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REDISCOVERY OF A FLORAL JEWEL IN THE PHILIPPINE ARCHIPELAGO : *RAFFLESIA SCHADENBERGIANA* GÖPPERT, 1885 (RAFFLESIACEAE)

Documents annexes
Il y a 1 document annexé à cet article.

- lejeunia182.pdf (731k)

Abstract

Abstract : More than one hundred years after its discovery on Mount Párag, Mindanao, Philippines, and never observed since, Philippine biggest flower : *Rafflesia schadenbergiana* Göppert, 1885, has been rediscovered in 1994 in the mountain rain forests of Southwestern Mindanao, in South Cotabato Province. A detailed description of the mature floral bud is provided.

Keywords : Key words : Rafflesia schadenbergiana, Mindanao, Philippines., Rafflesiaceae

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INTRODUCTION

So far, 15 species of *Rafflesia* have been described (plus 4 taxa whose valid specific status remains uncertain) (Barcelona & Fernando, 2002; Fernando & Ong, 2005; Meijer, 1997).

All the extant species occur only in the primary or secondary forests of Southeast Asia : Thailand (1 sp.), Peninsular Malaysia (3 spp.), Indonesia (Greater Sunda Islands only : Borneo : 8 spp., Sumatra : 7 spp., Java : 2 spp.) and the Philippines (4 spp.); the genus does not occur in Sulawesi or New Guinea. Species are found up to 1,800 m alt., but usually occur around 1,000m or at lower altitude. Like the other members of the two genera (*Rhizanthes* and *Sapria*) of the Rafflesiacieae tribe, *Rafflesia* species are obligate parasites and grow on the *Tetrastigma* vines (Vitaceae). The spongious tissues of the stems of *Tetrastigma* species accumulate readily flow water (a property well-known and used by thirsty travelling natives) and, as Bänziger (1991) pointed out, this could explain *Rafflesia'*s « choice » to parasitize them.

Taxonomic and phylogenetic affinities within the Rafflesiaceae remain conjectural (Meijer, 1997) ; the same is true for the Rafflesiales, and, for the latter, this might reflect a polyphyletic origin of the order as recently showed by nuclear, mitochondrial and chloroplast DNA studies (Nickrent *et al.*, 2004). Molecular phylogenetic studies suggest to place *Rafflesia* amongst the Malpighiales (Barkman, Lim, Salleh & Nais, 2004; Nickrent *et al.*, 2004).

It is amongst the species of *Rafflesia* that one finds the biggest flowers of the vegetal world, with *R. arnoldii* Brown, 1821 whose flower can reach up to 1 meter in diameter and weighing up to 7 kg.

The odour of decaying flesh emitted by *Rafflesia* flowers attracts carrion-flies (Calliphoridae) that will assure pollination. Quite paradoxically, the mechanism of pollination of these giant parasitic

flowers has only been elucidated recently by BEAMAN, DECKER & BEAMAN (1988) and BÄNZIGER (1991), confirming an ancient observation of SOLMS-LAUBACH (1876) that localised the stigmatic surface on the annular band on the underside of the disk. Carrion-flies and flesh flies (*Sarcophaga* spp., Sarcophagidae) assure pollination to other members of the Rafflesiaceae (BÄNZIGER & HANSEN, 1997; BÄNZIGER & PAPE, 2004; PAPE & BÄNZIGER, 2000, 2003).

The colours of the flower (usually dark brown-reddish) and the occurrence of numerous hair-like structures (the ramentae that cover the cupula) and other small hairs on the basal part of the column might – to a fly's eyes – look like a decaying body of a mammal; a point of view equally shared by BÄNZIGER (2001) for *Rhizanthes infanticida*'s flower.

Members of the Calliphoridae exhibit a rather wide spectrum of trophic selection. Their larvae can be omnivorous, necrophagous or carnivorous; whereas imagos are found on flowers or organic material, including corpses. A similar chemical and physical mimicry observed amongst the species of, for instance, *Amorphophallus*, *Arisaema*, *Aristolochia*, *Ceropegia*, etc., is probably also aimed at attracting such pollinating insects. In a evolutionary perspective, it is not surprising that natural selection has favoured carrion-flies to assure pollination of *Rafflesia*. Carrions and feces abound in tropical rain forests and common carrion-flies are the first to appear, sometimes just within a few minutes, when the decaying organic matters are available, and their hard stench facilitate their localisation. Whatever rare and dispersed are the flowers, and wherever or whenever the *Rafflesia* flowers blossom, they will always find, through those common carrion-flies – with their fast and long distance flying capacity – pollinator agents. It would probably have been too risky for such flowers to rely, for instance, on just one highly specialised insect.

The life-cycle of *Rafflesia* takes 3 to 4.5 years. In *Rafflesia gadutensis* MEIJER, 1984, of Sumatra, the ripening of fruits extends on about 8 months. Floral phenology never exceeds, at best, one week, but seems evenly distributed throughout the year (MEIJER, 1958, 1997). *Rafflesia* species could have adopted different reproductive strategies (sexual reproduction and apomixis) (BÄNZIGER, 2004). Fruits are eaten by micromammals (tree shrews, squirrels, rats) that play an obvious role as seed dispersers as shown by the field observations and laboratory experiments of BÄNZIGER (2004) and might also have an impact in the inoculation of *Rafflesia* on *Tetrastigma* roots or stems, along with soil microfauna (BÄNZIGER, 1991; MEIJER, 1958).

The biggest flowers of the world still retain some of their secrets : for instance, what is (are) the function(s) of its ramenta ? To prevent the landing of the pollinator flies on the cupula, forcing them to go directly to their targets : anthers and stigma (JUSTESEN, 1922); or would they play a role in facilitating the evacuation of water when rain partially fills the cupula, as suggested by BEAMAN, DECKER & BEAMAN (1988); to produce heat that combined with the rotting flesh smell, will imitate a carrion (BEAMAN, DECKER & BEAMAN, 1988). The same question arise for the processes : working as « radiator fins », with the produced heat that help the dispersion of the odour (MEEUSE, 1978) or something else ? There are also questions regarding the origin of aromatic compounds : the stench odour would come from the perigone lobes (BÄNZIGER, 1991) or, perhaps, from the zone of the circular groove under the disc (BEAMAN, DECKER & BEAMAN, 1988). BÄNZIGER (1991) reports the existence of a fruity fragrance emanating from the perigone tube, in both sexes (two different odours occur also in *Rhizan-thes*, BÄNZIGER, 1995). Questions remain regarding the « window panes » of the diaphragm : their function attributed by BEAMAN, DECKER & BEAMAN (1988), is rather doubtful : they would guide flies in the flower in order to avoid bumps against the underside of the diaphragm, thus not wasting the mass of pollen that stick on their thorax . If so, natural selection should have kept such advantageous « window panes » in all species, but this is not the case. Furthermore, the authors report observations showing that pollen masses, apparently coming from collisions by flies with pollen loads, have been found in different places inside flowers, demonstrating so that these « window panes» are not effective in their attributed function.

In the Philippines, four species of *Rafflesia* occur : *R. manillana* TESCHEMACHER, 1842 (the smallest of *Rafflesia* species : 15-20cm in diam.), an endangered very localised species in Luzon, with ancient records on Samar and Leyte; the newly discovered *R. mira* FERNANDO & ONG, 2005 (45-57cm in diam.), localised in the Campostela Valley Province in Mindanao, the recently discovered *R. speciosa* BARCELONA & FERNANDO, 2002 inhabiting some stations on Panay Island (BARCELONA & FERNANDO, 2002) and *R. schadenbergiana* GÖPPERT, 1885 (up to 80cm in diam.) that was only known from the type material of Mindanao. A dichotomous key for all Philippine *Rafflesia* species is provided by FERNANDO & ONG (2005).

From December 1881 to June 1882, Dr Alexander V. SCHADENBERG (Breslau, Germany 1851 - Capiz, Panay, Philippines, 1896, buried in San Pedro cemetery, Makati, Manila), a chemist that was managing a famous pharmacy (Botica Boie) in Luzon, lived, along with his Cebu based nephew Otto KOCH, amongst the Bagobo people of Sibulan, near Davao, collecting ethnographic, zoological and botanical material. They collected on Mount Apo in February 1882 and on the nearby Mount Párag in April of the same year where *R. schadenbergiana* was observed in a cleared forest at alt. 800m.

(Bernad, n.d.; Harper, 2005; Hieronymus, 1885; Van Steenis, 1950); since that time, no other occurrence has been firmly reported. Fernando & Ong (2005) state that : « Nais (2001) recorded this species [*R. schadenbergiana*] from nearby Mt. Matutum based on relayed information on a supposed collection of a bud, but it is not known if the identity of the specimen has been confirmed ».

CONTEXT OF THE DISCOVERY

In 1990, while collecting ethnological data amongst the native groups of Southern Mindanao, in the Philippines, I was informed of the existence of a species that, according to native informants, perfectly matched the description of a *Rafflesia* flower. The species was reported to occur in some places in the surrounding primary forest. However during my numerous trips in those forests, I never had the opportunity to see such a giant flower. On October 1994, after long discussions between them, the natives decided to bring me to what they consider as their secret territory, into the heart of their ancestral domain. For security reason (see the volatile political context of Mindanao, insurgency, etc.) and other considerations, the natives, in the past, had never brought any foreigner, or any local settler there. That territory is situated deep into the interior of the remaining forested areas of Southwestern Mindanao. The topography is particularly rugged making progressions slow and uneasy. The ecosystem is made of an old primary mountain forest, dominated by Dipterocarpaceae (*Anisoptera thurifera* (Blanco) Blume, *Diptero-carpus grandiflorus* Blanco, *Shorea guiso* (Blanco) Blume, *Shorea spp., Vatica spp.*)

On the morning of the 22th October 1994, accompanied by two locals, we left our base camp, situated in a clearing (made in a former native plantation, beside the head of the Ludang stream, now covered with secondary vegetation, including *Imperata cylindrica*), on Mount Temlofung *ca*. 124°35' E – 6°15' N, in South Cotabato Province and proceeded to visit a tableland at an altitude of 1,271m, locally known as Sugud Ebang (*sugud* refers to a flat area and *ebang* to a tree with edible red fruits that occurs predominantly there). According to the natives, this tableland is accessible only through four « gateways », the perimeter of the flat area being limited with sheer slopes. Although some tall trees can be encountered, middle and short sized trees dominate the surroundings. In some places, miry pools occur and we crossed several times the Kliku brook, a tributary of the Wayeg Sugud stream that flows into the very steep valley of the upper part of the Kloung river. Numerous fresh tracks of wild boars were observed. While slowly walking through the forest, my attention was caught by a dark balloon shaped object lying on the forest floor and that I immediately identified as a bud of a *Rafflesia*. For several reasons, it was materially impossible to wait for the opening of the flower, which could mean days or weeks of waiting. I however decided to slice the bud with a sharp native machete and took three pictures (slides) of the sectioned bud, two of which are reproduced at the end of this paper. Measures of length (diameter) and height were also taken. The rediscovery of *R. schadenbergiana* has been briefly mentioned by Lays (n.d.; David *et al.*, and in Fuentes, 2005).

THE FINDING

Incontestably *Rafflesia* species are rare plants and, consequently, seldom seen. The species existing in the Philippines are no exception, with the very rare and localised *R. manillana* Teschemacher, 1842, in Luzon, *R. speciosa* Barcelona & Fernando, 2002 in Panay and the newly discovered *mira* Fernando & Ong, 2005 in Mindanao. This is only the second time that *R. schadenbergiana* is observed since first collected on Mount Párag by A. Schadenberg in 1882. Obviously, the opportunity to observe this species is extremely rare, and that is the reason why a detailed description of the discovered specimen is given hereafter, thinking that it can be useful for future research and comparison. As mentioned above, two measurements were made in the field; the following description and further measurents were obtained in analysing the three sharp slides (100 ASA slide film), using a stereomicroscope Leica MS5 equipped with a micrometric graticule, allowing detailed views and measures.

Determination of sex : in *Rafflesia*, the male flower has its well visible anthers radially disposed between the neck of the column and the disc, with, still on the column, deep vertical anther grooves, with hairy ridges, that lead to them (a « landing zone » used by the pollinators); in the female flower, such structures exist but are just vestigial; the female flower exhibits a large stigmatic surface covered with very short hairs that occur on the lower surface of the disc. A close examination of pictures reveals no anthers (nor vestigial anthers, at least where the bud was sectioned); the visible grooves are rather shallow; the lower face of the disc shows a large surface covered with extremely short and whitish hairs (papillae), that seem to fit a stigmatic structure. In the section of the column occur what seem to be numerous ovules, and apparently a pollen tube transmission tissue. From the available data, one can infer that we are in presence of a female flower. So the following description is made from a halved female mature bud.

Mature bud : sessile, 27cm in diameter, height : 22cm; orange, with small very slightly darker dots

evenly distributed on the surface. Bracts (= scales) : 3 whorls, dark brown whose irregular (somewhat lobed) upper border reach the upper part of the base of the diaphragm with well marked veins.

Flower : length of perigone lobes are estimated – through direct measures as used here – to be 18 to 20cm + 27cm (bud diameter), so flower's size must reach between 63 and 67cm in diameter, and *ca*. 15cm high. Another way to assess flower's size would consist in comparing the mean ratio between the mature bud dimension and the size of the flower of the other species (from the data, for 9 species, provided by MEIJER, 1997). Except for one species, *R. schadenbergiana*, where the flower has 4 to 5 times the size of the bud, for the other species the mean of the ratio varies between 2.13 to 2.73 times. So, an expected size of the flower could be between 57 to 74cm. If one takes account of the ratio observed in *R. schadenbergiana*, then one will reach the exceptional size of 108 and even up to 135 cm. Naturally, those dimensions are purely tentative but may provide some ideas on the size of the flower.

Perigone : 5 lobes, imbricate, length : 18-20cm; breadth : not estimated. About 1cm thick at base. Lower face russet, smooth, like if wax covered; upper side light rusty brown, with very light orange/salmon pink warts. *Warts* : several shapes occur, but usually more or less circular or oblong, up to 1.5cm in diameter; they cover more space than the light rusty brown-coloured background. It is not known if the warts are disposed in row or not, but a close examination of the unfolded perigone lobes section shows an alternation of 5-6 (perhaps up to 9) rounded and flat segments, which might indicate the occurrence of a concentric distribution of warts. As seen on the photographs, the warts appear as turgescent structures (pustules). Each wart is made of a set of smaller circular (tubular ?) structures (: 0.7mm) bound together. Most of the warts, if not all, are well separated from each other, neither merged nor slightly interconnected.

Diaphragm : 24cm diameter, 12mm thick at the base and 2mm at the rim. Upper face : no data, but probably light rusty brown and with *ca*. 4 concentric rings of warts. Lower face : dark rusty brown, densely covered with ramenta; the rim entire, whitish, 2mm thick; aperture of diaphragm (= orifice; = window) 14cm in diameter.

Disc : 16cm in diameter, 15mm thick, dome-shaped, reddish-orange, rim of disk very neatly raised (*ca*. 45°) on 1.7cm, very finely crenulate, with, apparently, very minute whitish hairs on its crest; from the ringlike fissure under the disk (*sulcus coronalis infra discum*) to coronal ring of disk : 2.6cm; neck of column : 10cm; *annulus interior* : 14cm ; *annulus exterior* : apparently lacking. From the cupula base to the tip of the disk : 10cm. Lower face of the disk (stigmatic surface) covered with extremely short and whitish hairs (papillae); that face, whitish except for the rim, which is reddish-orange on 2-3mm. Upper face smooth, with small depressions here and there. Occurrence of brownish, very thin hairs from the *annulus interior* up to the sulcus and with a decreasing density from the base to the top. *Processes* : all reddish-orange. Two distinct shapes occur : the first kind consists of the outermost processes, forming a ring of blade-shaped processes, with a large elliptic base 1.5-2cm long, some millimetres thick, 2.5-2.8cm high and rounded at the tip; they must number *ca*. 30. The second kind is made of higher : 3-3.5cm but narrower (at the base) : 0.8-1cm processes, long cone-shaped with a rounded tip; this apical part very lightly darker than the rest of the process and seeming somewhat translucent, tip with, apparently, extremely minute whitish hairs. Although it is more difficult to assess, it could be possible that those processes exhibit a concentric distribution, then possibly forming 3 to 4 rings. The number of this second kind of processes is estimated at *ca*. 32. Only one process of the blade-shaped kind was found on the « 2nd ring » of processes, mixed amongst the long cone-shaped ones.

Ramenta : ramenta occur inside the cupula and on the inner side of the diaphragm. Their density is high from the base of the cupula up to the base of diaphragm, from there and up to the rim of the diaphragm, their density decreases; a 1.5-2cm zone just before the rim of the diaphragm is free of ramenta. Basically, the ramenta can be divided into two kinds : a first kind made long, straight and slender : 1mm width at base (prob. circular), 7-9mm high, usually simple, some being forked, the apical part being just very slightly thickened. This kind of ramenta entirely covers the cupula from its base, close to the *annulus interior*, up to the base of the diaphragm (Fig. 1a & 1b). The second kind is shorter, thicker and branched (with usually bifid tips) : basal part : 1.5-2mm large, 6mm high, apparently flattened apices : 4-5mm wide. They occur all over the lower face of the diaphragm, from its base almost up to its rim; those situated close to the rim are stouter, less developed and less dense. Here too, apices are very slightly thickened (Fig. 1c & 1d).

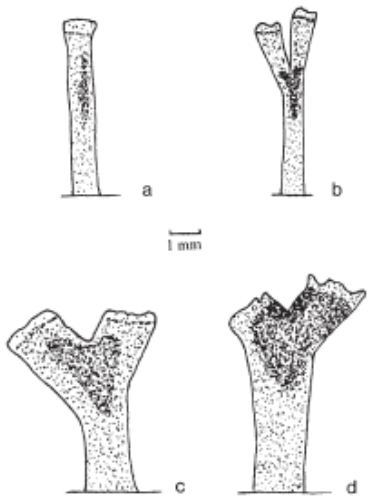

Fig. 1. – *Rafflesia schadenbergiana*
Remenia, forms a and b covering the cupula; forms c and d covering the diaphragm.

Even if an opened flower has not been observed, from the analyse of the photographic material, the specimen undoubtedly fits the description of *Rafflesia schadenbergiana*. Some differences exist regarding some parts of the discovered specimen and the descriptions available in the literature (MEIJER, 1997; SOLMS-LAUBACH, 1891) but I consider them as normal indi-vidual variation within the specific limits of this taxon.

Distribution : Philippines, Mindanao (Southwestern), South Cotabato Province (*ca*. 124°35' E – 6°15' N).

Habitat : in old primary mountain forest; altitude : 1,271 m (measure obtain-ned from a gauged Thommen electronic altimeter)

Ecology : native informants reported that the species blossoms just during a few days. The mature bud was found on the ground, fixed on the stem of a supposed *Tetrastigma* species (Vitaceae). No other bud was observed on that site. The specimen was left where found, with the stem untouched, leaving the opportunity for other flowers to grow again here.

As previously mentioned in the introduction, mammals seem to play a role in the dispersal of seeds and in the process of inoculation. The forests of Southern Mindanao, where *R . schadenbergiana* has been found in 1994 are inhabited by several species of mammals. Some of those that I have observed are : *Cervus marianus* DESMARET, 1822, *Cynocephalus volans* L., 1758, *Exilisciurus concinnus* THOMAS, 1888, *Macaca fascicularis* L., 1758, *Paradoxurus hermaphroditus* PALLAS, 1777, *Sciurus philippinensis* WATERHOUSE, 1839, *Sus barbatus* MÜLLER, 1838, *Tarsius syrichta* L., 1758, *Urogale everetti* THOMAS, 1892, *Viverra tangalunga* GRAY, 1832.

Floral phenology : although exact data are still lacking, the observed mature bud was seen in October, the month that ends the "wet season", although this part of Mindanao is classified amongst the regions without very pronounced seasonal characteristics. From the other species, one knows that anthesis is evenly distributed throughout the year (MEIJER, 1958, 1997).

Native name and use : *bowa*; the natives describe the plant as possessing irritating properties. People may hang one process in their home when they are absent: this is supposed to provoke irritations to potential thieves. The author has never seen the practice, which must be as rare as the plant itself. One may note that in Thailand, the buds of *R. kerii* MEIJER are used by the Thais for medicinal and religious purposes according to BÄNZIGER (1991)).

Considering the rarity of the plant, only vague data are voluntarily provided about the localisation of the site : what is at stake here is the very basic survival of one the biggest flowers in the world (see the considerations of BÄNZIGER (1991 : 51-52) regarding the problematic of the conservation of rare and potentially attractive plants like *Rafflesia*).

As BARCELONA & FERNANDO (2002) recently pointed out, it is surprising that the Philippine *Rafflesia* are not included in the IUCN Red List of Threatened Species. However, *Rafflesia* species are protected in the Philippines (FERNANDO & ONG, 2005). And this should equally be applied to all

Rafflesia species, worldwide. It would also imply the protection of their hosts (*Tetrastigma* spp.) and, above all, the ecosystems where they live.

Some sources of threats have been identified for the *Rafflesia* : habitat destruction (logging, shifting cultivation); cutting of its hosts; medicinal and religious purposes (in Thailand), perturbations from intense visits (tourists, etc.) (Bänziger, 1991; Beaman, Decker & Beaman, 1988); to that one has also to add their rarity owing to, as Bänziger (2004) pointed out, a fragile parasitic life cycle, low reproductive capacity and very high natural bud mortality. Recently, the Swiss scholar Dr Hans Bänziger (2004) has elaborated a very effective method of manual pollination of Rafflesiaceae, allowing a 78 % fruiting rate *vs*. a 8-12% in natural conditions (as observed in *Sapria himalaya*); this method could very advantageously contribute to preserve those rare flowers.

For this site, no present threat is known. The only source of threat that could appear in the future is the slash and burn cultivation, that is still practised in those mountainous regions (although officially prohibited). Otherwise, this site and the surrounding region are situated within a territory diversely protected : 1 - naturally, in a very remote place, hardly accessible and in a rugged topography; 2 - humanly, through the natives, civilians as well as by the CAFGU (paramilitary units); and outside the area are also roaming nomadic bands of Muslim rebels; 3 - legally, through several Presidential Proclamations and Decrees.

That Mindanao possesses its own *Rafflesia* species can be explain-ned : the geological history of the Philippine Archipelago is particularly complex and the general outlines of its more than 7,000 islands and islets have not always been what they are at present. Land connections between the islands of this archipelago and neighbouring islands appeared and disappeared through time (Miocene, Pliocene and Pleistocene). Mindanao, for instance, results from the « fusion » of several smaller islands. The archipelagic conditions that always prevailed in that region favoured isolation from Oriental and Austro-Papuan Regions, a factor that generated a high rate of endemism. Consequently and owing to those geological and paleogeographical events, six centres of endemism aroused within the Philippine Islands, one of them being Greater Mindanao. From a biogeographic point of view, Mindanao is divided into three zones : a first one, very large that comprises Northern, Central and Eastern Mindanao, along with some parts of the South; a second zone made of the Zamboanga Peninsula and Basilan; and a third one, named the Liguasan zone, that includes Southwestern Mindanao (Dickerson, 1928; Heaney *et al.*, 1998; Lays, 2000).

Is this discovery surprising ? Both, yes and no. Yes, if one considers that such a huge flower has, during more than a century, escaped from the attention of botanists or naturalists. Yes, if one realises that the finding occurs in a country where the old growth rain forests have been very largely sacrificed on the altar of « progress » and « development », reducing their size to only a few percents of their original cover (Klummer, 1992), considerably reducing the chance to observe *Rafflesia*. No if we take into account the very short floral phenology of *Rafflesia*, just a few days, making them difficult to meet. No also if, placed from a global point of view, one observes that among the 15 valid species so far known, 8 of them have been discovered and/or described during the last three decades. The last discovered new species having being described from the Philippines last year.

CONCLUDING REMARK

More than one hundred years after its discovery on Mount Párag, near Mount Apo, on Mindanao island, and never observed again since 1882, *Rafflesia schadenbergiana* Göppert, 1885, has been rediscovered in 1994 in the montane rain forests of Southwestern Mindanao, in South Cotabato Province.

The unexpected rediscovery of Philippines' biggest flower in the montains of Mindanao illustrates that the few remaining old forests still harbour some natural wonders and calls for their absolute protection.

This article is dedicated to the memory of Professor Ernst Mayr (Harvard University) who recently passed away at the very respectable age of 100. Prof. Mayr wrote, in 1946, the first authoritative book on Philippine avifauna (with J. Delacour), but he is mainly known for being amongst the founding fathers of the « evolutionary synthesis » (along with Th. Dobzansky, J. Huxley, B. Rensch, G.L. Stebbins and G.G. Simpson). Thanks to his extensive research conducted over eight decades, as well as those of others – Science remains a collegial odyssey – evolution, from a theory has become a fact. Prof. Mayr's work is immense and extends far beyond evolutionary biology; an outstanding work that certainly deserves an outstanding flower.

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