Formosan Entomologist
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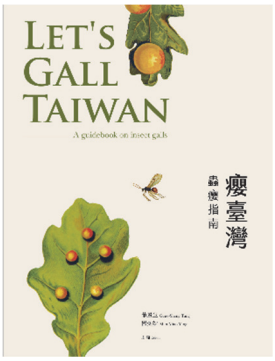
# *Let's Gall Taiwan: A Guidebook on Insect Galls*




edited by Gene-Sheng Tung and Man-Miao Yang, Published by the Council of Agriculture (Forestry Bureau), and the Taiwan Entomological Society, Taipei, 248 pages, 2018. ISBN: 978-986-05-5346-8 (Hard cover). Price: NTD 460$^{00}$

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Received: 19 November 2018 Available online: 3 June 2019

Taiwan, a 36000 km$^2$ island–country, occurs off the coast of south-east Asia, bordered by Fujian Province of the People's Republic of China in the west, South Korea and the Fukuoka Prefecture of Japan in the north, Luzon Province of the Philippines in the south, and the Philippine Sea in the east. Historically a shallow shelf of the Taiwan Strait connected the islandic Taiwan and China. During the interglacial periods of the Pleistocene glacial cycles, this shelf submerged separating China and Taiwan. Repeating topographic changes during the post-Pleistocene glacial cycles enabled the colonization of organisms between China and Taiwan (Chiang and Schaal, 2006). Yet *c*. 25% of Taiwanese plants are native to this land plate, which have evolved there because of (i) continent-island colonization, (ii) *in-situ* radiation, and (iii) synergy between colonization and radiation. Additionally, the Tropic of Cancer divides Taiwan into a southern tropical and a northern subtropical regions. Thus Taiwan's unique geography, over the years, has enabled the natural build-up of a delightful biological diversity across this island–nation. Additionally the subtropical climate has contributed to the varied demographics of Taiwanese plants and animals (Wu *et al*., 2006). Because of the high diversity of Taiwanese plants – most of which are endemic – more than 60% of the described plant-feeding arthropods of Taiwan are endemic as well (Shao *et al*., 2003). In such a context of a fascinating natural landscape and complex biological diversity, Gene-Sheng Tung and Man-Miao Yang have catalogued several arthropod-induced galls of Taiwan in this *c*. 250 page colourful and elegant book.

Galls are plant excrescences induced by the action of specific groups of Insecta and Acarina, which manifest as neoformed structures. Insect-induced galls are beautiful objects sculpted by Nature. We require a character – a special one – to admire the beauty of these natural sculptures. American photographer Wilson 'Snowflake' Bentley's (1835~1931, Jericho, Vermont) words,

> 'Their (snowflakes) uniqueness is part of their fascination and romance, yet there is undoubtedly something similar about them; they share a 'six-ness'. Which is more interesting? Perhaps it depends on the character of the observer.'

in *Appletons' Popular Science Monthly* (1898) ring in my ears as I write this section.

Arthropod-induced plant galls are in no way different from what Bentley speaks about snowflakes. The plant galls are stunning and

beautiful, yet each gall type induced by an arthropod species is unique in space. Arthropod-induced galls brilliantly bear witness to Gerald Holton's Ionian enchantment to me, because of their admirable orderliness in chaos in their form. I feel a delicate sense of Ionian enchantment, when I think of the spherical galls induced by *Eurosta solidaginis* (Diptera: Tephritidae) on the stems of *Solidago altissima* (Asteraceae) in North America and the sea-urchin galls induced by *Mangalorea hopeae* (Hemiptera: Beesoniidae) on the stems of *Hopea ponga* (Dipterocarpaceae) in southern India. The gross shape of any arthropod-induced gall, I am confident, will strike a pleasing chord in the minds of those, who look for and study these plant abnormalities. In northern Taiwan, galls of stunning shapes and structures arise on the foliage and stems of *Machilus thunbergii* (Lauraceae) because of the action of *Daphnephila taiwanensis, D. sueyenae, D. stenocalia, D. ornithocephala,* and *D. truncicola* (Diptera: Cecidomyiidae) (Tokuda *et al*., 2008). The other impressive element in the ecology of gall-inducing arthropods is that they are generally fussy and choosy of host plants. They display a strong level of commitment, which I prefer to describe as 'fidelity' to specific plants. In this context, gall-inducing Insecta and Acarina can be seen as highly reliable plant taxonomists. As a rule of thumb, experienced scientists working on galls and gall-inducing arthropods can easily determine the plant by looking at the inducing organism and the gall, and determine the inducing organism by looking at the plant and the gall.

Several amateur biologists and hobby natural historians passionately pursue these curious natural sculptures, similar to others interested in snakes and other reptiles, birds, butterflies, mushrooms, and ferns. Consequently many handbooks and plain-English guidebooks on plant galls have appeared through the world: *e.g*., Michael Chinery's *British Plant Galls: A Photographic Guide*, Ronald Russo's *Field Guide to Plant Galls of California and Other Western States*, and Rosalind Blanche's *Life in a Gall*. The *Let's Gall Taiwan* is one of that kind. This book, includes chapters contributed by Sheng-Feng Lin, Chang-Ti Tang, Yi-Chang Liao, Hsin-Ting Yeh, Chuan-Chan Wang, and Meng-Yuan Huang, further to the editors, Gene-Sheng Tung and Man-Miao Yang. Chien-Chun Hsiao, translator, has generally done a good job in rendering English texts, although certain parts could have been done better. This book's key purpose is to empower amateur biologists, who would be looking for arthropod-induced galls and the inducing arthropods in Taiwan. My commentary offered in the following paragraphs will refer only to the English sections of this book, since I am illiterate with Chinese characters.

First, on the overall quality and get-up of the book. This hard-cover book, elegantly Bradel bound, includes thick-gauge, high-quality A4-size pages. The spine bears a neat imprint of the book name in English and Chinese characters, along with the names of editors and publisher. The front cover is spectacular with attractive water colours of the European red-pea galls on *Quercus* leaves (Fagaceae) and the inducing *Cynips* (Hymenoptera) extracted from the *Alternating Generations: A Biological Study of Oak Galls and Gall Flies* by Hermann Adler (translated from German by Charles Straton, 1894, Clarendon Press, London, 198 pages). The back cover includes beautiful water-colour illustrations depicting the developmental sequence of the architecturally complex, urn-shaped Taiwanese gall arising on the leaves of *Machilus zuihoensis* (Lauraceae) induced by *Daphnephila urnicola* (Diptera: Cecidomyiidae). Several superbly executed water-colour and crayon sketches decorate different pages. The India-ink artworks in pages 24~25 referring to the rollings induced by Coleoptera on *Bischofia javanica* (Phyllanthaceae) and *Rhus chinensis* (Anacardiaceae) are superb. I will applaud the artists, Chu-Yu Quo and Li-Li Tseng, who have provided scientifically accurate artworks that creatively and aesthetically supplement the efforts of Gene-Sheng and Man-Miao.

Chapters 1~3 (pages 8~72) provide notes on the general context of arthropod-induced plant galls, their evolutionary and ecological significance, how the inducing arthropods behave during gall induction, and how galls have been used by humans, as in dyeing and medicine, over millennia, in easily-readable prose. Chapter 2.5, 'Coloration of galls', explains the mechanism

of hyper- and hypo-pigmentation that develop in galls. We need to recall here that the physiology of insect-induced galls is broadly similar to the physiology of normally developing fruits, although the proportions of production, transport, and storage (and utilization by the inhabiting larva) of various primary and secondary metabolites, of course, would vary with the species involved. Photosynthesis, for instance, is intensely altered in gall systems, but the sugar transport from other parts of the same plant that bear no galls occurs via both symplast and apoplast. Dehiscence of galls and dehiscence of fruits display similar physiological processes. In both systems, normally dehiscing fruits and dehiscing galls include newly differentiated specialized cells and a tight coordination of molecular and biochemical events that would lead to cell separation freeing seeds in fruits and the larva (or adult in some instances) in galls, once they mature.

Chapter 4 (pages 74~93) offers insights into the biologies and management of gall-inducing insects that have invaded Taiwan's agri- and horticulture in recent years: *Quadrastichus erythrinae* (Hymenoptera: Eulophidae) on species of *Erythrina* (Fabaceae), *Leptocybe invasa* (Hymenoptera: Eulophidae) on quite a few commercially important species of *Eucalyptus* (Myrtaceae), *Anselmella miltoni* (Hymenoptera: Eulophidae) on *Syzygium samarangense* (Myrtaceae), *Procontarinia mangicola* and *P. robusta* (Diptera: Cecidomyiidae) on *Mangifera indica* (Anacardiaceae), and *Dryocosmus kuriphilus* (Hymenoptera: Cynipidae) on *Castanea mollissima* (Fagaceae). Gene-Tung and Man-Miao, the authors of this chapter, refer to different biological-management efforts trialled and practiced in Taiwan in the last few years. Useful basic information to people and plantation managers in nearby nations and those far away, who grapple with similar problems.

Chapter 5 (pages 96~243) constitutes the main part of this book - the guide to various gall-inducing arthropods, galls, and host plants of Taiwan. In about 135 pages this Chapter refers to 126 galls and associated insects. As in the rest of the world, the Cecidomyiidae top the list with 45 taxa, followed by the Cynipidae with 34. A few Taiwanese hemipteran gall-inducing taxa from the Homotomidae, Aphididae, Adelgidae, Triozidae, Phacopteronidae, and Tingidae, and six taxa from the less-known gall-inducing groups, *viz*., Gracillaridae, Sesiidae (Lepidoptera), Phlaeothripidae (Thysanoptera), and Curculionidae (Coleoptera) are also included. Details of all of these taxa are presented in a consistent style with brief notes in both Chinese and English characters, supported by high-quality images of galls and the inducing taxa, each taxon neatly accommodated within a page. Occasional supplementary photographs add value. Overall, this chapter, more-than adequately, fulfils the primary purpose of this volume by supplying images and notes that would substantially help an amateur gall enthusiast.

Two galls, one induced by *Bruggmaniella* sp. (Diptera: Cecidomyiidae) on Litsea acuminata (Lauraceae) (page 111) and another by *Daphnephila* sp. (Diptera: Cecidomyiidae) on *Machilus japonica* (Lauraceae) (page 121) reminded me of two Indian galls: *Apsylla cistellata* (Hemiptera: Aphalaridae) on *Mangifera indica* (Anacardiaceae) and *Phacopteron lentiginosum* (Hemiptera: Phacopteronidae) on *Garuga pinnata* (Burseraceae), because of similarities in gall morphologies. I will not attempt to make any comparisons here because the Taiwanese galls are induced by the Cecidomyiidae and the Indian galls by the Psylloidea. However, their apparent external similarity rang a bell of morphological convergence, which may have significant implications in evolutionary ecology.

As I was reading through, for a moment, I paused in page 135, which speaks about the Cecidomyiidae (*Asphondylia* sp.)-induced fruit galls of *Alpinia intermedia* (Zingiberaceae). That was an interesting pause. On an overall scale of gall incidence on angiosperms, the number of galls on monocotyledons is low — immensely low. The best-known examples of galls on monocotyledons are 'silver shoots' on *Oryza* (Poaceae) induced by *Orseolia* (Diptera: Cecidomyiidae) (Gagné, 2010). One other monocotyledon bearing galls is *Phragmites australis* (= *P. communis*, Poaceae) due to the action of *Giraudiella inclusa* (Diptera:

Cecidomyiidae) known in Europe (Skuhravý, 1981). Odette Rohfritsch (Strasbourg, France) and Teja Tscharntke (Göttingen, Germany) have published several papers on the physiological ecology and population ecology, respectively, *of G. inclusa–P. australis* system in later years. Why so few galls occur on monocotyledons is a million-dollar question. The image in page 135 that details the developmental stage of the inhabiting *Asphondylia* was so good that I felt that this system requires a close investigation, that too soon, given that *Alpinia intermedia* is medicinally important (Amagai *et al*., 2017). At least >500 secondary metabolites of significant medicinal use are known today in several species of *Alpinia* (Ma *et al*., 2017). I am confident that the Gene-Sheng—Man-Miao team will study the *Alpinia intermedia–Asphondylia* system and come out with detailed bionomical and chemical-ecological data.

The book ends with a short epilogue (pages 245~246) and a list of books and relevant references, which would be of use to the user.

I cannot but avoid saying the following: the book suffers from a few errors. I will cite some as examples: cinipid for cynipid in p. 39, *Qadrastichus* for *Quadrastichus* in p. 76, use of 'infected' for 'infested' in p. 85 (this error is repeated in different places), *Castanea mollisima* for *Castanea mollissima* in p. 92. Two different subsection theme pages for Hemiptera (pages 144 and 162) confused me. The Aphididae- and the Tingidae-induced abnormalities shown in pages 166, 167, 168, 169, and 182 made me wonder whether these abnormalities could be considered galls! I did applaud the beautiful artworks included in different pages of the book: but in many a page, these artworks have not been suitably annotated with a legend. For example, in page 30, a beautiful water-colour image of a vertical sectional view of a triozidine (Psylloidea) gall exists. Various segments of this beautiful gall, impressively adapted to the needs of the inhabiting immature, have been shown in bright colours. How the intended details of this image would be understood by a hobby natural historian, I am not sure. Similar gaps are glaring in all chapters except Chapter 5. In Chapter 5 the photographs can be interpreted by the reader because the biological names of plants and insects are supplied in the same page, although not as a legend to the figure. Whether the frequently used terms 'monothalamous' and 'polythalamous', I doubt, would be understood by the intended readers. A glossary explaining such professional terms would have been helpful. How come no acarine gall has been listed in this book, especially in Chapter 5? The absence of an index (at least an index of binomials), I felt, was prominent. I am hopeful that the editors would address these in the next edition.

Inclusion of a plastic magnifying lens *(ø* 6 cm) with a c. 6 cm long handle that includes the markings of a centimetre ruler*,* supplied *gratis* with each book copy, is thoughtful. A handy and helpful item in the field! This beautiful book is priced at NTD $460^{00}$. The price is highly reasonable given the high quality of production. Readers from other countries too, I am sure, can procure a copy of this book with no hesitation, since the international price would be US$ $16^{00}$.

When I reached the back cover after my journey through the book, I felt a deep sense of satisfaction. The book is splendidly illustrated with perfect and high-resolution images. I am sure that any gall enthusiast interested in pursuing the beauty of Taiwanese galls will benefit substantially from this handsome volume. In short, this book is as beautiful as the *Daphnephila*-induced galls on *Machilus* in Taiwan are! From all of us — the community of gall enthusiasts and researchers from all over the world — heartfelt thanks go to Gene-Sheng and Man-Miao for this elegantly presented informative book. A splendid and welcome addition to world gall literature.

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