TUTICORIN RAGHAVACHARI GOVINDACHARI

(30 July 1915 – 28 December 2001)

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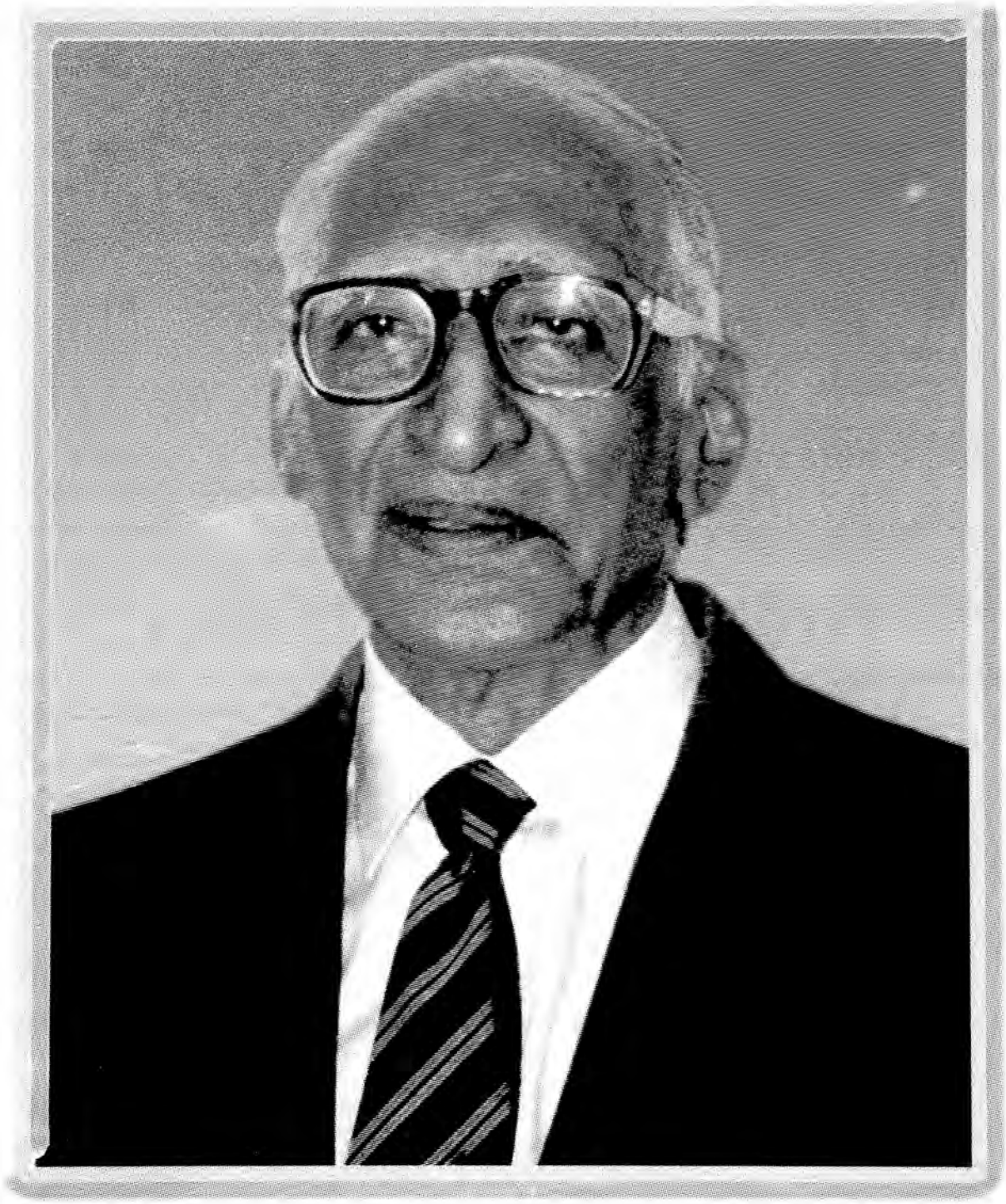


T. R. Govindarajan

TUTICORIN RAGHAVACHARI GOVINDACHARI

(1915-2001)

Elected Fellow 1959

TUTICORIN RAGHAVACHARI GOVINDACHARI, widely known as TRG in scientific circles, was an internationally known Natural Products Chemist who had devoted his entire professional life to this pursuit. Apart from his profound scientific contributions to the investigation of Indian flora, he established several institutions of basic research. He was greatly loved and admired for his personal traits like deep erudition enriched by simplicity and gentleness.

BIRTH, EARLY LIFE AND EDUCATION

TRG was born on July 30, 1915 at Irulappa Street, George Town, Madras (now known as Chennai). His parents were TG Raghavachari and Rajalakshmi, orthodox but forward looking Aiyangars. The former was a lawyer by profession but had many interests and talents, most of which were inherited by TRG who also was heir to his mother's great love of gardening.

TRG whose pet name in the family circle was Patta started his schooling at the Hindu Theological School in GeorgeTown, Madras and later studied in Pachiappa School. His college education was at the Loyola College (1930-1932, Intermediate) and then Presidency College (1932-1934, B.Sc. Chemistry). He was awarded the Wilson Medal in Chemistry for 1934. In keeping with his conservative background, he wore a tuft up to his college days.

TRG was a bright student and a voracious reader who would cry even if he came second in class! Playing cricket and *gilli-danda* and flying kites with his friends were his childhood pastimes. During the summer holidays the family used to visit Polipakkam, the ancestral village where TRG learnt swimming with the local boys. In his twenties the family shifted from George Town to T Nagar, another part of Madras where he lived for the rest of his life but for a twelve-year stint in Bombay. As a child he loved *jelabis* which he used to buy with the daily allowance of four annas (twenty five paise, its current value may be twenty rupees!) which his mother gave him. A vegetarian all along, his eating habits were very catholic except for his great aversion for onions and garlic (somewhat inexplicable considering his passion for Natural Products Chemistry and the documented medicinal properties of garlic— *Allium sativum*!)

TRAINING IN RESEARCH – DOCTORAL AND POST-DOCTORAL WORK

After completing his B.Sc., TRG joined Professor BB Dey, Head of the Chemistry Department, Presidency College (and later Principal) for his M.Sc degree by research. This covered investigations in the isoquinoline series (a class of compounds which form an important core of a large number of alkaloids in nature) and was completed in 1937. Thereafter TRG continued to work with Professor Dey for his Ph D degree as a research assistant in CSIR (Council of Scientific and Industrial Research) scheme for the production of dye and drug intermediates from cheap and readily available raw materials by electrochemical methods. This project was carried out during World War II as an import substitution measure. The laboratory which housed the equipment was active for quite some years and was the place for training of Dr HVK Udupa, who would become Director, Central Electrochemical Research Institute, Karaikudi, Dr R K Maller who specialized later in metabolic chemistry and Dr B R Pai who became a staunch ally of TRG in his scientific pursuits. After getting the Ph D degree for his work on isoquinolines and contributions to electrochemistry, he left for USA in 1946 by sea, as one of the first batch of Government of Madras scholars after the War. After some adventures, he ended up in the laboratories of Professor Roger Adams of the Department of Chemistry, University of Illinois, in Urbana. The redoubtable Professor was at the peak of his career then and had a unique status in Organic Chemistry. He wielded considerable influence in government circles also. TRG was assigned the task of unveiling the structures of the Senecio alkaloids having a pyrrolizidine ring system. By dint of his singular dexterity, untiring perseverance and deep insight, traits which took him to great heights in later years, TRG made seminal contributions to the problems assigned to him which endeared him to Professor Adams. 'Govinda' as he came to be called affectionately by the Professor left an enviable record in the department. Adams was also editing two important series of monographs at that time, '*Organic Synthesis*' and '*Organic Reactions*' which had become standard reference works for researchers. TRG along with WB Whalley contributed two chapters in Volume VI of Organic Reactions, one on the Bischler – Napie ralski Reaction and the other on the Pictet-Spengler Reaction, both employed in the synthesis of isoquinolines, an area in which TRG had already considerable proficiency and which continued to be dear to him for the rest of his life.

PROFESSIONAL CAREER

Presidency College, Madras

After three years of postdoctoral work with Roger Adams, TRG returned to India in 1949. The Government of Madras had appointed a committee headed by Sir C V Raman to recommend measures to strengthen selected departments of the

Presidency College. The committee had identified the Chemistry Department as one of them for special assistance in terms of new positions and increased financial support. TRG was recruited under this scheme and he rejoined his alma mater as Additional Professor of Chemistry in January 1950. He became Chief Professor in 1952 and Principal of the College in 1961. During these years, TRG painstakingly built up an active group of research scholars. (The author who had his first exposure to him in 1949-1950 during his inter-collegiate lectures in mechanistic Organic Chemistry delivered to the final year Chemistry Honours students of Presidency and Loyola Colleges, was one of the first batch who joined him in July 1950 for research for the Ph D degree, along with N Arumugam, MV Lakshmikantham, NS Narasimhan and BS Thyagarajan; some of the later students were S Rajappa, N Viswanathan and PC Parthasarathy). With the help of talented scholars who flocked to him for guidance, TRG carried out pioneering work in Natural Products Chemistry, particularly on Indian medicinal plants. The work resulted in 25 students getting the Ph D degree and covered the isolation and structural elucidation of several novel types of alkaloids, terpenes and oxygen heterocycles. Alongside, synthesis of the prototype structures and in many cases, the naturally occurring molecules was also accomplished. The chemistry laboratories of Presidency College where this work was carried out were relatively spacious and had already seen steady research activities in earlier years first from Simonsen (of terpenoid fame) and then, Dey. There was no dearth of research chemicals (next to the author's laboratory, there were cupboards letting out assorted smells of a large number of Kodak chemicals collected by TRG). 'Quick Fit' glassware, a novelty and luxury at that time consisting of various items with ground glass joints was a treasured item which TRG distributed judiciously and with accountability. However sophisticated spectroscopic equipment which is given in leading Indian laboratories now (students of this era requisition HRMS and high field NMR spectra rather than determine melting points!) was nonexistent but for a manually operated Beckman DU spectrophotometer (a push model). TRG tended it with loving care and when it fell sick occasionally, he would take it to the nearest clinic, which happened to be CLRI and restore it to normal health. An IR instrument was a treasured addition around 1958-1959. Most of the research work was done by hard labour, employing classical degradation reactions like Hofmann elimination, permanganate oxidation and selenium dehydrogenation. Oxygen and nitrogen bound methyl groups were estimated by the Zeisel method employing hydriodic acid in contrast to the gentler and noninvasive use of NMR now-a-days. For many years, the students carried out the estimation of nitrogen by semimicro analysis themselves, although Weiler and Strauss of Oxford was patronized later for all elemental microanalyses until a full-fledged facility was established in the department for which S Selvavinayakam, though recruited for a lecturer's vacancy, was trained. During these and subsequent years, TRG collaborated with X-ray crystallographers like S Ramaseshan. The appointment of S Swaminathan to a chair in the Madras University Organic

Chemistry Department provided opportunities for lively interaction of the two active groups and created a stimulating scientific atmosphere. TRG also had very warm associations with T S Sadasivan, GN Ramachandran and PS Sarma, all eminent Professors of the Madras University. BGL Swamy, Professor of Botany at Presidency College, who was also a painter and poet of considerable talent was a close friend who helped TRG in his plant collections.

The series of original publications of TRG on novel structures in Natural Products Chemistry attracted international attention and served to establish his reputation as a leader in this field and the Chemistry Department of Presidency College as a premier centre for such research. He also came to be respected as a persuasive teacher of modern Organic Chemistry. During all these momentous years, BR Pai for whom TRG had been the unofficial Ph D guide, was a pillar of support in smoothening administrative hassles and ensuring unhampered research activities.

CIBA Research Centre, Bombay

Around 1961-62, TRG's reputation as an outstanding chemist brought him to the attention of Dr A Wettstein, International Research Director of CIBA, headquartered in Basel, Switzerland and an established researcher in steroids. CIBA was planning to implement the vision of Dr Kappeli, its chairman, to have a basic research centre in India and had identified Goregaon, a suburb of Bombay for its location. They were looking for an eminent scientist in the right age group to head it. CIBA accepted Wettstein's recommendation that TRG would be the right choice to lead the new centre. TRG had by that time become the Principal of Presidency College. While he was administering it very ably, he was perhaps beginning to feel hamstrung by such activities in his scientific pursuits and chose to accept the new assignment which offered challenges in the area of new drug development. This was a major objective of the proposed centre wherein natural products could play a significant role. The development of new synthetic dyes was another objective of the research centre. One can well imagine the trepidation that TRG might have had in making this momentous change. Subsequent events proved this to be unfounded since the directorship turned out to be rewarding all round.

CIBA Research Centre started functioning from January 1963 but was formally inaugurated by Jawaharlal Nehru in March that year. It was set in a sylvan campus of 80 acres of undulating land and had modern laboratories, remarkable instrumentation facilities, abundant funds and comfortable residential quarters for senior and other essential staff. Under the unobtrusive but inspiring leadership of TRG, the Centre attracted the best young scientists of the country. The division for new drug development was organized along the required multidisciplinary lines and was staffed by eight senior chemists, five in synthesis and three in natural

products. Evaluation of compounds and plant extracts was carried out by a team of biologists with expertise in areas ranging from pharmacology to microbiology. As and when new chemical entities of interest developed, they were studied in depth by scientists proficient in metabolism and then toxicity ranging from acute to chronic ascertained by a group of toxicologists having access to animals bred and/or maintained under standard conditions in a full-fledged animal house. The research group also was comprised of clinical investigators who pursued selected compounds in humans through Phase I (tolerability, safety) to dose searching (Phase II) to Phase III (efficacy trials). The Dyestuffs Chemistry division had three synthetic chemists, two for physico-chemical studies and one for studying applicability of newly synthesized dyes to fibres. All activities were supported by appropriate sophisticated electronic instrumentation which was continuously augmented and modernized and expertly maintained by S Selvavinayakam. The spectroscopic and analytical facilities were freely and generously extended by TRG to research scholars of many universities and institutions of the country. This is mentioned with respect and gratitude even today in scientific circles.

During TRG's stewardship from 1963 till retirement in1975, CIBA Research Centre became Hindustan CIBA Research Centre due to a general fiat of the Indian Government and around 1973, Hindustan CIBA-Geigy Research Centre due to the merger of the two Basel behemoths and finally CIBA-Geigy Research Centre and acquired international repute for its research output of high standard and TRG's personal reputation also grew. These factors, coupled wih the excellent hospitality provided by the guest house of the Centre located strategically on top of a hillock, served to attract a stream of famous scientists to stay on the campus and edify the scientists with their seminars. This became so accepted that on occasions, agencies like INSA would include a stay at CIBA Research Centre automatically in the itinerary of visiting scientists on exchange programmes, sending a copy to the Centre for confirmation as an afterthought!

By the time of TRG's retirement, the Centre had more than 600 publications, about 200 of which were from the Natural Products group with which he had a special affinity. In spite of the heavy demands on his time as the Director, TRG pursued his interest in phytochemistry, showing up unfailingly in mornings and afternoons for discussions with his coworkers. The dedication translated into about 140 publications with his authorship, a number that slightly exceeded his output from Presidency College as a student and later as a professor. A newer dimension added to the natural products work at CIBA was that crude and purified plant extracts and compounds isolated from them were examined extensively in the biological screens which were available, particularly in those that had a bearing to the medical claims of the respective plants. The period 1955-1975 can be considered to be the golden era of Natural Products Chemistry in India and TRG made a significant contribution to it. Additionally 20 new chemical entities out of over 10000

synthetic samples submitted for biological evaluation were taken through preclinical and clinical investigations.

Post-retirement Period–Amrutanjan Research Centre, SPIC Centre for Agrochemical Research

After his retirement from CIBA Research Centre in June 1975, TRG moved back to Madras accepting an invitation from the Central Leather Research Institute to be their consultant for a period of two years. Then he took up the sizeable task of founding a decent R&D facility for the Madras-based pharmaceutical company, Amrutanjan (1977-1986). He collected a small team of scientists and pursued his work on natural products in addition to process development of drugs. The Centre worked out a viable process for the isolation of vinblastine from *Catharanthus roseus (Vinca rosea,* Apocynaceae). Also initiated was a major sustained programme for the investigation of the constituents of the neem tree *(Azadirachta indica).* Some work had been done earlier in his group by NS Narasimhan in Presidency College around 1957, centering mainly on the isolation and structure elucidation of nimbin. But in the following years, neem had come to be looked upon as an important tree because of the isolation of the well-known and potent insect antifeedant, azadirachtin A and several analogues.

The work was carried over by TRG to the Centre for Agrochemical Research which he set up as his last successful effort in institution building. The Centre was part of the SPIC Foundation created (almost specially for him) by the fertilizer giant in Madras, Southern Petrochemical Corporation. The Centre was modest in size but very well equipped and staffed by enthusiastic and experienced organic chemists and entomologists. TRG guided and directed this group from 1987 till well towards the end of 2000 until he was physically incapacitated. At this Centre TRG carried out systematic and painstaking investigations on the neem constitutents which resulted in the isolation and structural assignment of several new members of the azadirachtin family. Additionally TRG's group at this Centre was involved in an intense, bioactivity assisted study of many other Indian plants with potential insecticidal and antifungal activities.

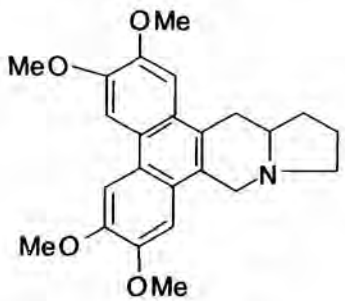
Scientific Contributions

TRG's research career, spanning a period of more than six decades was highly fruitful as evidenced by his publications numbering about 340, mostly in the field of Natural Products Chemistry which he pursued with single-minded devotion and tenacity, unmindful of changing fads and fashions in research trends. His work covered the isolation and structure elucidation of a broad spectrum of natural products like alkaloids, terpenoids, oxygen heterocycles and other classes. He also contributed significantly to the synthesis of heterocycles like isoquinolines,

phenathridines, benzophenanthridines, pridophenanthridines (aporphines) and dibenzoquinolizines (protoberberines), terpenes, flavones, furocoumarins – often related to the structures he had elucidated and occasionally representing total synthesis. Among Natural Product chemists, he can be considered as one belonging to a select, small group who had handled an amazing variety of structures, ushering in many a time a new prototype, without inviting the criticism of spreading himself too thin. It will be difficult to do full justice to his contributions in this article and the reader is invited to consult the bibliography to enlighten himself on this subject. Some of the highlights are summarized below to give a flavour.

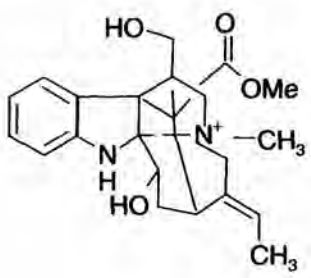
Alkaloids

Tylophora asthmatica, belonging to the Asclepiadaceae family and reputed to have antiasthmatic activity, yielded several novel phenanthraindolizidine alkaloids, the first example being tylophorine **1**. The structure of **1** was elucidated by classical degradation and total synthesis eventually.



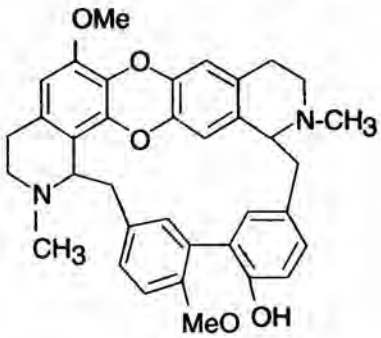
1

Echitamine **2** was obtained from the bark of *Alstonia scholaris* (Apocynaceae) and its structural elements were identified by spectroscopic and chemical methods. The complex edifice was unveiled by X-ray crystallography in association with S Ramaseshan.



2

Investigation of *Tiliacora racemosa* (Menispermaceae) afforded a novel dimeric bis-benzylisoquinoline alkaloid, tiliacorine **3** with a diphenyl link and a dibenzodioxane scaffold.

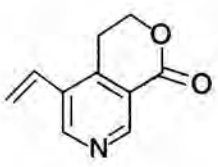


3

The alkaloid, kopsine which had been reported to be present in *Kopsia fruticosa* (Apocynaceae) was jointly studied by TRG and H. Schmid in Zurich and shown to have the unique heptacyclic structure **4**, representing probably the terminus of biogenetic transformation of aspidospermine found in this genus. *Kopsia fruticosa* was also shown to be a cornucopia of alkaloids like fruticosine, fruticosamine etc., some of which represent subtle biogenetic transformations.

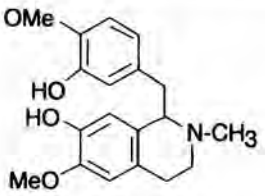
4

Gentianine **5**, reported earlier to be present in *Gentiana kirlowi*, was obtained from *Enicostemma littorale* (Gentianaceae) and shown to have a delta lactone structure rather than the gamma one given earlier. The assignment was further substantiated by synthesis. **5** is closely related to swertaimarin, the bitter principle of *Swertia japonica* (Gentianaceae) which has immense biogenetic significance, eg elaboration of D,E rings of Yohimba alkaloids. There has been some doubt that gentianine is an artefact of extraction and has no natural occurrence but evidence has been adduced in favour of the latter.



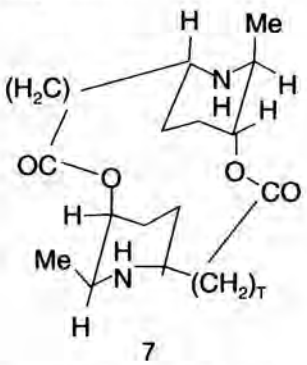
5

Anona reticulata (Anonaceae) was found to have the alkaloid, reticuline **6**, with a diphenolic 1-benzyltetrahydroisoquinoline moiety. The enormous importance of **6** as the biogenetic precursor of many aporphine and morphine-type alkaloids was subsequently established.



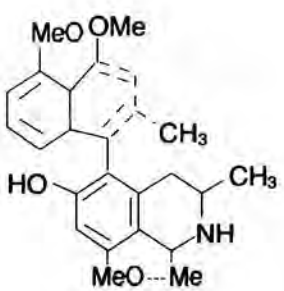
6

A reinvestigation of the structure of carpaine, an alkaloid of *Carica papaya* (Caricaceae) by TRG and another research group established that it had a piperidine ring with a macrocyclic lactone connecting positions 2 and 5. A minor alkaloid, pseud arpaine was shown to be an epimer at the hydroxyl centre. Later carpaine was found to be a dimeric dilactone. Subsequently TRG's work demonstrated that pseudocarpaine was also dimeric and its structure deduced as **7** by application of high filed proton NMR spectroscopy. Interestingly the two methyl groups on the two halves of pseudocarpaine had different conformations. The dimeric structure of carpaine fascinated TRG till the end, with the possibility of formation of host-guest complexes. A posthumous publication with SS Rajan has reported single crystal structure of a quaternary salt of carpaine.



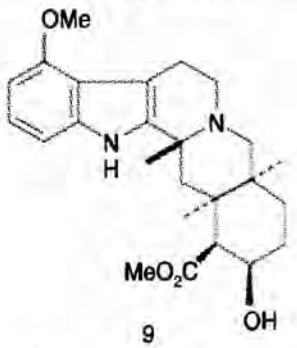
7

Unlike the classical isoquinoline alkaloids derived biogenetically from phenylalanine, ancistrocladine **8**, isolated by TRG from *Ancistrocladus heyneanus* (Ancistrocladaceae), turned out to be a naphthylisoquinoline with a unique **polyketide origin.** The absolute stereochemistry was deduced in collaboration with K Nakanishi applying the 'exciton chirality' technique. A few other naphthylisoquinolines were isolated from the plant. The potent anti HIV activity found later for dimeric naphthylisoquinoline alkaloids added considerable significance to this chemistry.



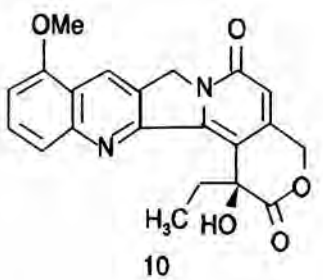
8

Chemical examination of *Alstonia venenata* (Apocynaceae) yielded a new alkaloid, venenatine **9** belonging to the yohimbine group. Of crucial relevance to structure assignment was the isolation of a methoxy-beta-carboline by selenium dehydrogenation which could have been a 5- or 8-methoxy derivative. Synthesis of both derivatives and identity with the 5-methoxy isomer clinched the issue. An interesting side was that the crude alkaloidal extract showed significant hypotensive activity which upon persistent activity directed followup, proved to emanate from reserpine, a minor component of the plant and not venenatine, which was the disappointing source of the biological property.



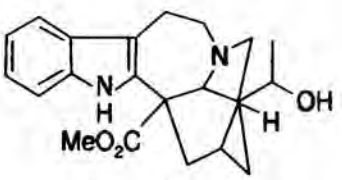
9

Extraction of the heartwood of *Nothapodytes nimmoniana* (*Mappea foetida*, Icacinaceae) afforded an unbelievably generous yield of camptothecin which was then a hot lead for antitumour activity with a novel mechanism of action of DNA topoisomerase inhibition. The alkaloid had been initially obtained in miniscule amounts from the Chinese tree, *Camptotheca accuminata* and frantic scientists were chasing milligrams. The work additionally led to the isolation and structure assignment of the 9-methoxy derivative **10.**



10

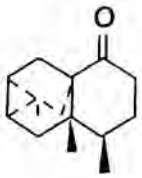
Heyneanine **11** isolated from *Tabernaemontana heyneana* (Apocynaceae) was another interesting alkaloid having the skeleton of ibogamine to which it was related by simple chemical transformations.



11

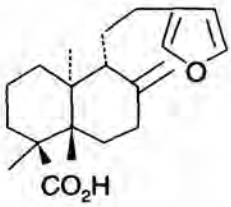
Terpenes

From the essential oils of *Aristolochia indica* (Aristolochiaceae), ishwarone **12**, a novel, complex heptacyclic sesquiterpene ketone was isolated and the structure elucidated by chemical degradation coupled with detailed 1 H NMR studies. The absolute stereochemistry was also determined. A few other related molecules were also obtained from the plant.



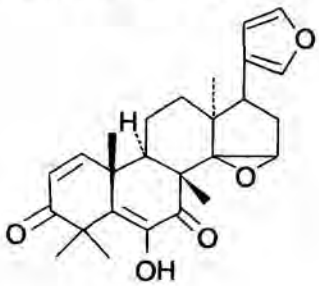
12

Polyalthic acid **13,** a new diterpene acid with a pendant furan ring was found in *Polyalthia longifolia* (Annonaceae) and its structure assigned by spectroscopy and degradation.



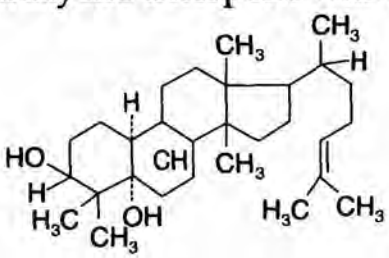
13

The structure of cedrelone, a modified limonoid from *Cedrela toona* Roxb. was established as **14** in collaboration with D Arigoni in record time.



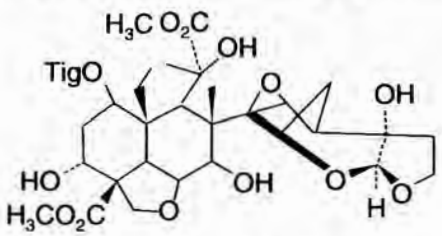
14

Litsomentol **15**, a new tetracyclic triterpene was isolated from *Litsea tomentosa.*



15

Major investigations were carried out by TRG on the constituents of *Azadirachta indica* (neem) which has become justly famous for one of its constituents, azadirachtin A **16** with remarkable antifeedant activity. The work which was initiated in the 1980s by TRG and extended right up to his terminal illness, resulted in the isolation of several congeners and in about 20 publications. The climax of this monumental effort was the production of crystals of **16** and structure determination by X-ray. The author had the privilege of witnessing the childlike enthusiasm which TRG evinced when he displayed the crystals with satisfaction and sense of fulfillment although he was close to 80 at that time! The azadirachtin saga was remarkable for the extensive use of HPLC for elaboration of separation methods, incisive use of high field NMR spectroscopy and sustained collaboration with entomologists on one hand and X-ray crystallographers on the other.

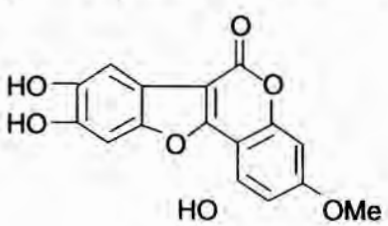


(Tig = tigloyl)

16

Oxygen Heterocycles

TRG's investigation of Indian plants led to the isolation of several flavones, isoflavones and coumarins. Wedelolactone **17** from *Wedelia calendulaceae*, a medicinal plant grown routinely in many backyards of south Indian homes and used



17

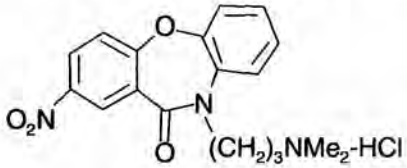
in folklore as well as in modern clinical practice for the treatment of jaundice, can be easily considered as one of the most novel structures in this field with its benzofuranocoumarin framework. The structure of **17** rested on degradative studies and synthesis of its tri-O-methyl derivative. It was also isolated from a related plant, *Eclipta alba* which additionally elaborates the desmethyl congener, norwedelolactone. In later years, phenolic oxidative coupling, a widely occurring biogenetic phenomenon, was elegantly marshalled by Wanzlick (Ber., 1963, 96, 305-307) for a slick synthesis of **17**. The work by Wagner in Germany on wedelolactone gave experimental support to its hepatoprotective properties. A somewhat unpleasant

incident associated with wedelolactone may be noted here. Coumestrol, a didesmethy analogue had been reported one year earlier from USA in the plant alfalfa (*Medicago sativa*, Leguminoceae), but its structural assignment occurred **after** the work on wedelolactone was published and its degradation pathway utilized. However its prior isolation bestowed on it the honour of the name, coumestane being allotted to the bezofurobenzopyran scaffold deduced for wedelolactone. Insult was added to injury by coumestrol finding an entry into the Merck Index but not wedelolactone!

TRG's work in Natural Product Chemistry brought him many national and international invitations to write authoritative reviews and monographs, his articles for Manske's The Alkaloids being but one example.

Medicinal Chemistry

It was noted earlier that basic research for development of new drugs at CIBA Research Centre resulted in 20 compounds being taken to the clinic. Five of these were eventually registered in India – an antidepressant, a major tranquilizer, a nasal decongestant, an anthelminthic and an antiprotozoal. The first one, nitroxazepine **18,** was introduced by CIBA with the brand name, Sintamil. The last one, satranidazole **19** is now available in the country as Satrogyl.



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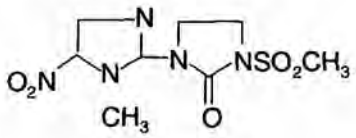

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Memberships, Awards, National and International Honours and Extra Curricular Activities

TRG's research career, which spanned a period of about six decades, was remarkably productive as evidenced by his publications of over 340 in the field of natural products and synthesis. National recognition for his achievements was bestowed upon him in the form of many awards and honours – Shanti Swarup Bhatnagar Prize for Chemical Sciences, 1960; Indian National Science Academy's awards, Meghnad Saha Medal, 1975, Golden Jubilee Commemoration Medal, 2000; Professor K Venkataraman Endowment Lecturership of Bombay University for 1965-1966, Sir S Subramania Iyer Lecturership in Physical Sciences of the Madras University for 1969-1970; Dr Mahendra Sircar Memorial Lecturership, 1970; HK Sen Memorial Lecturership, 1970; PC Ray Award, Lifetime Achievement Award of Chemical

Research Society of India, 2000. He was the President of the Indian Chemical Society for 1971-1972.

International recognition for his contributions came to him through an invitation to give a plenary lecture in the first ever meeting of the Natural Products Section of the International Union of Pure and Applied Chemistry (IUPAC) held in Australia in 1960. Later in 1963 he was elected a member of the IUPAC Board for eight years. He was a keynote speaker of the Swiss Chemical Society meeting in 1962. He was a delegate of the Indian team in the Indo-Soviet Conference on Natural Products held alternately in Russia and India. He was an invited speaker in many international conferences on natural products, especially between 1995and 2000 in symposia on neem.

TRG was a Fellow of the Indian National Science Academy and the Indian Academy of Sciences. The highly coveted Fellowship of the Royal Society however eluded him. The Third World Academy of Sciences was also remiss in not honouring him with its fellowship. TRG was a member of many international scientific societies like the Royal Society of Chemistry, the American Chemical Society and the Swiss Chemical Society. He was a founder trustee along with Drs SC Bhattacharyya, Nityanand, Sukh Dev and S Swaminathan of the National Organic Symposium Trust, a non-profit organization for the promotion of Organic Chemistry (and related inter-disciplinary areas) in India. The Trust was very much dear to his heart and in its formative period, he mobilized resources for its corpus fund in spite of his advancing years. The Trust has been doing yeoman service by bringing productive researchers together for three to four days through periodic symposia for intensive discussions and interactions. His unceasing interest and benevolent presence in these events (he did not miss even one until he was laid up) was a source of inspiration and is being greatly missed now. NOST is an example of how TRG was a builder of institutions and not empires.

In addition to his scientific pursuits, TRG utilized his skills in science management and administration for the benefit of the country in several ways. He was associated with the research councils of many CSIR laboratories like National Chemical Laboratory, Pune and Central Drug Research Institute, Lucknow. He served as a member of the Pharmaceuticals and Drugs Committee of CSIR for several years. He was a founder member of the editorial board of the *Indian Journal of Chemistry*. He was connected with several universities whose Boards of Studies utilized his knowledge for improving the curricula and teaching systems.

PERSONAL LIFE AND TRAITS, LAST DAYS

TRG had a long and happy married life with Mrs Rajamani who predeceased him. They have two sons and a daughter who with their own offsprings formed a close

knit family bestowing upon one another much affection and love. TRG's elder son, Dr T G Rajagopalan, a well-known biochemist who specialized in pharmacokinetics, retired as Director, R&D, of Proctor & Gamble in India. The younger son, T G Sundararajan, a chartered accountant, retired as Director of Finance of Air India. The daughter, Anuradha youngest of the three is married to a Chartered Accountant and is an accomplished Bharatha Natyam dancer trained in the Vazhuvoor style by Vidwan Rajarathnam Pillai. TRG has six grand children who are all based in the USA. Infrequent breaks in the scientific pursuits saw TRG spending holidays with his grand children.

Complementing his passion for Natural Products Chemistry was TRG's love for horticulture. His interest in cultivation of roses probably started in his T.Nagar House and took firm roots when he was residing in the spacious bungalow of the Principal of Presidency College. The author remembers how TRG converted mounds of soil that were dug out when a new chemistry building came up into beautiful greenery. TRG blossomed as a horticulturist really in the large campus of CIBA Research Centre in Bombay wherein he cultivated rose gardens extensively, which won prizes consistently in exhibitions. To cap it all, TRG ushered in a new hybrid rose aptly christened 'Rajamani' after his wife. Expertise in roses logically led him to venture into orchids, calling for greater knowledge and techniques. He not only collected the plants personally from all corners of the earth but would also cajole friends and relatives into bringing him rare species. It was no wonder that during his annual visits to CIBA Basel in summer, an excursion to an orchid nursery in a suburb was a must, accomplished partly by tram and the rest by foot, accompanied by 'yours faithfully'. Retirement from Bombay saw TRG migrating to Madras with its high heat and humidity, loathsome to humans but coveted by orchids. TRG created a climatised nursery on the terrace of his house wherein he nurtured hundreds of them and displayed their blooms with brilliant hues with undisguised rapture to the visitors who dared to climb the steep, winding spiral staircase. It is heartwarming to see Rajagopalan still maintaining them in good shape.

Govindachary was a great lover of literature and read avidly and widely. He was also a rasika of the fine arts, especially Carnatic music (but preferred to hear it from accomplished musicians in a concert hall rather than from his Ph.D. students in the laboratory however talented they might have been in the art!) and Bharatha Natyam. It was natural that he should also have a great liking for sculptures and temple architecture. He undertook many an excursion to collect plants, which often ended in visiting temples. He was religious but not in a conventional, parochial way, inspired as he was by the poetry of the saints.

Govindachary was tall and lean. His face with a prominent nose displayed nobility, erudition and scholarship. He was spartan in his habits and frugal in his speech and writings, avoiding superlatives and embellishments. Despite his formidable fame, he was easily accessible. Shy by nature and reticent by disposition

he was modest to a fault about his achievements and generous in publicly acknowledging the contributions of his associates. He was soft-spoken but in spite of his apparent mildness, he had strong views which would occasionally erupt in unwanted satire. He was a stickler to punctuality and did not suffer tardiness or sloth and pulled up students and colleagues who did not observe his standards.. He put in very long hours of work and appreciated others doing so. He had an uncanny knack of spotting talent and stimulating and sustaining it with his readiness to delegate responsibilities. Thus a fresh lecturer in the Chemistry Department of Presidency College was encouraged by TRG to become a microanalyst and then an instrumentation specialist until the former eventually became a nationally acknowledged expert. An animal house warden of CIBA was given the opportunity to tend the gardens and become an authority on roses. Of course TRG was human and did err sometimes in his judgement. These events were rare and brought him much anguish. However his innate kindness and generosity did not allow him to seek retribution. He was not a committee man but stood up for causes to which he was committed as being just and right.

People who had seen TRG in the summer of 2000 when he was 85 years old would not have known what was coming. After spending some holidays with his grand children, he returned with what seemed to be a minor ailment. The problem which was not fully well diagnosed worsened insidiously, slowly disabling him but he still went to the SPIC laboratories although for restricted hours, right through the end of 2000. But his condition started to deteriorate until he became totally bed-ridden and eventually passed away peacefully on December 28, 2001, surrounded by his children and their families who had attended on him with loving care and utter dedication through-out his illness.

CONCLUSION

There has been a worldwide resurgence of interest in natural products as benign therapeutic agents and eco-friendly plant protection chemicals. India provides plentiful opportunities in this area with its abundant flora growing in vastly different climates. Exploitation of this floral wealth will be aided by a thorough study of the constituents—structure and biological activity—using modern scientific methods. TRG was a pioneer in this regard and deserves to be emulated in earnest. The author had the good fortune of being associated with him continuously from 1950, directly for a good part of this period, as a Ph D student from 1950 to 1954, as a postdoctor from 1954 to 1957 and a colleague in charge of synthetic medicinal chemistry when he was the Director of CIBA Research Centre between 1962 and 1975. This article is contributed with a deep sense of gratitude. Readers are invited to refer to a few other articles on TRG – *J Sci ind Res* (1976) **35**: 139-148; *Curr Sci* (1995) **69**: 373-371; *Arkivoc* (2001) **part viii;** 1-8; *Curr Sci* (2002) **82:** 219-222.

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