Lithocarpus graniticus (Fagaceae), a New Species from the Granitic Mountain Valleys of Southern Fujian, China

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Abstract. An elegant new species of Fagaceae, *Lithocarpus graniticus* S. P. Chen & Y. Z. Lin, was discovered in the valley of a granite mountain in southern Fujian, China. The new species is most similar to *L. cucullatus* C. C. Huang & Y. T. Chang in having grayish-white waxy scales on abaxial leaf surfaces, cupules enclosing more than 1/2 of the nut, and the seed scar convex and ca. 1/3 of the nut. It is distinguished by its cupular cupule, relatively densely pilose inflorescences, ovate or ovate-elliptic leaves, and sparsely pilose indument on branches and abaxial surfaces of young leaves. Photographs, a line drawing, and a description of the new species are provided.

Key words: Fagales, *Lithocarpus*, Southeast China, stone oak.

Lithocarpus Blume, commonly known as stone oaks, comprises a total of 347 species worldwide, the second largest genus within Fagaceae, with 123 species in China (Hassler, 2023). Its primary center of distribution is in southeastern and southern Asia (Huang et al., 1999). In China, it is most abundant in Yunnan, Guangdong, and Guangxi Provinces while being widely distributed along coastal regions and extending northward to the southern slope of the Qinling Mountains (Huang et al., 1999). Notably, it plays a crucial role as one of the dominant species in tropical and subtropical evergreen broad-leaved forests.

The genus was established in 1825 by Blume (1825), who published a new species, *Lithocarpus javensis* Blume, which serves as the type species. Prior to this, a few species now placed in *Lithocarpus* had been discovered and classified under *Quercus* L., with *Q. molucca* L. being the earliest recorded species. *Lithocarpus* differs decisively from *Quercus* in that the former is entomophilous (vs. anemophilous) and some inflorescences are bisexual (vs. unisexual) (Kaul, 1985). From the 1880s onward, numerous new stone oaks were discovered globally, with up to 44 new species published between 1933 and 1942; this momentum continued into the 1990s (Fig. 1). Subsequently, there was a sudden decrease in discoveries per decade. The overall trend in China aligns with that of the world; however, a significant number of new species were found during the period of preparation for *Flora of China* between 1983 and 1992 (Huang & Chang, 1988) (Fig. 1). In this new century, only three new *Lithocarpus* species have been found in China (Ye et al., 2004; Wang et al., 2005), one of which is in coastal Fujian (Zhang et al., 2023). The high diversity of *Lithocarpus* may be attributed to potential refuges within its vast distribution range where numerous ancient species were preserved, and subsequent in situ diversification led to a high level of neo-endemics (Yang et al., 2018). Despite fewer recent discoveries, new stone oaks can still be observed within certain specialized habitats.

In 2019, we discovered a striking stone oak in the valley of a granite mountain in the Wushan Scenic Area, bordering Yunxiao and Zhao'an Counties in southern Fujian, China. It was identified as distinct from any previously documented species (Huang et al., 1999). It is most notable for the thick abaxial layer of nearly white waxy scales on the leaves, which is unique in Fujian, China (Fig. 2A). Important reproductive characters include infructescences 5–8 cm long; cupules in clusters of one to three, cupular, 1.8–2.5 cm in diam.; bracts ovate-triangular; the mature cupule enclosing 2/3–3/4 to most of the nut (Fig. 2B); and broadly conical nuts, the scar convex, ca. 1/3 of the nut, the exposed part with appressed short hairs and waxy scales. Furthermore, the branchlets and both sides of the young leaves of this species are sparsely pilose, the trichomes

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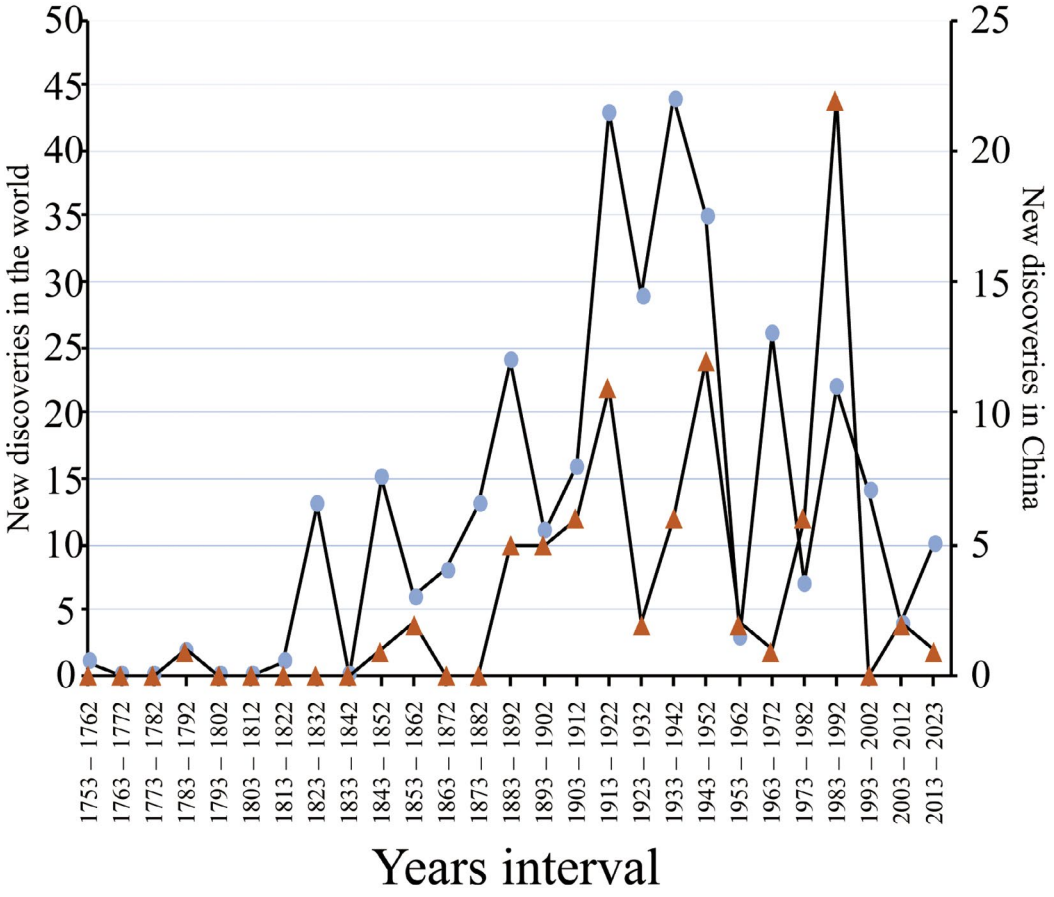

Figure 1. New species of *Lithocarpus* Blume discovered every decade from 1753 to the present (data from Hassler, 2023). Blue circles represent global discoveries; red triangles represent species in China.

easily deciduous with maturity; the inflorescences are relatively densely pilose and have waxy scales (Fig. 2C). Upon search and comparison, this species is closest to *Lithocarpus cucullatus* C. C. Huang & Y. T. Chang (Huang & Chang, 1988) (Fig. 3A). It has similar grayish-white waxy leaf scales, cupules enclosing more than 1/2 of the nut, and convex seed scars ca. 1/3 of the nut. Nevertheless, *L. cucullatus* is well distinguished from this species by its unusual cucullate cupule (Fig. 3B) and tawny tomentose indument on the new branches, abaxial leaf surfaces, and inflorescences (Fig. 3C, E).

This new species of *Lithocarpus* is named *L. graniticus* S. P. Chen & Y. Z. Lin and described in this paper.

Materials and Methods

Fifteen type specimens (one holotype, 12 isotypes, and two paratypes) were used for measurements of leaves, inflorescences, and infructescences; field observation and high-resolution photographs from the field provided additional descriptive information. Terminology mainly follows *Flora of China* (Huang et al., 1999), with macroscopic trichome classification based on Beentje (2010), and microscopic classification following Deng et al. (2013). Photographs showing details of flowers and leaf trichomes were taken using a Leica M205 FA-DFC550 stereo microscope (Leica, Wetzlar, Germany). The trichome types of this new species were observed on all collected specimens; the trichome density was calculated based on 10 young and 10 old leaves, randomly selected. Morphologically similar species were identified from *Flora of China* (Huang et al., 1999), and their leaf shapes, leaf trichomes and scales, inflorescences, cupules, and nuts were compared. Voucher specimens were deposited in the dendrological herbarium of College of Forestry, Fujian Agriculture and Forestry University (FJFC), and the herbarium of South China Botanical Garden, Chinese Academy of Sciences (IBSC).

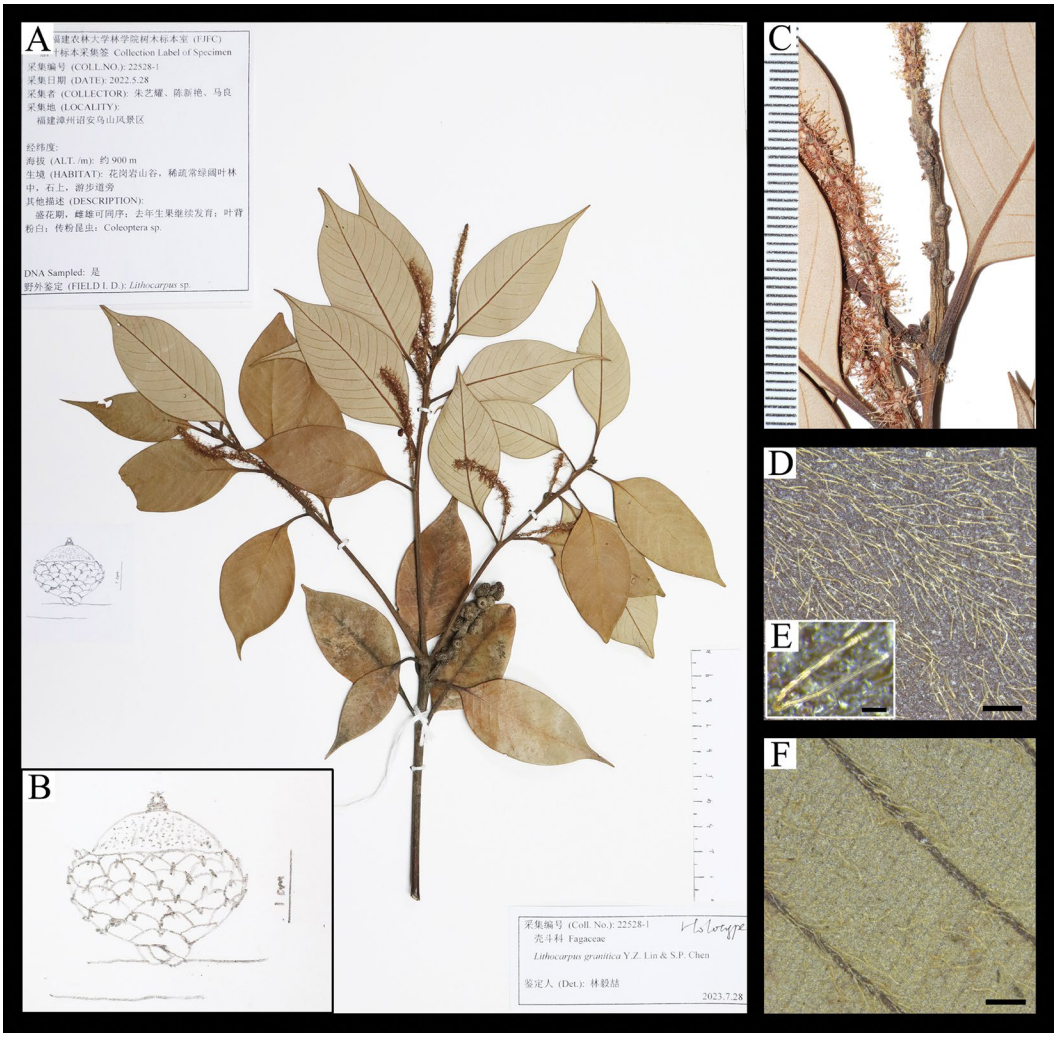

Figure 2. Holotype of *Lithocarpus graniticus* S. P. Chen & Y. Z. Lin (A–C) and photos of young leaf epidermis trichomes (D–F). —A. Specimen. —B. Fruit. —C. Inflorescence. —D. Upper epidermal trichomes; scale bar = 1000 μm. —E. Close-up of fasciculate trichome in the upper epidermis; scale bar = 100 μm. —F. Lower epidermal trichomes; scale bar = 1000 μm.

Taxonomic Treatment

Lithocarpus graniticus S. P. Chen & Y. Z. Lin, sp. nov. TYPE: China. Fujian: Zhao'an, Wushan scenic area, a dry valley with sparse evergreen broad-leaved forests, on a granite stone, roadside, ca. 900 m, 28 May 2022, *Y. Y. Zhu, X. Y. Chen & L. Ma 22528-1* (holotype, FJFC!; isotypes, FJFC!, IBSC!). Figures 2A, 4, 5.

Diagnosis. *Lithocarpus graniticus* S. P. Chen & Y. Z. Lin is distinguished from *L. cucullatus* C. C. Huang & Y. T. Chang by its sparsely pilose (vs. tomentose) branchlets and abaxial surfaces of young leaves; ovate or ovate-elliptic (vs. narrowly oblong to lanceolate) leaves; relatively densely pilose (vs. tomentose) inflorescences; and cupular (vs. cucullate) cupules.

Tree 5–7 m tall. Young twigs green, slender, with slight longitudinal grooves, sparsely pilose and with few yellowish waxy scales, early glabrescent. Old branchlets sparsely lenticellate. Stipules 2, linear, early deciduous. Buds small, ovate. Leaves with blade thinly coriaceous, ovate or ovate-elliptic, 6.5–8.5 × 2.5–4 cm; apex short caudate; base cuneate, symmetric or sometimes inequilateral; margin entire, recurved slightly; adaxial surface green, midvein raised from base to middle and flat from middle to apex, abaxial surface pinkish green, with a thick and somewhat loose layer of nearly white waxy scales; both surfaces sparsely pilose, trichomes deciduous at maturity, or slightly residual on the veins, and deciduous faster abaxially; secondary

Figure 3. Holotype of *Lithocarpus cucullatus* C. C. Huang & Y. T. Chang (A–C) and photos of young leaf epidermis trichomes (D, E). —A. Specimen. —B. Fruit. —C. Inflorescence. —D. Upper epidermal trichomes; scale bar = 1000 µm. —E. Lower epidermal trichomes; scale bar = 1000 µm.

veins 11 to 15, parallel, tertiary veins abaxially slender, dense, slightly visible; petiole 1–1.2 cm, with slightly dense yellowish short pilose indument. Inflorescences spicate, clustered at the apex of branches, rachis relatively densely yellowish pilose and bearing waxy scales. Staminate spikes ca. 6.5 cm, in clusters of 2 to several flowers, with a reddish-brown triangular bracteole below each cluster; perianth 4- to 7-lobed, lobes distinct, unequal, imbricate, ovate, nearly round to obovate, sometimes triangular or lanceolate, apex obtuse, base cuneate to broadly cuneate, adaxially puberulent, abaxially yellowish pubescent and waxy scaled; stamens 8 to 11, borne between and among perianth lobes, 3–5 mm; anthers yellow, dorsifixed; rudimentary pistil small, enclosed by hairs. Bisexual spikes up to 5.6–8.2 cm, rachis base 2.5–2.7 mm in diam., male flowers borne near apex, 3–3.8 cm, female flowers borne near base, 1.8–3.6 cm; female flowers in clusters of (1 to)3, bracteoles the same as in staminate spikes; involucre yellow-green, borne at the base of female flowers; ovary perianth-wrapped; styles 3, extending beyond perianth, recurved, yellowish, glabrous; stigma a terminal pore; puberulous and with waxy scales on the surfaces of perianth and involucre. Pistillate spikes similar to the female part of bisexual spike but longer. Infructescence 5–8 cm, carpopodium thick. Young fruit sessile, cupule completely enclosing nut, cupular bracts triangular. Mature cupule enclosing

Figure 4. Line drawing of *Lithocarpus graniticus* S. P. Chen & Y. Z. Lin. —A. Branches and leaves with young infructescence. —B. Abaxial leaf surface. —C. Androgynous inflorescence, showing the cluster of staminate flowers borne near apex and pistillate flower borne far from apex, each with a bracteole. —D. Mature infructescence. —E. Nut. Drawn by Xue-Jing Lan.

Figure 5. Photographs of *Lithocarpus graniticus* S. P. Chen & Y. Z. Lin. —A, B. Habitat and full body. —C, D. Young branchlets and leaves. —E, F. Branchlets and leaves of last-year growth. —G, H. Infructescences, cupules, and nuts. —I. Inflorescences. —J. Male flowers. —K. Female flowers.

2/3–3/4 to most of the nut; wall 1.5–3 mm thick, corky, cupular, 1.1–1.6 cm tall, 1.8–2.5 cm in diam.; inner surface glabrous, yellow-green; bracts ovate-triangular, near the cupular base larger in size, wider than high, imbricate, appressed except the triangular apex, dark green, with yellowish waxy scales. Nut broadly conical, widest below middle, flat at top, 1–1.5 cm high, 1.2–1.9 cm in diam., exposed part with appressed short hairs and waxy scales; stylopodium ca. 1.5 mm high; scar convex, ca. 1/3 of the nut.

Table 1. Morphological character comparison between *Lithocarpus graniticus* S. P. Chen & Y. Z. Lin and *L. cucullatus* C. C. Huang & Y. T. Chang.

Characters	*Lithocarpus graniticus*	*Lithocarpus cucullatus*
Leaf blade	6.5–8.5 × 2.5–4 cm, ovate or ovate-elliptic	6–16 × 1.5–4.5 cm, narrowly oblong to lanceolate
Leaf trichome type and density	adaxially and abaxially pilose, sparse, glabrescent; solitary unicellular and fasciculate trichomes present in upper epidermis, only the former observed in lower epidermis	adaxially floccose, glabrescent, relatively dense at first; abaxially tomentose, persistent or not, dense; solitary unicellular, fasciculate, and appressed parallel tufted trichomes present in lower epidermis (upper epidermal trichome of young leaf is unclear)
Leaf secondary veins	11 to 15 pairs	10 to 14 pairs
Inflorescence indument	slightly dense yellowish short pubescent	dense tawny tomentose
Cupule shape	cupular, 1.1–1.6 cm tall, 1.8–2.5 cm in diam.	cucullate, ca. 1.5–2 cm tall, 1.6–2.4 cm in diam.
Cupule bracts	imbricate, ovate-triangular, appressed except for the triangular apex	imbricate, ovate-triangular, appressed except for the subulate apex, basal bracts fused to wall and reduced to scars
Nut	broadly conical, 1–1.5 cm high, 1.2–1.9 cm in diam., with appressed short hairs	broadly conical, ca. 1.2–1.7 cm high, 1.4–2.1 cm in diam., with appressed short hairs
Nut coverage	ca. 2/3–3/4, embraced tightly; nut higher by ca. 1/3 of its height than the edge of the cupule	most of nut, upper half of cupule embraced loosely (cucullate); nut slightly higher than the edge of the cupule
Cupule scar	convex, ca. 1/3 of the nut	convex, ca. 1/3 of the nut

Distribution and habitat. The new species has only been discovered in the type locality up to now, scattered in granite mountain valleys, on stone, in a dry environment with poor soil, at low frequency (Fig. 5A), and rare. The local evergreen broadleaf forest is relatively sparse and low, including many other species of Fagaceae plants, especially *Lithocarpus*, such as *L. hancei* (Benth.) Rehder, *L. uvariifolius* (Hance) Rehder, *L. glaber* (Thunb.) Nakai, and *L. calophyllus* Chun ex C. C. Huang & Y. T. Chang.

Phenology. *Lithocarpus graniticus* flowers in May to June, with fruit ripening in October to November of the following year.

Reproductive ecology. *Lithocarpus graniticus* is mainly insect-pollinated; a beetle of the genus *Cteniopinus* Seidlitz was observed to be active during flowering.

Etymology and common name. The epithet "graniticus" indicates the new species was discovered growing in granite mountains. The proposed Chinese name of *Lithocarpus graniticus* is 岩柯 (yan ke).

Notes. *Lithocarpus graniticus* exhibits significant morphological differences from known species. The prominent differences of cupule, leaf, inflorescence, branchlet, and leaf epidermis trichome between the new species and *L. cucullatus* are displayed in Figures 2 and 3; see also Table 1. Apart from the characteristics mentioned in the diagnosis, leaf epidermal trichomes have some easily discernible differences. There are two kinds of trichomes observed in the young leaf upper epidermis of *L. graniticus* by stereo microscope: solitary unicellular (Fig. 2D) and fasciculate (Fig. 2E) trichomes. The former is dominant and the latter rare. Only solitary unicellular trichomes were observed on the lower epidermis (Fig. 2F). The average densities of trichomes on the upper and lower epidermis of young leaves were 639.87 and 87.97 per cm^2, respectively, supporting a description as "sparsely pilose." According to Deng et al. (2013), there are three types of trichomes on the lower epidermis of *L. cucullatus* leaves, i.e., solitary unicellular, fasciculate, and appressed parallel tufted trichomes; they did not characterize the trichomes on the upper epidermis of young leaves. We use the terms "tomentose" and "floccose" to describe the lower and upper epidermis trichomes, respectively, based on type specimens of *L. cucullatus*. The lower surface of young leaves of *L. cucullatus* is covered with dense trichomes (Fig. 3E) so that the epidermis cell of the lower surface is not visible; trichomes are even persistent on some old leaves. The hair in the upper epidermis is relatively dense at first but fragmentary and glabrescent (Fig. 3D).

The habitat of *Lithocarpus graniticus* is also distinctive, in a valley of a typical granite mountain with many huge exposed rocks (Fig. 5A). By contrast, *L. cucullatus* grows in luxuriant montane forests (Huang & Chang, 1988). Since we have not obtained molecular data for

the rare endangered plant *L. cucullatus*, phylogenetic study to confirm their close relationship will have to remain for the future. Even if *L. cucullatus* is the sister species, the significant morphological differences between the two are sufficient to establish the status of *L. graniticus* as a new species.

Manos et al. (2001) proposed that a new subgenus of *Lithocarpus* should be recognized based on ITS data, but did not give it a formal name. The preliminary fruit characteristic of this suggested subgenus is the convex shape of the cupule scar, similar to that seen in *L. graniticus*. The cupule scar is meaningful in tracing interspecific relationships, and the results of Manos et al. (2001) support this understanding. However, given the small number of species they studied, the status of this clade and the evolution of morphological traits within it are still inadequately understood. Nevertheless, new species may help to explain the morphological evolution of this clade in future studies.

Paratypes. CHINA. **Fujian:** Zhao'an, Wushan scenic area, 911 m, 23°55′8.76″N, 117°10′53.72″E, 21 Apr. 2023, *Y. Z. Lin 20* (FJFC).

Additional specimens examined. Lithocarpus cucullatus: CHINA. **Guangdong:** Renhua, Changjiang Town, valley, dense forest, 700–900 m, 30 Aug. 1958, *L. Teng 7336* (IBK-00083080, IBSC-0037005); Yingde, Shakou Town, Huashui Mtn., ridge, near dense forest, 590 m, 17 Apr. 1943, *B. H. Liang 84289* (IBSC-0037006); Ruyuan, Wuzhishan Mtn., slope, sparse forest, 900 m, 16 June 1973, *Yue 73* (IBSC-0037007); Ruyuan, Ruyang Forestry Bureau, Tianmenzhang, slope, dense forest, 1200 m, 8 May 1974, *Guangdong Timber Investigation Group 147* (IBSC-0037004).

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