History of discovery of the fastest growing angiosperm, *Wolffia microscopica* (Griff.) Kurz entwined with British India

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Wolffia microscopica (Griff.) Kurz, the fastest multiplying angiosperm, belongs to the family Lemnaceae (the duckweed family) and characteristically exhibits frequent flowering. Interestingly, the discovery of this plant species originally designated as Grantia microscopica by William Griffith (1810–45) is interlinked with the ascent of the British in India. In this note, a historic account of the discovery, nomenclature and uniqueness of this species of duckweed endemic to the Indian subcontinent is presented in view of its gaining attention as a potential bioresource when there is resurgence in duckweed research globally for its utility as a model plant for both basic and applied studies.

India is a land of diversity, whether it is biodiversity, geographical diversity, climatic zones or cultural diversity; the country is a rich assortment of all of them. Historically, for ages, India was ruled by several dynasties and rulers, with intermittent conquests and defeats, the last being the British colonial rule. The entry of the British into India was initially as a trading company, viz. the East India Company (EIC). The trade of natural resources and plant-based products was one of the aims of EIC. As trade turned out to be profitable, EIC started to explore avenues to expand its reach. One of the initiatives was to bring in scholarly resources from the West to explore the Indian subcontinent for tapping the natural resource potential. A few such explorers who made noteworthy contributions include William Roxburgh, Robert Wight, William Griffith, Robert Kyd and Joseph Hooker[1]. Most of them studied medicine and had special interest in botany. The main aim of their expeditions in the East, being a part of EIC, was to explore the economically important plants for their use as a source of food, spice, medicine, beverage and industrial products. However, most often because of their scholarly interests, they also collected and studied the flora of these majorly unexplored treasured areas. One such study was the discovery of *Wolffia microscopica* (Griff.) Kurz (Figure 1) by Griffith in 1838 during his botanical excursions in Bengal[2].

Discovery of *W. microscopica*

In 1838, Griffith (1810–45) (Figure 2) serving as an Esquire (Esq.) in EIC, discovered a unique duckweed species from Calcutta and Serampore, Bengal and named it *Grantia microscopica* in honour of James William Grant, Esq., who was an expert in microscopic observations[2]. Voigt[2], however, had left the question open whether it could be included in the genus *Wolffia* Horkel ex Schleid. Subsequently, in 1866, Wilhelm Sulpiz Kurz (1834–78)[3], who was a curator of the herbarium at the Royal Botanic Garden in Calcutta during the British rule, reassigned *Grantia microscopica* Griff. ex Voigt to the genus *Wolffia*, named in honour of Johann Friedrich Wolff (1778–1806), a German physician and botanist who also published the book entitled *Commentatio de Lemna*[4]. Consequently, this plant species was renamed as *Wolffia microscopica* (Griff.) Kurz[3]. This redesignation was confirmed by Christoph Friedrich Hegelmaier (1833–1906), the then expert on Lemnaceae[5,6], who wrote an outstanding monograph on duckweeds[7].

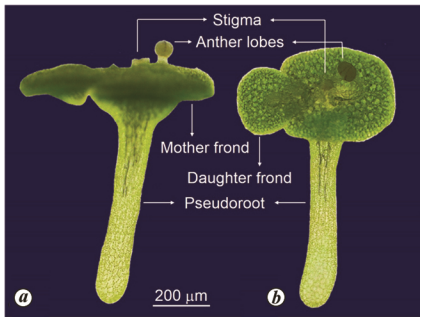

Figure 1. Morphology of *Wolffia microscopica* (Griff.) Kurz. Light microscopic images of a flowering frond: (***a***) lateral view and (***b***) top view of the floating part of the frond showing the pseudoroot on ventral side, and anther and stigma ejected out of the floral cavity on the dorsal side. Also note the daughter frond emerging out of the vegetative pouch of the mother frond.

However, the name *Grantia microscopica* has an interesting historical record. In 1839, the type specimen designated for the genus *Wolffia* Horkel ex Schleid. was *Wolffia delilli*. Years later, in 1949, it was found that *W. delilli* was in fact a species belonging to the genus *Wolffiella*, i.e. *Wolffiella hyalina*. This reassignment left the generic name *Wolffia* invalid because of the lack of a type specimen. At this juncture, the generic name coined by Griffith, *Grantia* Griff. ex Voigt, was available[4]. However, den Hartog[4] decided to continue with the use of the generic name *Wolffia* in order to avoid the hassle of nomenclature changes of more than a dozen species of the Lemnaceae family. Otherwise, to the credit of Griffith, the discoverer of the species, this plant could have been called as *Grantia microscopica*[2].

William Griffith: the discoverer of *W. microscopica*

Digging deep into the discovery of *W. microscopica*, we realized that it was

Figure 2. William Griffith Esq. FLS (1810–45)[8].

closely connected with the history of India. Although William Griffith, Esq., Fellow of the Linnean Society, London, had studied medicine from London, he had obtained training in botany at the University College London because of his interest in plants[8]. This interest was clearly evident during his expeditions while serving EIC, travelling through the then Bengal and Burma, going as far as Afghanistan, recording and collecting the mainly unexplored flora[8–10]. The works of Griffith[11,12], however, were published only posthumously because of his sudden death at the young age of 35 years[8]. Apart from the discovery of *W. microscopica*, an expedition to the forests of Assam in 1835, together with Nathaniel Wallich, a Danish botanist and John M'Clelland, a British geologist is noteworthy[9]. It was the detailed investigations of Griffith and the recommendation of this exploration that paved way for the development of tea estates in Assam by EIC[8], the fruits of which the world reaps even today as a refreshing cup of Assam tea.

Superintendent of the EIC's botanic garden in Calcutta

EIC's Botanic Garden in Calcutta (presently Kolkata), what is today known as the Acharya Jagadish Chandra Bose Indian Botanic Garden, was set up in 1787 by Colonel Robert Kyd of EIC, who was managing the required funds from the Company[13]. EIC was convinced with his recommendation that such a botanical garden will be a stock collection of plants that may be important for commercial use. Under the leadership of Kyd, succeeded by William Roxburgh in 1793, a passionate botanist, the Botanic Garden in Calcutta not only served commercial functions of EIC, but was soon a hub of scientific study of Indian flora. In 1842, Griffith took charge as the Superintendent of EIC's botanic garden, succeeding Wallich[11,13]. The two had collaborated well before Griffith's travel to India. Griffith was a student of John Lindley and Robert Brown at the University College London. Wallich considered Griffith as a young talented botanist who had contributed plant drawings to the former's Plantae Asiaticae Rariores[14,15]. However, as colleagues, their work approaches were quite different and this led to several reordering sessions at EIC's Botanic Garden, changing its map several times[13]. Recognizing Griffith's contributions and his association with the Botanic Garden, a memorial has been built in it that stands in his honour even today[10].

What is unique about *W. microscopica*?

While describing the genus *Grantia*, Griffith made an impressive note: 'To those indeed who estimate the interest of a plant merely from the size of its flower and the gorgeousness of its colouring, this family is not likely to be attractive. These minute plants are however interesting as exhibiting indications of wonderful design in the adaption of the most simple structure to the highest functions of vegetable life.'[11]

Morphology of W. microscopica

It is a member of the family Lemnaceae, which comprises 36 species of duckweeds[16] and is found to be endemic to the Indian subcontinent[17]. Morphologically, *W. microscopica* is one of the smallest angiosperms with its frond measuring less than 1 mm in length[18]. The frond is flat on the dorsal side and under normal physiological conditions, it has a pseudoroot on the ventral surface which helps in delineating it from other *Wolffia* species[18,19] (Figure 1). The first description of the plant came from Griffith[2]. He described this species as 'Flos monandrus, terminalis. Spatha nulla. Anthera unilocularis. *Planta minima*, *claviformis inter Phanerogameas simplicissima*', translated as monandrous flowers, terminal. No spathe. Unilocular anthers. Very small plant, key shaped, simplest of phanerogams. He also gave a detailed description of this plant together with the drawings[11,12]. He was also the first to discuss whether the unique ventral projection present in this plant should be considered as a root or not[11].

With the reassignment of this species to the genus *Wolffia* in 1866, Kurz[3] described it as 'Frondiculae lineam vix excedentes, cellulosae, supra planiusculae, subtus in radiculam (?) subcylindricam productae; pollen glabrum'[3]. This is translated as leaf-like plants hardly exceeding a line (a measure of length, usually 1/12 of an inch), have cells, flat upper part, bottom has kind of roots (?) subcylindrical; pollen without hair. In the subsequent years, Hegelmaier[5] made a critical description of this rare plant and paid special attention to what he called a rhizoid – the ventral, cone-shaped protrusion and stated that it functions in securing the horizontal position of this little plant.

Gupta[20], who worked on the embryology of *W. arrhiza*, which was published in one of the very first volumes of *Current Science*, started research on the development of *W. microscopica* after being inspired by Panchanan Maheshwari (1904–66). Later, detailed study of this minute plant species[19,21] with respect to its embryology[22,23] was carried out by one of the authors (late S.C.M.). One of these articles was published in 1956 in *Nature*[23]. Accidentally, in the beginning of the present century, all the clones of *W. microscopica* that existed in different clonal collections globally were lost; however, one specimen of this species fixed in alcohol is available with one of the authors (J.P.K.) in flowering condition. A major effort was thus launched by us to recollect this species. With uncompromised efforts the unique duckweed was eventually rediscovered[18,24], and soon thereafter we carried out an in-depth morphological and anatomical study of *W. microscopica* together with Karoly Boka and Aron Keresztes from Eötvös Loránd University, Budapest, Hungary[18]. The ventral protrusion was named as pseudoroot[18]. This species can also exist without a pseudoroot, as a dimorphic flat form, having only a slightly convex surface on the ventral side. Hence, the suggested role of this ventral projection in keeping the fronds afloat on the water surface needs further research[5]. However, the pseudoroot is always present in flowering fronds. So, perhaps the pseudoroot helps the frond balance itself at the time of flowering. From the study of Bog *et al*.[25] it can be inferred that *W. microscopica* occupies one of the basal branches of the phylogenetic tree of the genus *Wolffia*, and it could be speculated that the pseudoroot is a structure representing an evolutionary link between the two groups of Lemnaceae species, viz. those which bear roots and those that are devoid of roots[26].

Physiology of W. microscopica

Remarkably, this species is the fastest growing angiosperm[27,28]. The basis of its fast growth rate has been well documented[18]. Moreover, in contrast to most other duckweed species, flowering in *W.*

microscopica is frequently observed[19,29]. Already Griffith had an easy access to flowering fronds of this species in its natural habitat[11,12]. Rukmani Venkataraman and Prakash Narayan Seth, working in the laboratory of late S.C.M. at the University of Delhi, continued with the studies on photoperiodic behaviour and flowering in *W. microscopica*[27,30], followed by more extensive studies by one of the authors (J.P.K.) in the same laboratory[29,31,32].

History worth a revisit for future prospects

Considering its remarkably high growth rate and other unique features[18,28,33], *W. microscopica* has the potential to emerge as a model plant for basic research and practical applications[33], as demonstrated at the first three international meetings on duckweed research and applications[34–36], with the most recent ones held in Kerala in 2017 (ref. 37) and Rehovot, Israel in 2019. A few challenges en route would be to explore the molecular basis of their fast vegetative growth and to understand the developmental process of the specialized structures like pseudoroot that might have evolutionary significance. The reduced structural complexity in combination with high flowering frequency makes this species a potential candidate for answering some of the basic questions of angiospermic plant structure and development using advanced molecular tools. On the other hand, the high nutritional value of this plant as food source for humans[33] together with the large biomass production capacity[28] makes it a good candidate for commercial exploitation as well.

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ACKNOWLEDGEMENTS. We thank Dr Naini Burman (Department of Plant Molecular Biology, University of Delhi South Campus, New Delhi) for help in using the stereomicroscope at J.P.K.'s laboratory, and Jochen Müller (University of Jena, Germany) for help with the translation of Latin descriptions.

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Edited by S. K. Satheesh, and printed & published by G. Madhavan for Current Science Association, Bengaluru 560 080.
Typeset by WINTECS Typesetters, Bengaluru and Printed at Lotus Printers Pvt Ltd, Bengaluru (Ph: 2320 9909)