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SYSTEMATICS

Cotoneaster rosiflorus (Rosaceae), a new species from Taiwan

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ABSTRACT. *Cotoneaster rosiflorus* K. C. Chang & F. Y. Lu, a new species of Rosaceae subfam. Spiraeoideae, tribe Pyreae (formerly subfamily Maloideae) from Taiwan is described. A taxonomic treatment, line drawings, color photographs and pollen SEM micrographs are provided to illustrate the species. A somatic chromosome number of $2n = 68$ is reported for the first time for *C. rosiflorus*. *Cotoneaster rosiflorus* occurs mainly at 2,500-3,500 m altitude in central Taiwan. It resembles *C. morrisonensis* vegetatively, but is distinct by the erect to slightly spreading pink petals, pink or reddish filaments, 3-5 styles, and 3-5 pyrenes.

Keywords: *Cotoneaster horizontalis*; *Cotoneaster morrisonensis*; *Cotoneaster rosiflorus*; Maloideae; New species; Rosaceae; Spiraeoideae; Taiwan.

INTRODUCTION

Cotoneaster (Rosaceae) is a genus of about 90 species widespread in temperate Asia (except Japan), Europe and North Africa (Yü and Lu, 1974; Lu and Brach, 2003), although other authors consider the number of species 260 (Mabberley, 2008) or closer to 400 (Fryer and Hylmö, 2009). In 1911 Hayata described from Taiwan three species of *Cotoneaster*, namely *C. formosana* Hayata, *C. koidzumii* Hayata and *C. taitoensis* Hayata, all of which were synonymized under *Pyracantha koidzumii* (Hayata) Rehd (Ohashi, 1993). Subsequently, Hayata, (1913, 1915) published three species, *C. konishii* Hayata, *C. morrisonensis* Hayata and *C. rokujodaisanensis* Hayata, in 'Icones Plantarum Formosanarum.' Masamune (1932) treated *C. rokujodaisanensis* as a synonym of *C. morrisonensis*, which was followed by Kanehira (1936), Li (1963), Liu and Su (1977) and Ohashi (1993). Only two species of *Cotoneaster*, *C. konishii* and *C. morrisonensis*, were recognized in the second edition of Flora of Taiwan (Ohashi, 1993). Hsieh and Huang (1997), in their revision of the genus *Cotoneaster* in Taiwan, considered *C. morrisonensis* and *C. rokujodaisanensis* distinct, and added a neglected species, *C. horizontalis* Decne. In 2001 Fryer and Hylmö published a new species, *C. hualiensis* J. Fryer & B. Hylmö, from this island. Lai and Hsieh (2001, 2003) added two neglected species, *C. subadpressus* Yü and *C. apiculatus* Rehd. & Wils., to the flora of Taiwan. Lu et al. (2005) documented another new distributional record, *C. dammeri* C. K. Schneid., in Taiwan. More recently, Chang et al. (2009) clarified the taxonomic confusion involving *Photinia kudoi* Masamune and recognized *Cotoneaster bullatus* Bois for Taiwan. Fryer and Hylmö (2009) published a new species, *C. nantouensis* Fryer & Hylmö, from Taiwan. We checked the protologue and examined a type specimen image of *C. nantouensis* (*E. H. Wilson 10072*!, MO) and hereby consider it to be a synonym of *C. subadpressus*. In this study we report yet an additional new species, *C. rosiflorus* K. C. Chang & F. Y. Lu, which occurs at 2,500-3,500 m altitude in Central Mountain Ranges on this island. The number of recognized species of *Cotoneaster* in Taiwan has increased drastically in the recent decade, which is unusual for a woody genus on this island.

MATERIALS AND METHODS

Cryo scanning electron microscopy

Fresh leaves of *Cotoneaster rosiflorus* K. C. Chang & F. Y. Lu, *C. horizontalis* Decne and *C. morrisonensis* Hayata were dissected and attached to a stub. The samples were frozen with liquid nitrogen slush, then transferred to a sample preparation chamber at -160°C. After 5 min, when the temperature rose to -130°C, the samples were fractured. The samples were etched for 10 min at -85°C. After coating at -130°C, the samples were transferred to the

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SEM chamber and observed at -160°C with a cryo scanning electron microscope (FEI Quanta 200 SEM/Quorum Cryo System PP2000TR FEI). Vouchers are deposited at HAST (*Cotoneaster rosiflorus*, *Peng 21493*) and TCF (*C. horizontalis*: *Chang 2486*; *C. morrisonensis, Chang 2684*).

Chromosome cytology

Root tips were pretreated with 2 mM 8-hydroxyquinoline solution at 15-18°C for 8-9 h and fixed with ethanol-acetic acid (3:1) at about 4°C for over 24 h. Fixed materials were macerated and stained in 10:1 mixture of 2% acetic orcein and 1N HCl for chromosomal observation. The plant used in this study (*Cotoneaster rosiflorus, Peng 21493,* HAST) was collected in the field and cultivated in the experimental greenhouse of Academia Sinica.

Pollen observation

The anthers of fresh flowers of *Cotoneaster rosiflorus* (*Chang 2487,* holotype at HAST) were carefully removed with tweezers, then sequentially dehydrated with alcohol (30%, 5 min; 40%, 5 min; 50%, 5 min; 60%, 5 min; 70%, 5 min; 80%, 5 min; 95%, 5 min). The anthers were then broken with a dissection needle under the stereomicroscope to scatter the pollen. Pollen were kept in a desiccator with silica gel over night. Finally, the pollen was observed under the scanning electron microscope (HITACHI S-3000N) and photographs were taken after gilt.

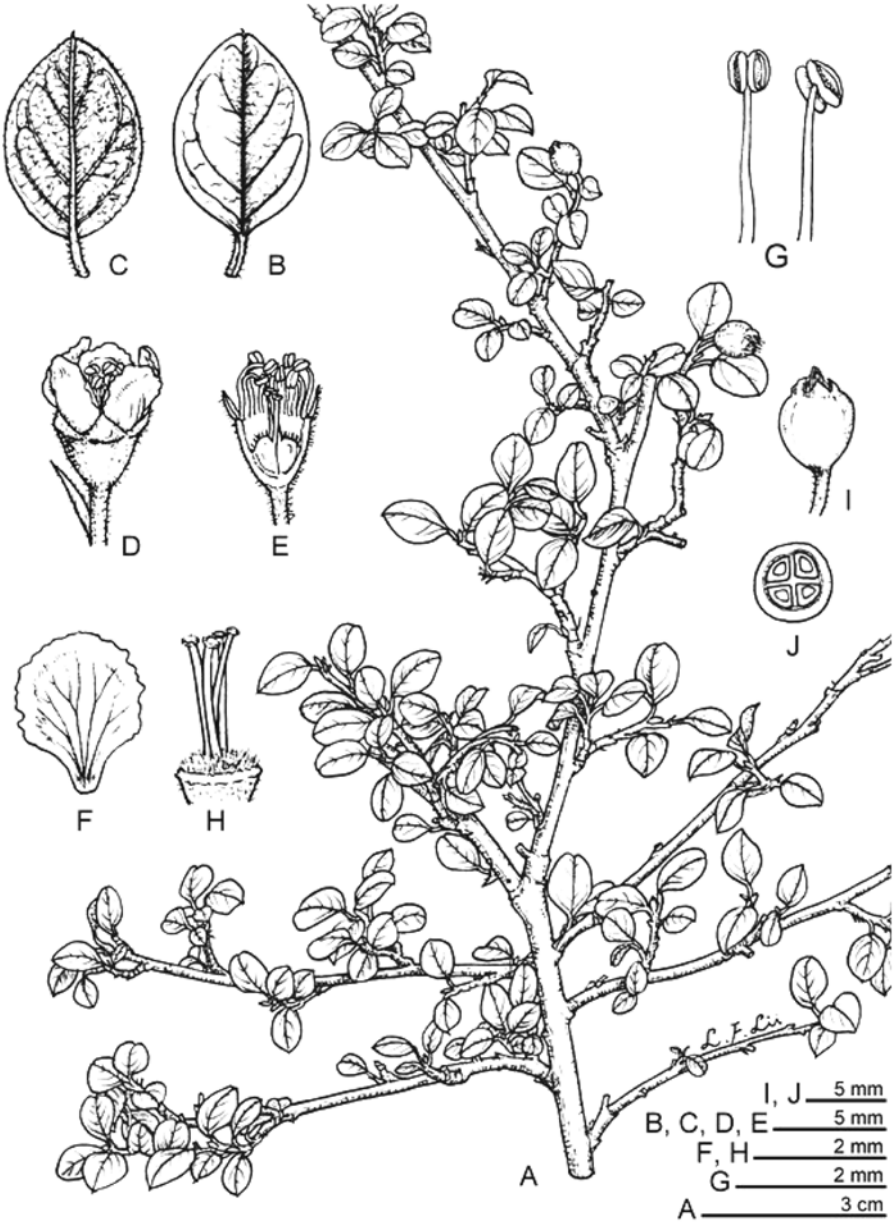

Figure 1. *Cotoneaster rosiflorus* K. C. Chang & F. Y. Lu. A, Habit; B, Leaf, adaxial surface; C, Leaf, abaxial surface; D, Flower; E, Dissected flower; F, Petal; G, Stamens; H, Styles; I, Pome; J, Pome, dissected to show pyrenes.

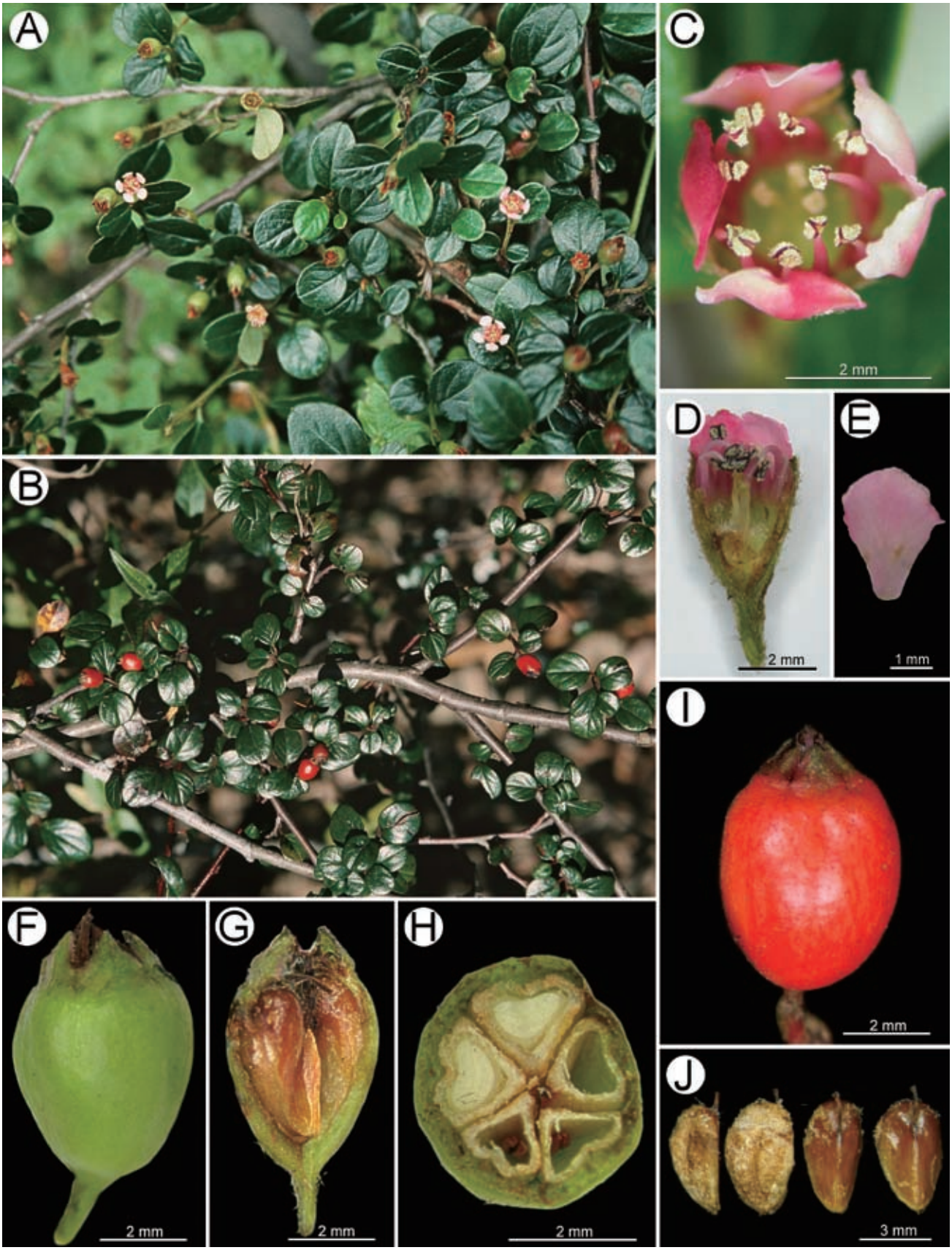

Figure 2. *Cotoneaster rosiflorus* K. C. Chang & F. Y. Lu. A, Habit, flowering; B, Habit, fruiting; C, Flower, viewed from above; D, Flower, longitudinal section; E, Petal; F, Immature pome; G, Immature pome, longitudinal section; H, Immature pome, cross section; I, Ripe pome; J, Pyrenes.

NEW SPECIES

Cotoneaster rosiflorus K. C. Chang & F. Y. Lu, sp. nov.– TYPE: TAIWAN. Nantou Hsien, Hsinrengang, 2,300 m altitude. 23 June 2004, *K. C. Chang 2487* (holotype: HAST; isotypes: A, MO, TCF). 粉紅花舖地蜈蚣

(Figures 1, 2, 3A-D)

Haec species affinis Cotoneastro morrisonensi Hayata, sed planta habitu semi-decidua, foliis chartaceis usque subcoriaceis, petalis erectis, roseis, stylis (3-)5, pyrenis (3-)5 differt.

Semi-evergreen low shrubs less than 50 cm tall, branchlets grayish brown to grayish, terete, initially yellowish appressed-pilose, glabrescent. Leaves chartaceous, rotund,

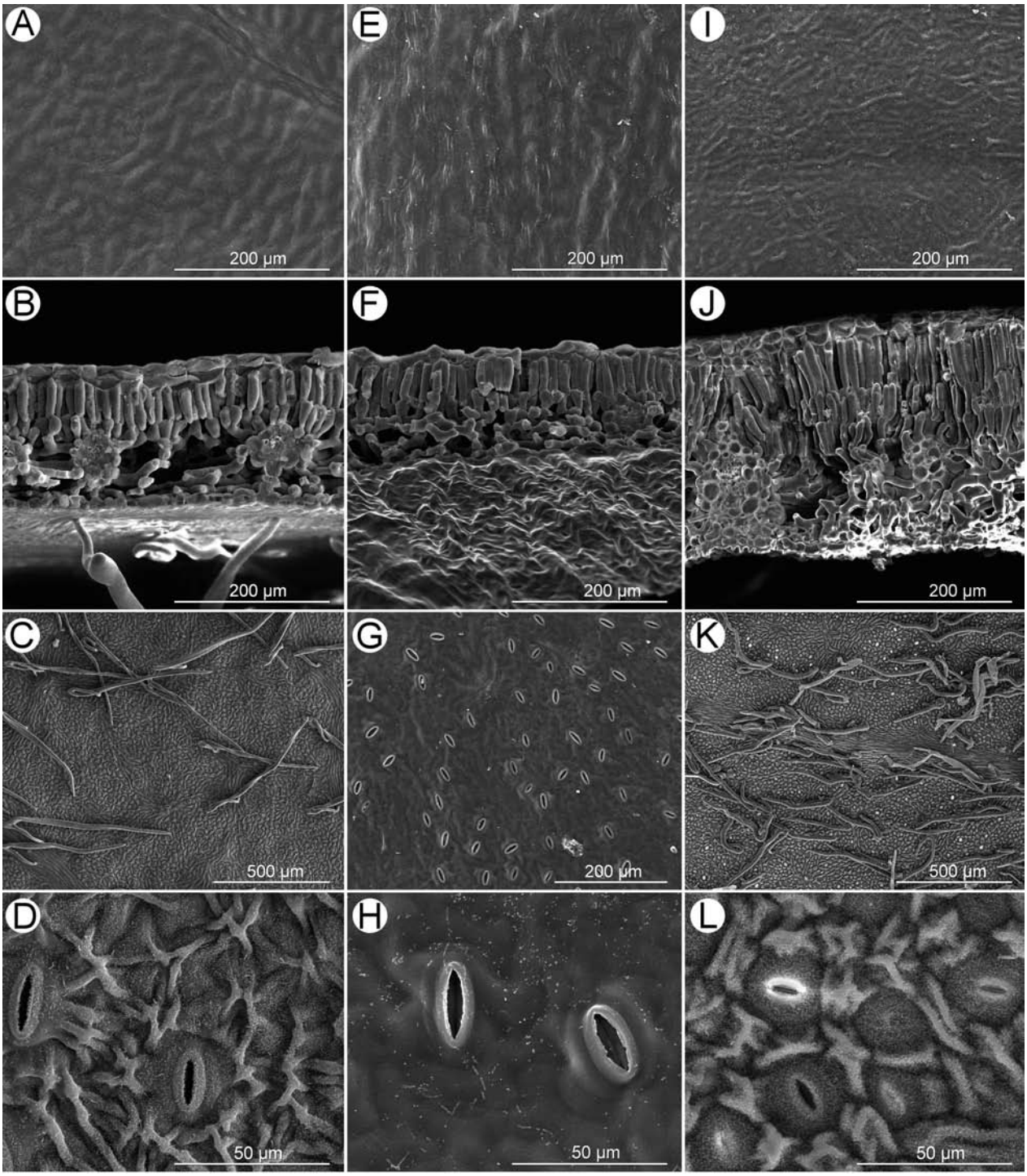

Figure 3. SEM-micrographs of leaf blade of *Cotoneastesr rosiflorus* (A-D), *C. horizontalis* (E-H) and *Cotoneaster morrisonensis* (I-L). A, E, I, Adaxial surface; B, F, J, Cross section; C, G, K, Abaxial surface, showing trichomes; D, H, L, Abaxial surface, showing stomatal apparatus.

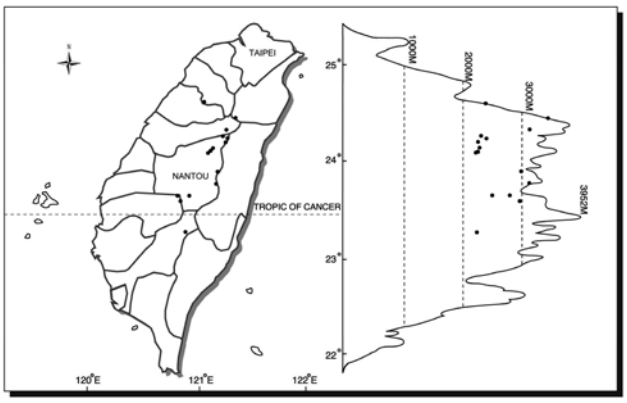

Figure 4. Latitudinal and altitudinal distributions of *Cotoneaster rosiflorus* in Taiwan.

ovate or elliptic, 0.4-3 cm long, 0.4-1.7 cm wide, apex apiculate, rounded, obtuse or acute, rarely emarginated, base obtuse to broadly cuneate, margins recurved; upper surface initially appressed pilose on veins, glabrous, shiny, with slightly impressed veins, veinlets inconspicuous when old, lower surface persistently densely tomentose; veins 3-5 pairs; petiole 1.6-3 mm long, pilose; stipules mostly caducous, lanceolate, 1.4-2.3 mm long, abaxially puberulent. Inflorescence usually 1-flowered, rarely 2- or 3-flowered, flower 7-9 mm long (including hypanthium), 3-5 mm across, pedicel 1.7-4 mm long, densely tomentose; bracts linear-lanceolate or lanceolate, abaxially puberulent, 2-3 mm long. Hypanthium campanulate, abaxially puberulent; sepals triangular, acute at apex, 1.3-1.5 mm long, 1.2-1.7 mm wide, puberulent abaxially and on margins. Petals 5, erect or slightly spreading, pink, subrotund, 2.5-4 mm long, 1.9-2.8 mm wide, margin erose dentate, slightly clawed at base. Stamens 7-18, ca. 2.4 mm long, filaments pink, 1.5-2.2 mm long, anthers ellipsoid, purple or purplish red, ca. 0.5 mm long. Ovary pilose apically; styles (3-)5, free, ca. 2.4 mm long, glabrous. Fruits light yellowish orange to red, light red at maturity, obovoid, ellipsoid, or subglobose, 5-8 mm long, 4-6 mm across, initially appressed-pilose, glabrous when old, the ripe pome summit rounded or angular, base rounded; sepals persistent on summit of ripe fruit, greenish-brown to dark red, thick and fleshy, coalescent; pedicels 1.5-4 mm, pilose. Pyrenes 3-5, 4-5 mm long, 2-2.7 mm across, outer surfaces strongly rugose, summit smooth, style or style scar remains 3/4 from base. Flowering May to July; fruiting June to December.

Distribution and Habitat. Endemic to Taiwan, occurring in relative abundance at 2,500-3,500 m altitude in the Central Mountain Range, usually on semi-shaded arid sites, over conglomerate, in fields or rocky places, at margins of broadleaved or pine forests (Figure 4). *Cotoneaster rosiflorus* is not in the threatened category. *Cotoneaster rosiflorus* is a creeping shrub. Its branches always hang down or climb in the crags. It is usually found on semi-open, gentle to steep eastern and southern aspects, often co-occurring with *Pinus taiwanensis* Hayata, *Miscanthus sinensis* Anders., *Rubus rolfei* Vidal or *Cotoneaster apiculatus* Rehd. & Wils., etc. in the field.

Chromosome cytology. A somatic chromosome number of $2n = 68$ was observed for *Cotoneaster rosiflorus* (Figure 5). The 68 chromosomes at mitotic metaphase varied gradually from 0.4 to 1 μm in length. As positions of the centromeres were not ascertainable, the karyotype analysis was not possible.

The genus *Cotoneaster* belongs to subfamily Spiraeoideae tribe Pyreae subtribe Pyrinae (formerly subfamily Maloideae. see Potter et al., 2007; Campbell et al., 2007), which has a basic chromosome number of $x = 17$ (Raven, 1975; Campbell et al., 2007). Somatic chromosome numbers of $2n = 34$, 51, 68, 85 and 102 (e.g., Kroon, 1975; Klotz and Krügel, 1983; Krügel, 1992; Zhou and Wu, 1999; Zhou et al., 2000) were known in plants of the genus, representing diploids, triploids, tetraploids, pentaploids and hexaploids respectively. Our report of $2n = 68$ suggests that *C. rosiflorus* is a tetraploid. This is the second cytological report on Taiwanese

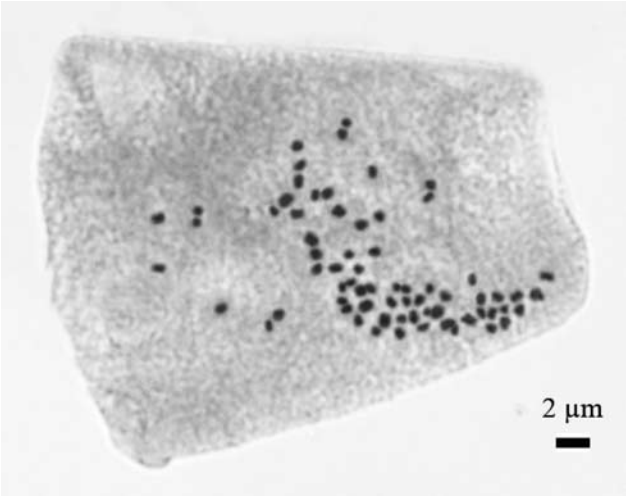

Figure 5. Somatic chromosomes at mitotic metaphase of *Cotoneaster rosiflorus* ($2n = 68$, from *Peng 21493, HAST*).

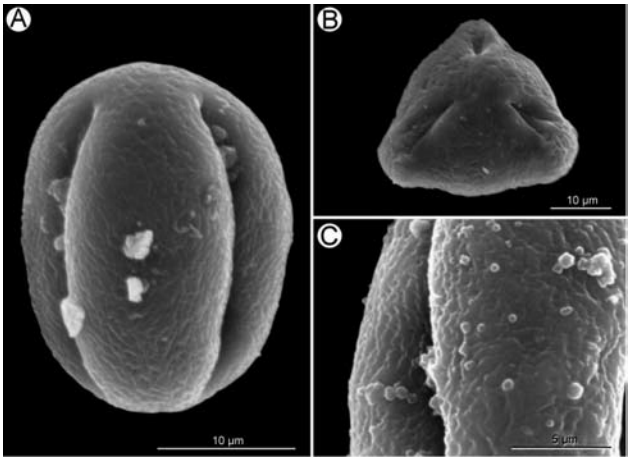

Figure 6. SEM-micrographs of pollen grain of *Cotoneaster rosiflorus*. A, Equatorial view; B, Polar view; C, Ornamentation on the equatorial view.

Cotoneaster. Fryer and Hylmö (2001) indicated triploid chromosome count for *C. hualiensis* that occurs also in Central Mountain Range.

Additional specimens examined. **TAIWAN.** HSINCHU HSIEN: Luchangdashan ('Mt. Rokujodaishan'), 10 Nov 1983, *Lu 13460* (TAIF), 3 Aug 2003, *Chang 1544* (CHIA), 11 Aug 2003, *Chang 1611* (CHIA), 13 Jun 2004, *Chang, 2465, 2486* (CHIA). TAICHUNG HSIEN: Mt. Shenmachenshan, 25 Jun 1994, *Wang 968* (HAST); Mt. Shaunshan, 13 Jul 1983, *Lin & Hsieh s. n.* (TAIF). HUALIEN HSIEN: Tayuling, 4 Dec 1997, *Liu 775* (TAIF); Piluchi, 17 Jul 1980, *Ou et al. 5538* (TCF), 9 Nov 1986, *Yang & Yang 3200* (TNM), 5 Jun 1998, *Su s. n.* (TNM), 4 Sep 1988, *Lu 12806* (TAIF); Pilu log road, 4 Dec 1991, *Wang s. n.* (TNM), 7 May 2000, *Chung 2777* (TAIF). NANTOU HSIEN: Yuanfeng, 26 Jun 1979, *Tu s. n.* (TCF), 17 Oct 1982, *Ohashi et al. 12553* (TAI), 17 Jul 1996, *Lin 179* (TAIF), 8 Aug 2003, *Chang 1594* (CHIA), 26 Oct 2003, *Chang 2175* (CHIA); Hsinrengang, 15 June 1993, *Chiu 1955* (HAST, TNM), 13 July 1993, *Wang w00050* (TNM), 12 Apr 2000, *Cheng 3018* (TAIF), 5 Jul 2000, *Cheng 3296* (TAIF), 28 Jan 2003, *Chang 583* (CHIA), 27 May 2004, *Wang s. n.* (TCF), 11 June 2008, *Peng 21493* (HAST); Tsuifeng, 20 Jun 1981, *Ou et al. s. n.* (TNM), 22 Sep 1996, *Lin* s. n. (TAIF); Yunhai, 13 Oct 1992, *Liu 15* (HAST), 27 Nov 1998, *Wang et al. 3823* (TNM), 8 May 2004, *Tunghai Collecting Team 9305097* (TNM); Tienchih, 25 Aug 1984, *Tateishi et al. 18120* (TAI), 2 Jan 2003, *Chang 418* (CHIA); Mt. Nengkaoshan, 23 Aug 1929, *Sasaki s. n.* (TAIF); Tungpu, 19 May 1969, *Hsu 5364* (TAI). CHIAYI HSIEN: Tatachiaanpu, 11 Nov 1990, *Wu et al. s. n.* (TNM), 17 May 1991, *Lin & Lin s. n.* (TNM), 7 Aug 1991, *Leu 1179* (HAST); Mt. Lulinshan, 15 Jul 1990, *Ou et al. s. n.* (TNM), 9 Nov 1986, *Chen et al. 900008* (TNM), 25 Dec 2002, *Chang 344* (CHIA), 18 Jun 2004, *Wu s. n.* (CHIA). KAOHSIUNG HSIEN: Tienchih, 21 May 1992, *Wang 1150* (HAST).

Notes. *Cotoneaster rosiflorus* is similar to *C. morrisonensis* and *C. horizontalis* vegetatively. A comparison of salient morphological features of the three species is shown in Figure 3 and Table 1. Six species of Taiwanese *Cotoneaster* assume prostrate or decumbent habit. The rest (four species) are erect shrubs or small trees. To aid in identification, we provide a key to the six creeping spe-

Table 1. Comparisons of *Cotoneaster rosiflorus*, *C. horizontalis* and *C. morrisonensis*.

	C. rosiflorus	*C. horizontalis*	*C. morrisonensis*
Habit	Semi-evergreen	Deciduous	Evergreen
Leaf			
Shape	Rotund, ovate or elliptic	Obovate, ovate, broadly elliptic to subrotund	Elliptic to oblong
Size (mm)	4-30 × 4-17	5-14 × 4-9	6-18 × 3-12
Margins	Recurved	Plane	Recurved
Adaxial surface sculpture (SEM)	Shortly roughly striate (Figure 3A)	Shortly roughly striate (Figure 3E)	Finely striate (Figure 3I)
Palisade tissue	1 or 2 layers (Figure 3B)	1 or 2 layers (Figure 3F)	3 layers (Figure 3J)
Abaxial surface sculpture (SEM)	Forked striate (Figure 3D)	Not striate, slightly rugose (Figure 3H)	Shortly forked striate (Figure 3L)
Abaxial trichome	Sparse (Figure 3C)	Glabrous (Figure 3G)	Relatively dense (Figure 3K)
Stomata	Sparse (Figure 3D)	Sparse (Figure 3H)	Dense (Figure 3L)
Flower			
Petals	Erect or slightly spreading	Erect	Spreading
Color	Pink	Red	White
Filaments	Pink or reddish	Red	White
Anthers	Purple or purplish red	White	Purple
Styles	(3-) 5	2 (3)	2 (3)
Fruit			
Shape	Obovoid, ellipsoid or subglobose	Obovoid to subglobose	Ellipsoid or obovoid
Pyrenes	(3-) 5	2 (3)	2 (3)
Pollen			
Ornamentation	Prominently rugose (Figure 6)	Prominently rugose and perforate (Hsieh & Huang, 1997: Figures 3-8)	Striate (Hsieh & Huang, 1997: Figures 9-14)

cies of *Cotoneaster* currently known in Taiwan. Fryer and Hylmö (2009) chose a Taiwanese endemic species *C. rokujodaisanensis* as a type to establish a new section *Rokujodaisanense*. Unfortunately, their description of *C. rokujodaisanensis* tallies with *C. rosiflorus*, the new species we reported in this article. Upon detailed examination of the type collection (fruiting specimen that is devoid of flowers) of *Cotoneaster rokujodaisanensis* at TAIF and plants in flower collected from the type locality, we are convinced that *C. rokujodaisanensis* has leathered and mostly elliptic leaves and white, spreading petals, which did not conform to the description of Fryer and Hylmö (2009). The color photograph of *C. rokujodaisanensis* in their book turned out to be bona-fide *C. rosiflorus*. *Cotoneaster rosiflorus* is cultivated massively by Hualien District Agricultural Research and Extension Station in Taiwan as a promising ornamental plant.

KEY TO CREEPING TAXA OF *COTONEASTER* IN TAIWAN

1a. Petals fully spreading, white; filaments white; plants evergreen; veinlets on upper leaf surface reticulate or not.
  2a. Leaf veinlets markedly reticulate.
    3a. Styles 4 or 5; fruits obovoid to globose; pyrenes 4 or 5 ..... *C. dammeri*
    3b. Styles 2(3); fruits ellipsoid-ovoid or ellipsoid; pyrenes 2 (3)..... *C. morrisonensis*
  2b. Leaf veinlets not reticulate, only primary and secondary veins visible ..... *C. rokujodaisanensis*
1b. Petals erect or slightly spreading, red or pink; filaments red or pink; plant deciduous or semi-evergreen; veinlets on leaf upper surface not reticulate.
  4a. Anthers purplish; filaments pink; styles (3-)5; pyrenes (3-)5 ..... *C. rosiflorus*
  4b. Anthers white; filaments red; styles 2(3); pyrenes 2(3).
    5a. Leaves chartaceous to subcoriaceous; stems horizontally spreading, distichously branched ..... *C. horizontalis*
    5b. Leaves thick coriaceous; stems tufted on ground, irregularly branched ..... *C. subadpressus*

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台灣產枸子屬(薔薇科)一新種：粉紅花舖地蜈蚣

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本文報導台灣產枸子屬 (*Cotoneaster*) 一新種：粉紅花舖地蜈蚣 (*C. rosiflorus* K. C. Chang & F. Y. Lu)，並提供形態描述、手繪圖、花果照片及葉片與花粉的掃瞄式電子顯微鏡照片以供辨識。本種主要分布於台灣中部海拔 2,500-3,500 m 之山區，其形態近似玉山舖地蜈蚣 (*C. morrisonensis*) 或平枝枸子 (*C. horizontalis*)，但本種的花瓣直立或微開展、花瓣與花絲粉紅色、及花柱與小核 3-5 可與之區分。

關鍵詞：平枝枸子；玉山舖地蜈蚣：粉紅花舖地蜈蚣；蘋果亞科；新種；薔薇科；繡線菊亞科；台灣。