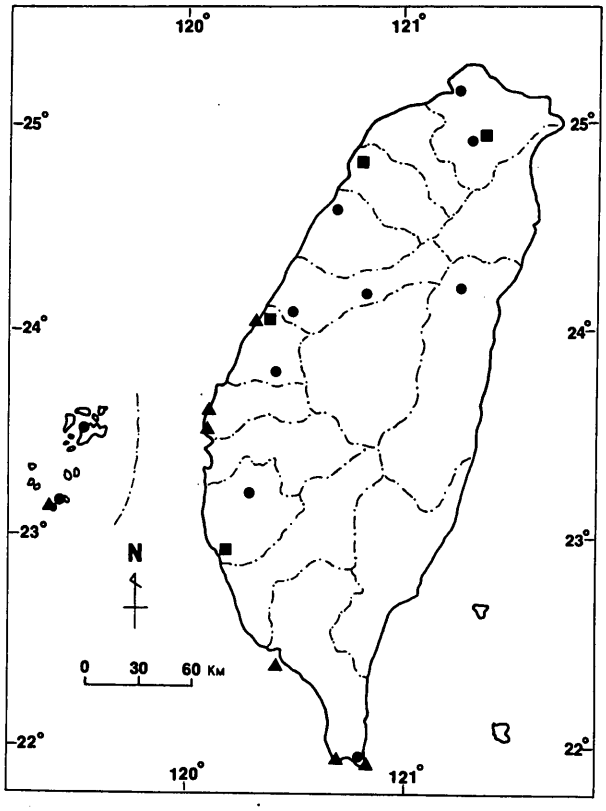

Fig. 17. Distribution of *C. makinoi* (solid circle), *C. serpens* (solid square) and *C. taihsiensis* (solid triangle) in Taiwan.

trata and *C. thymifolia*. However, *C. makinoi* is easily distinguishable from the latter two by its characteristics described above.

11. **C. prostrata** (Ait.) Small, Fl. SE. U. S. 713. 1903; Hurusawa in J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 287. f. 37. 1954; Kao & Chaw in J. Taiwan Mus. 40(2): 43. 1987. 伏生大戟 Fig. 14, 18.

Euphorbia prostrata Ait., Hortus Kew 2: 139. 1789; Keng in J. Washington Acad. Sci. 41: 207. 1951; Keng in Quart. J. Taiwan Mus. 4: 256. 1951; Keng in Taiwania 6: 44. 1955; Hsieh *In* Li *et al.*, Fl. Taiwan 3: 463. 1977.

E. liukiuensis sensu Sasaki, Cat. Govern. Herb. (Form.) 305. 1903; Suzuki *In* Masamune, Short Fl. Form. 119. 1936; Masamune, List Vasc. Pl. Taiwan 46. 1954, *non* Hayata.

C. liukiuensis Hara in J. Jap. Bot. 14: 356. 1938, *non* Hayata.

Herb; stem prostrate to ascending, branching from base, pale green or red, puberulent on the upper side; stipules at the upper side of stem free, triangular to linear-lanceolate, 0.2 - 1 mm long, puberulent at margin, those at the lower side fused, bifid at apex. Leaves green to red, rounded to oblong, 2 - 6.7 mm long, 1.6 - 4.6 mm wide, acute to rounded at apex, obliquely rounded at base, serrulate at margin, glabrous or puberulent at the apex of lower surface; petioles 0.5 - 1 mm long, subglabrous. Cyathia solitary at nodes, usually on short congested lateral branches; involucres campanulate, 0.5 - 0.9 mm long, puberulent at tip of outside; stalks 0.7 - 3.3 mm long; glands 4, red, transversely elliptic or oblong, slightly concave, 0.1 - 0.3 mm long; appendages reddish, narrowly elliptic, entire to undulate, less than 0.2 mm long, 0.1 mm wide; bracteoles acicular. Male flowers 3 - 5, anthers red. Female flower with puberlulent pedicel; ovary hirtellous mainly along angles; style and stigma 0.1 - 0.2 mm long. Capsules exserted, nutant, hirtellous mainly along angles, the pedicels to 2.5 mm long; seeds grayish, tetragonal, oblong-ovoid, 0.7 - 0.9 mm long, 0.4 - 0.6 mm diam, transversely rugose.

Distribution: This species is pantropical (Keng, 1951; Hsieh, 1977), commonly found in various habitats such as grasslands, roadsides, cultivated fields and seashores throughout the islands.

Specimens examined: TAIPEI CITY, NTU Campus, *Hsu 15009* (TAI), *C. M. Kuo 4448* (TAI), *Jeng s. n.* 17 Aug 1980 (TAI); NTNJGC Campus, *C. S. Kuo 1417* (TAI); Yangmingshan to Peitou, *Kimura & Hurusawa s. n.* 27 Oct 1940 (TI); Nankang, Academia Sinica, *Chaw & Lin 1203* (HAST); Taipei City, without further locality, *Ichizuka s. n. 14 Nov 1909* (TAIF), *Suzuki s. n.* 12 May 1923 (TAI), *Shimada s. n.* Aug 1919 (TI), *S. Sasaki s. n.* Feb 1927 (TAI), *Nakahara 4354* (TAIF). TAIPEI CO.: Yinhotung to Taichichiao, *I. Sasaki T568* (TI); Tanshui, *Hayata s. n.* Jul 1908 (TI), *Lin 528, 532* (THAI); Sanchih, *Chang s. n.* 16 Oct 1983 (PAI). ILAN CO.: Houhou, *Lin et al. 502, 505* (THAI); Paimi River, *Lin et al. 478* (THAI); Lotung River, *Lin et al. 519* (THAI). TAOYUAN CO.: Sanchiaoyung, *Soma s. n.* 1912 (TAIF); Jenmei, *C. M. Kuo 6392* (TAI); Yangmei, *Peng 731* (TAI). HSINCHU CO.: Hsinchu City, Kangnanli, *Lin et al. 446* (THAI);

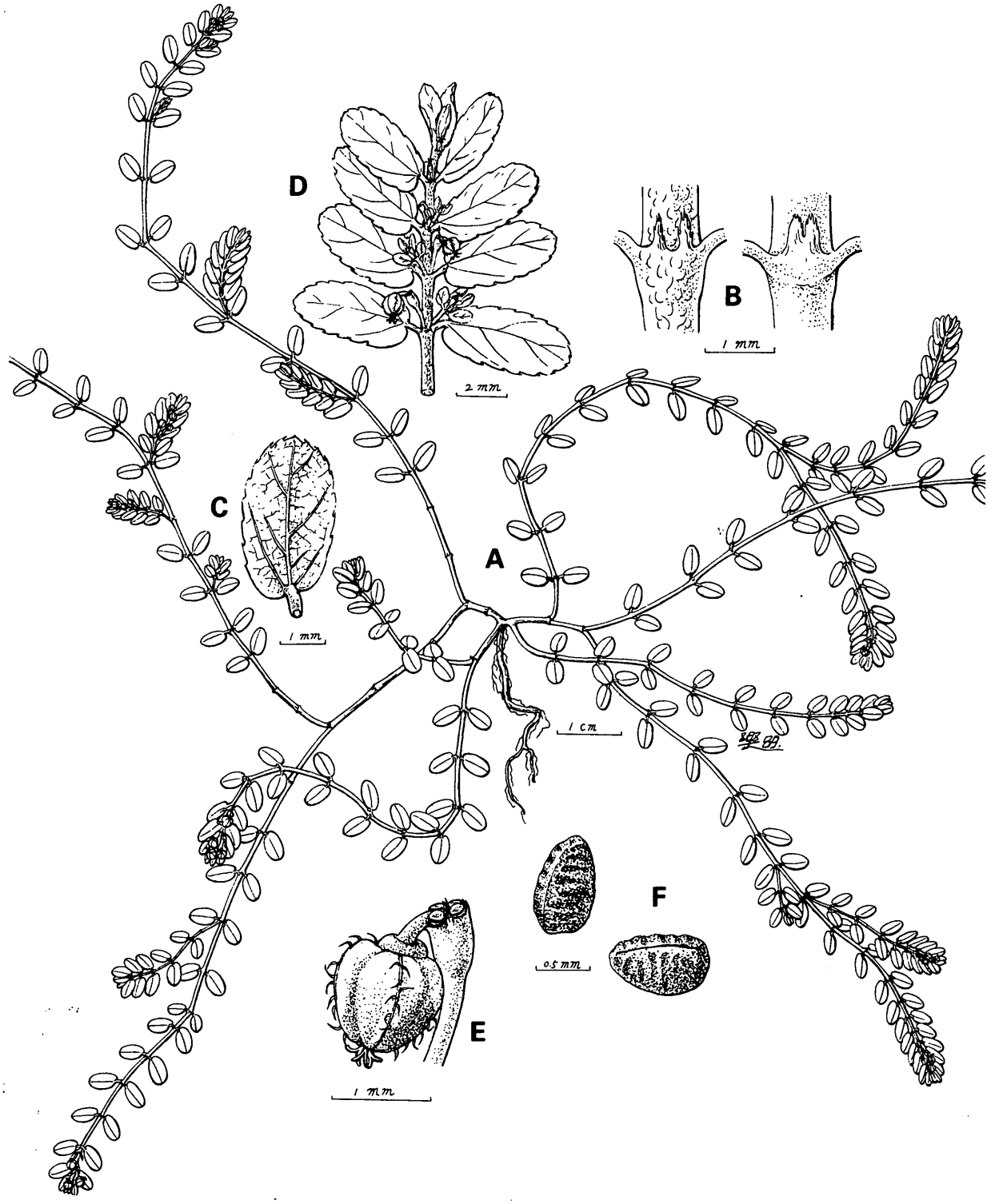

Fig. 18. *C. prostrata* (*Chaw & Lin 1203*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, leaf, abaxial view; D, cyathia solitary at nodes; E, cyathium, showing the immature but distinctive nutant capsule; F, seeds.

Tahu, *Suzuki 12414* (TAI). MIAOLI CO.: Yuanli, *Lin et al. 250, 252* (THAI), *Lin & Chou 258* (THAI). TAICHUNG CO.: Taichung City, THAI Campus, *Lin 28, 30, 65, 152, 232* (THAI); NCU Campus, *Lin 292, 293, 296, 297* (THAI); Liuchuan, *Lin 60, 62* (THAI). Techi, *Lin 239* (THAI); Tachia, *Lin & Chou 258* (THAI); Taan, Haiwei, *Lin & Chou 275* (THAI). NANTOU CO.: Yuechih, Lienhuachih, *Lin 212, 230* (THAI); Wushe, *Lin 156* (THAI), *Mikage 72184* (KYO). CHANGHUA CO.: Peitou, *Lin 202, 205* (THAI); Peitou to Hsichou, *Lin 149* (THAI); Tienwei, *Lin 199* (THAI); Shenkang, *Lin et al. 552, 554* (THAI). YUNLIN CO.: Santiaolun, *Lin & Li 138, 141, 143* (THAI). TAINAN CO.: Tainan City, Chukaotso, *Morlani 2021* (TI); Tainan City, without further locality, *Yamamoto & Suzuki 2373* (TAI), *Kawakami & Shimada s. n.* 24 Aug 1908 (TAIF); Chiali, *Morimoto 101* (TAI); Kuangtien, *Lin et al. 385* (THAI); Hsishu, *Lin et al. 388* (THAI). KAOHSIUNG CITY: *Shimada 121* (TAIF). PINGTUNG CO.: Pingtung, NPTAC Campus, *S. J. Yang & Ho 112* (PAI); Nanshan, *Huang 7888A* (TAI); Hengchun, *Huang & Hsiao 8215* (TAI); Nanwan, *Lin 395* (THAI); Chuanfanshih, *Lin 402* (THAI); Kenting, *J. C. Ou & Kao 8857* (TAI); Sheting Park, *Lin 424* (THAI); Shadao, *T. Y. Yang 1139* (TAI); Oluanpi, *Kamikoti 52* (TAI), *Kamiyoshi s. n.* 6 Aug 1977 (TI); Hengchun to Maopitou, *Lin et al. 117* (THAI); Hsiaoliuchiu, Tientai, *Hosokawa 1941* (TAI); Hsiaoliuchiu, without further locality, *Hosokawa 1939* (TAI), *Lin et al. 71, 99* (THAI). PENGHU CO.: Penghu Islands, *Kudo & Mori 3070* (TAI); Tunglian, *Cheng 3071* (TAI). HUALIEN CO.: Hualien, *Lin 384* (THAI); Wenshan to Yuehwangting, *Lin 359* (THAI); Tienshang, *I. Sasaki T874* (TI); Tailuko, *Shimizu & Kao 10467* (KYO); Shihmenchia to Tungli, *Suzuki 1667* (TAI); Hunglin, *Kao 9804* (TAI); Chuiyin to Tungmen, *Suzuki s. n.* 18 Aug 1929 (TAI). TAITUNG CO.: Taitung, *Lin 655, 656* (THAI); Chulu, *Namba et al. 344* (TAI); Lanyu; *Takagi 117* (KYO), Hungtou to Yehyin, *Lin 791* (THAI); Lutao, *Chang 16554* (PAI).

Classification notes: *Chamaesyce prostrata* has either red or green forms, the former appears to be more common. These two forms occasionally occur together. This species often cohabits with *C. thymifolia*. Both species are sometimes confused in the herbarium. However, they are easily distinguishable by the different pubescent states of stem and cyathium, as well as the relative length of capsular capsule and involucres. In *C. prostrata*, the stem is puberulent on the central part of the upper side, the capsule is hirtellous mainly along the angle, and the capsular pedicel is long enough that the capsule is nutant to the side of the involcure. While, in *C. thymifolia* the stem is sericeous on the upper side, the capsule is sericeous all over, and the pedicel is shorter than the involucres so that the capsule is not completely exserted at maturity.

In herbaria, the species is ocassionally labeled as *Euphorbia chamaesyce*. Kuo & Wang (1978) used *E. prostrata* as a synonym of *E. chamaesyce*. The same treatment is also found in Hatusima (1971) and Hurusawa (1982). Burch (1966) considered the above two species as different. We have not seen the type specimens of *E. chamaesyce* and *E. prostrata*, but judging from Boissier's (1862) description and the distribution of the two species, the entity in Taiwan should be *C. prostrata* rather than *E. chamaeyce*.

The name *Euphorbia liukiuensis* had been misapplied for *E. prostrata* until Keng (1951) reported the latter species as a new record in Taiwan. Hara (1938) had transfered *E. liukiuensis* to the genus *Chamaesyce*, but mistakenly enumerated it as a taxon of Taiwan. *Chamaesyce liukiuensis* (Hayata) Hara is a native of Liukiu and differs from *C. prostrata* by its glabrous appearance and serrulate margin at leaf apex (Hatusima, 1971; Walker, 1976).

12. **C. serpens** (H. B. & K.) Small, Fl. SE. U. S. 709. 1903. 匍根地錦 Fig. 17, 19.
Euphorbia serpens H. B. & K., Nov. Gen. Sp. 2: 52. 1815; Boiss. *In* DC., Prodr. 15(2): 29. 1862.

Herb; stem rooting at nodes, green or with several pink stripes, glabrous; stipules white, deltoid, 0.4 - 0.8 mm long, incised at apex, glabrous. Leaves ovate -rounded to rounded-elliptic, 2 - 5 mm long, 1 -3.5 mm wide, retuse to rounded at apex, obliquely rounded to cordate at base, entire at margin, glabrous on both surfaces; petioles pale green, 0.2 - 1 mm long, glabrous. Cyathia solitary at nodes; involucres turbinate -campanulate, 0.5 - 0.7 mm long, glabrous outside, pilose inside; stalks 0.7 - 1.7 mm long; glands 4, red, rounded to transversely elliptic or oblong, to 0.2 mm long; appendages white, reniform, entire or subundulate at margin; bracteoles acicular to linear, lacerate to laciniate at margin. Male flowers 3 - 5, anthers red.

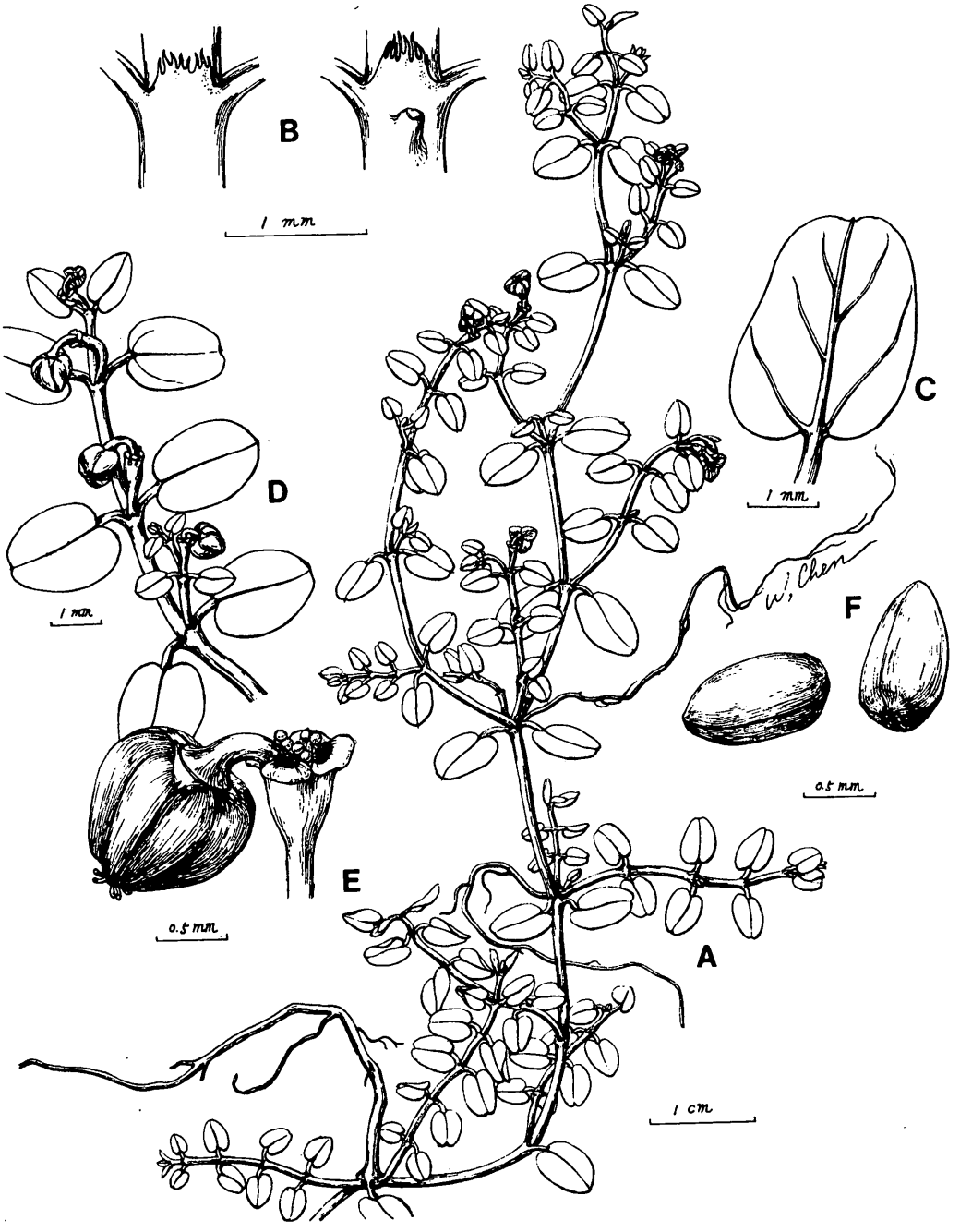

Fig. 19. *C. serpens* (*Lin 391*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, leaf, abaxial view; D, cyathia solitary at nodes; E, cyathium, showing the glands with petaloid appendages and the immature capsule subtended by receptacle lobes; F, seeds.

Female flower with 1 - 3 minute, triangular perianth segments; ovary glabrous; style and stigma ca. 0.3 mm long. Capsules 1.5 - 1.8 mm long, 1.6 - 1.9 mm diam., subtended by persistent perianth segments, exserted, nutant,glabrous, the pedicels to 2 mm long; seeds grayish to brownish, tetragonal, oblong-ovoid, 0.9 - 1.1 mm long, 0.6 - 0.9 mm diam., smooth to slightly rugulose.

Distribution: *Chamaesyce serpens* is of American origin (Boissier, 1862; Small, 1903), and is recently naturalized in the western part of Taiwan. Locally, the species grows in sandy places along tarred roads and coastal areas.

Specimens examined: TAIPEI CITY: Nankang, Academia Sinica, *Chaw & S. C. Lin 996* (HAST). HSINCHU CO.: Hsinchu City, *Y. C. Lin s. n.* 31 May 1987 (THAI). CHANGHUA CO.: Shenkang, Changpin 2nd Industrial District, *S. C. Lin & Wang 856* (TAI, THAI). TAINAN CO.: Hsinta Power Plant, *S. C. Lin et al. 391* (*THA*I); *Y. C. Lin s. n.* 26 Mar 1987 (THAI); Sueichia, *Kao 10451* (TAI), *Lin et al. 248* (HAST, THAI). KAOHSIUNG CO.: Linyuan, *Hsieh et al. 325* (THAI).

Classification notes: *Chamaesyce serpens* is akin to *C. makinoi*. Both are rooting at the nodes, glabrous in appearance and similar in shape and size of the leaves. But the former has pale green (sometimes with several pink stripes) stems and green leaves rather than red stems and dark green leaves of the latter. In *C. serpens*, the glandular appendages are petaloid, conspicuous, reniform and entire or subundulate at margin rather than obscure, narrowly elliptic and distinctly undulate at margin; the capsules are usually subtended by 1 - 3 minute, triangular perianth segments.

13. **C. taihsiensis** Chaw & Koutnik in Bot. Bull. Acad. Sin. 31: 163 - 167. 1990. (Holotype, *Chaw 475*, HAST!) 臺西地錦 Fig. 17.

Likely perennial herb; stem prostrate, spreading, glabrous; stipules deltoid, 0.3 - 0.5 mm long, laciniate at apex, free above, fused below, glabrous. Leaves elliptic to obovate, 2.5 - 6 mm long, 1.5 - 3.5 mm wide, truncate to emarginate at apex, obliquely rounded at base, serrulate at tip to entire at margin, glabrous on both surfaces; petioles reddish, 0.2 - 1 mm long, glabrous. Cyathia solitary at nodes; involucres campanulate, 0.8 1 mm long, glabrous outside, pilose inside; stalks 0.5 - 0.7 mm long; glands 4, green to red, elliptic or oblong, 0.2 - 0.3 mm long; appendages narrowly elliptic, entire to distinctly undulate at margin; bracteoles linear, sublaciniate. Male flowers 3 - 10, anthers red. Female flower occasionally with 1 or 2 minute, triangular, perianth segments; pedicel and ovary glabrous; style and stigma 0.2 - 0.3 mm long. Capsules 1.3 - 1.7 mm long, 1.2 - 1.7 mm diam., exserted, nutant, glabrous, the pedicels to 2.4 mm long; seeds grayish or brownish, tetragonal, oblong-ovoid, 0.8 - 1.2 mm long, 0.6 - 0.9 mm diam., smooth or slightly rugulose.

Distribution: *Chamaesyce taihsiensis* usually occurs in sandy crevices of cement embankments and coral reefs, or sometimes in sandy wilderness along coast of Taiwan (Chaw & Koutnik, 1990). We have found that the distribution range of this species is greater. Evidence from herbarium specimens showed it has been gathered in Penghu since 1931. We have additional specimens other than those listed by Chaw and Koutnik (1990) from Penghu Co.: Penghu Island, *Kudo & Mori 3070* (TAI); Chiyuyu, *Hsu s. n.* 26 Jun 1985 (TAIF); Chimetao, *Huang 74* (TAI).

Classification notes: *Chamaesyce taihsiensis* is recently described by Chaw and Koutnik (1990). It is distinguishable from other congeneric species, recorded in Taiwan by a combination of glabrous in all parts, absence of adventitious roots at nodes, and leaves with serrulate apices.

14. **C. thymifolia** (L.) Millsp. Publ. Field Columbian Mus., Bot. ser. 2: 412. 1909; Hara in J. Jap. Bot. 14: 356. 1938; Hurusawa in J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 6(6): 286. 1954; Kao & Chaw in J. Taiwan Mus. 40(2): 43. 1987. 千根草 Fig. 14, 20.
Euphorbia thymifolia L. Sp. Pl. 454. 1753; Forbes & Hemsley in J. Linn. Soc. Bot. 26: 417. 1889; Henry, List. Pl. Form. 81. 1896; Hayata in J. Coll. Sci. Univ. Tokyo 20: 77. 1904; Matsumura & Hayata in J. Coll. Sci. Univ. Tokyo 22: 368. 1906; Hayata, Gen. Ind. Fl. Form. 66. 1917; Sasaki, List Pl. Form. 262. 1928; Suzuki *In* Masamune, Short Fl. Form. 120. 1936; Keng in Quart. J. Taiwan Mus. 4: 255. 1951; Masamune, List Vasc. Pl. Taiwan 47. 1954; Keng in Taiwania 6: 45. 1955; Hsieh *In* Li *et al.*, Fl. Taiwan 3: 466. 1977.

Herb; stem prostrate to ascending, green or reddish, sericeous on the upper side; stipules free at the upper side of stem, linear-lanceolate, 0.3 - 1.2 mm long, sericeous abaxially, those at the lower side sometimes fused. Leaves green to reddish, obovate-oblong to oblong-lanceolate, 3 - 7.8 mm long, 2 - 4.7 mm wide,

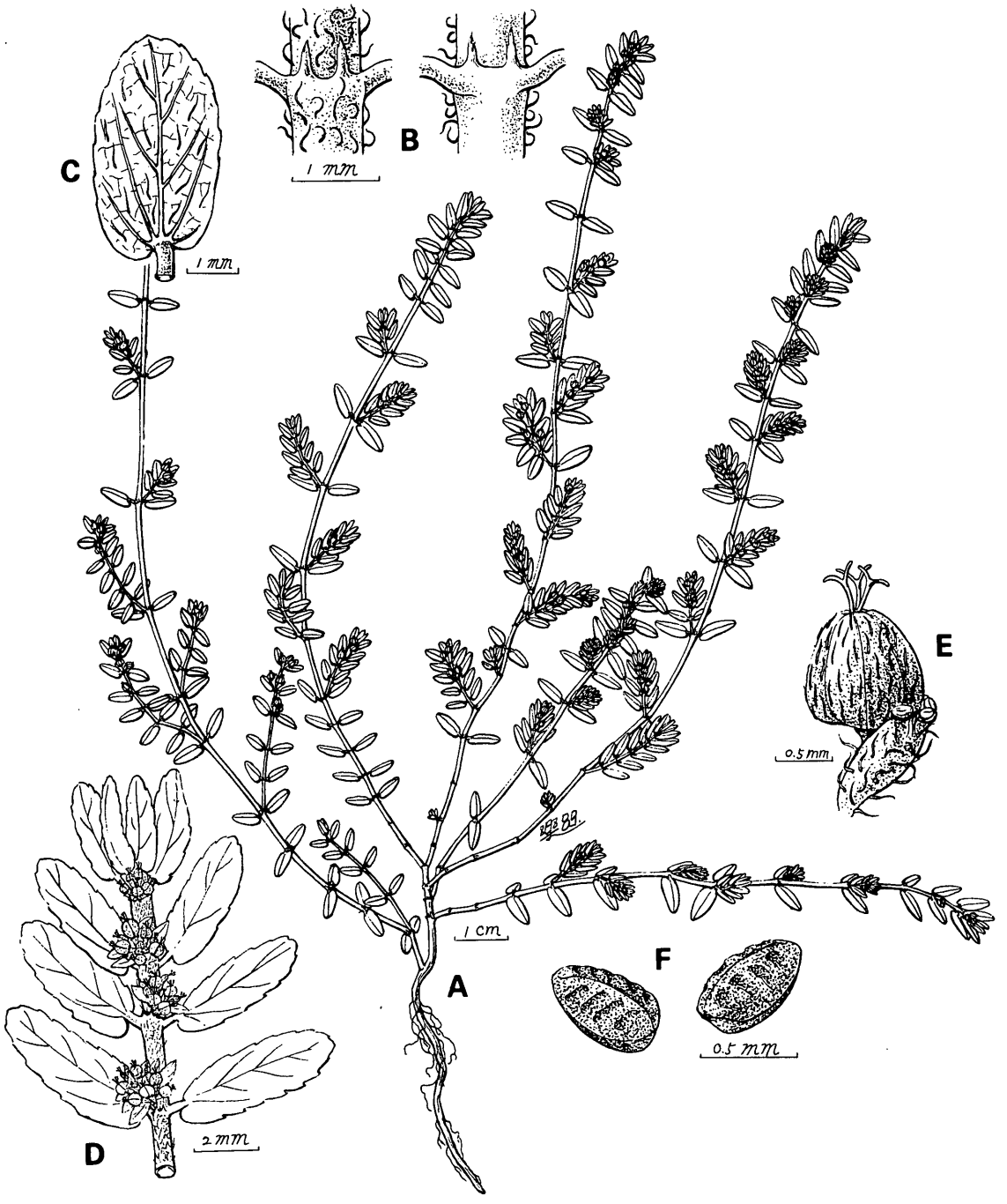

Fig. 20. *C. thymifolia* (*Chaw & Lin 994*). A, habit; B, stipules (left, upper side of stem; right, lower side of stem); C, leaf, abaxial view; D, cyathia solitary at nodes; E, cyathium, note the incompletely exserted capsule; F, seeds.

acute to rounded at apex, obliquely truncate, rounded to subcordate at base, serrulate at margin, sparsely sericeous below; petioles 0.4 - 0.8 mm long, sericeous abaxially. Cyathia 1 to few on short congested lateral branches and appearing clustered; involucres turbinate -campanulate, 0.5 - 0.7 mm long, sericeous outside, pilose inside; stalks 0.2 - 0.5 mm long; glands 4, pale green or red, rounded to transversely elliptic or oblong,

slightly concave, 0.1 - 0.2 mm long; appendages white to reddish, depressed obovate, undulate, up to 0.5 mm long, 0.2 mm wide; bracteoles acicular. Male flowers 3 - 4, anthers red. Female flower with sericeous pedicel and ovary; style and stigma to 0.6 mm long. Capsules ca. 1 mm long, 1 mm diam., not completely exserted at maturity and often rupturing side of involucres, sericeous; seeds reddish, tetragonal, oblong-ovoid, 0.6 - 0.7 mm long, 0.4 - 0.5 mm diam., transversely rugose.

Distribution: This species is nearly pantropical (Hsieh, 1977), commonly found in grasslands and wilderness, cultivated fields and seashores throughout the islands.

Specimens examined: TAIPEI CITY: Kungkuan, *Tanaka & Shimada 11115* (TAI, TI); Peitou, *Shimada s. n.* 27 Jun 1907 (TAIF); Taipei City, without further locality, *Shimizu 2466* (TAI), *Makino s. n.* 12 Nov 1896 (TI), *Makinoi s. n.* 21 Nov 1896 (TI), *Makinoi s. n.* 22 Nov 1896 (TI), *Sasaki s. n.* Feb 1927 (TAI), *A. T. Hsieh*, 22 Jul 1924 (TAIF). TAIPEI CO.: Keelung City, *Makino s. n.* 31 Oct 1896 (TI), *Sasaki, s. n.* 13 Sep 1908 (TAIF), *Masamune et al. 84* (TAI). Wanli, *Kao 8830* (TAI); Wulai, *C. S. Hsu & R. Hsu 3500* (TAI); Tanshui, *Makino s. n.* 13 Nov 1896 (TI), *Makinoi s. n.* 17 Nov 1896 (TI), *Faurie 331* (KYO), *Lin 533* (THAI); Chinshan, *Namba et al.* 1329 (TI); Tashianglan, *Lin et al. 283*; Choshui, *Yamamoto s. n.* 28 Oct 1928 (TAI). ILAN CO.: Ilan, *Kudo & Sasaki 15446* (TAI); Meihuahu, *Lin et al. 474* (THAI); Lanyang river, *Lin et al. 509* (THAI); Lotung river, *Lin et al. 513* (THAI); Tahu, *Miyake s. n.* 5 Nov 1899 (TI); Taipingshan, *Suzuki s. n.* 29 Jul 1929 (TAI); Tuchang, *Suzuki 1181* (TAI). HSINCHU CO.: Hsinchu City, *Sakada 25* (TAI); Tahu, *Suzuki 12415* (TAI). MIAOLI CO.: Tonghsiao, *Lin & Chou 266* (THAI). TAICHUNG CO.: Taichung, THAI Campus, *Lin 151, 153, 640, 859* (THAI); NCU Campus, *Lin 295* (THAI); .CHU Campus, *C. M. Kuo 5649* (*pro parte*) (TAI); Kukuan, *Ando et al. 272* (TI). NANTOU CO.: Yuechih, Lienhuachih, *Lin 213* (THAI); Jihyuetan, *Kimura & Hurusawa s. n.* 22 Oct 1940 (TI); Wushe, *Suzuki 2788* (TAI), *Namba et al. 2409* (TI). CHANGHUA CO.: Tienwei, *Lin 299, 300* (THAI); Shenkang, *Lin 556* (THAI); Peitou, *Shimada s. n.* 17 Mar 1909 (TAIF). YUNLIN CO.: Shuichangliu to Peikang river, *Owatari s. n.* 19 Jan 1898 (TI). CHIAYI CO.: Chiayi, *Lin et al. 278* (THAI); *Shimada s. n.* Sep 1917 (TAIF), *Saito 1706* (TI). TAINAN CO: Tainan City, *C. C. Hsu 9601* (TAI); Kuangtien, *Lin et al. 386*; Hsishu, *Lin et al. 389* (THAI); Matou, *Morimoto 103* (TAI); Chiali, *Morimoto s. n.* 11 Oct 1941 (TAI). PINGTUNG CO.: Pingtung City, *Matuda 162* (TAI); NPTAC Campus, *C. E. Chang 4134* (PAI); *Yang & Ho 183* (PAI); Fengkang, *Saito s. n.* 16 Nov 1924 (TI), *Cheng 1475* (TAI); Sehmen, *Kao 7123* (TAI); Henchun, *Tashiro s. n.* 16 Mar 1898 (TI); Oluanpi, *Ohwi s. n.* 30 Mar 1933 (KYO); Chuanfanshih, *Lin 405* (THAI); Maopitou, *Lin et al. 119* (THAI), *Lin 414, 415, 418, 419, 565, 566* (THAI); Sheting Park, *Lin 425* (THAI); Longkeng, *Lin 435* (THAI); Hsiaoliuchiu, *Hosokawa 1936, 1938* (TAI). PENGHU CO.: Penghu Islands, *T. C. Huang & Kao 6904* (TAI); Fengkuei, *C. C. Hsu & Kuo C. S. 14018* (TAI). HUALIEN CO.: Hualien Port, *Kawakami & Shimada s. n.* 20 Oct 1912 (TAIF); Hualien City, *Lin 382* (THAI); Wenshan to Yuehwangting, *Lin 358, 364* (THAI); Henglin, *Kao 9802* (TAI); Kunfun, *Dun 24* (TAI); Tienhsiang, *Kuo C. S. et al. 6998* (TAI). TAITUNG CO.: Taitung, *Kobayashi s. n.* 27 Jan 1906 (TAI); Taitung to Pahsientung, *Lin 648* (THAI); Tawu, *Kobayashi s. n.* Sep 1907 (TAIF); Peinan, *Kawakami & Kobayashi 1577* (TAIF); Sanhsientai, *Yamamoto 2077* (TAI); Lanyu: Hungtou, *Lin 802, T. C. Huang & Kao 5075* (TAI); Mt. Hungtou, *T. C. Huang & Kao 6323* (TAI); Yehyin, *Lin 790*; Hungtou to Tienchyr, *H. J. Chang 2286* (TAI); Hungtou to Yehyou, *C. C. Hsu 4902* (TAI); Yehyu, *C. E. Chang 17195* (PAI); Tungching, *L K H & C 174, 247* (TAI), *C. E. Chang 16650* (PAI); Langtao, *C. E. Chang 12290* (PAI); Chientushan, *H. J. Chang 2297* (TAI); Dantau, *T. C. Huang & Kao 6390* (TAI); Hsiaolanyu, *Sata 1457* (TAI); Lanyu, without further locality, *T. C. Huang & Kao s. n.* 6 Aug 1970 (TAI), *C. F. Hsieh 1599* (TAI), *Kawakami & Mori 2458* (TAIF), *T. C. Huang & Kao 5076* (TAI); Lutao, *Kudo & Mori 185* (TAI).

Classification notes: *Chamaesyce thymifolia* has either red or green forms, the former is more common. These two forms rarely grow together. It often cohabits with *C. prostrata*, under which their differences are compared. The marginal vein of *C. thymifolia* is continuous (Fig. 1F).

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臺灣地錦草屬植物之分類研究

林叔芊[1] 趙淑妙[1] 謝長富[2]

[1]中央研究院植物研究所

[2]國立臺灣大學植物學系

地錦草屬(*Chamaesyce* S. F. Gray)的基部多分枝習性與大戟屬(*Euphorbia* L.)最爲不同。該習性是因爲頂芽分生組織在發育早期已被第一對眞葉所耗盡，而且所有的枝條都是側枝性的。此外，地錦草屬的葉柄之間有托葉，葉對生、基部歪斜、有束鞘細胞，杯狀花序通常有四個帶花瓣狀附屬物的腺體，以及種子沒有種阜等特徵都可和大戟屬區分。本屬在臺灣地區共有 14 種。本文報導一新種(新竹地錦，*C. hsinchuensis* Lin & Chaw)，三新記錄種(斑地錦，*C. maculata* (L.) Small；匍根地錦，*C. serpens* (H. B. & K.) Small；心葉地錦，*C. sparrmannii* (Boiss.) Hurusawa)，並訂正一學名(紫斑大戟，*C. hyssopifolia* (L.) Small)；討論地錦草屬在臺灣的分類歷史和種間的分類特徵；提供種的檢索表，各種的描述，繪圖和地理分佈；記述所檢查的標本和作者的分類心得。