

Bijoor Sanjiva Rao, morellin and early natural products chemistry in India

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The chemistry of natural products, molecules from nature, often dismissed in the teaching of biochemistry as secondary metabolites, has had a long tradition of research in India. In the first three decades after independence, the centres at Delhi University (T. R. Seshadri), National Chemical Laboratory (NCL), Pune (K. Venkataraman and Sukh Dev), Calcutta University (Asima Chatterjee) and Presidency College Madras (T. R. Govindachari), among others, were major centres of natural products research. Among the early studies of plant derived natural products, the investigations on the pigment morellin bear special mention¹. In the mid-1960s, morellin achieved the distinction of being the first complex organic substance to have its three-dimensional structure determined by X-ray crystallography in India². The morellin story has been told on the pages of this journal³. While researching background material for describing the Kartha–Ramachandran structure for morellin, I encountered the work of Bijoor Sanjiva Rao, who described the first purification of morellin from *Garcinia morella* in 1937, while working in the Department of General and Organic Chemistry of the Indian Institute of Science (IISc), Bangalore⁴. The problem originated in the laboratory of John Simonsen, at the Forest Research Institute in Dehra Dun⁵. Simonsen moved later to IISc as Professor of Organic Chemistry in 1925. Simonsen, a student of W. H. Perkin Jr at Manchester, came to India in 1910, to begin organic chemistry teaching and research at the Presidency College, Madras. His work on essential oils, which led to his extensive contributions to terpene chemistry, began in Dehra Dun and continued at IISc Bangalore. Simonsen catalysed the development of the field of natural product chemistry at IISc, an area that he surveyed in 1928 in his Presidential address to the 15th Indian Science Congress in Calcutta⁶. Bijoor Sanjiva Rao, then his assistant, began work on the isolation and characterization of morellin, with the first mention of success appearing in the IISc Annual Report of 1928. In the 1950s and 60s, morellin was actively investigated by P. L. Narasimha Rao (P. L. N. Rao), who was trained in organic chemistry at IISc, but moved next door to the

Biochemistry Department^{7,8}. Morellin then made its way to the Physics department, where the first X-ray diffraction data were obtained, by the efforts of Gopinath Kartha, working under the supervision of G. N. Ramachandran².

In embellishing my story, I searched for a photograph of Bijoor Sanjiva Rao. It was then that I encountered his namesake Basrur Sanjiva Rao. South Indian names often include the village or town of origin. Google Maps quickly revealed two small towns Basrur and Bijoor (now Bijooru) on the Udipi coast of Karnataka, barely 48 km apart. I will refer to them from here on only by the distinctive places of origin. Both Basrur and Bijoor were elected (or more accurately, appear to have been elected) to two of India's science academies, the Indian Academy of Sciences (IASc), Bangalore and the Indian National Science Academy (INSA), Delhi. Basrur was born in 1895 and Bijoor in 1896 from the available record. Both, apparently, served on the Council of IASc as early as the 1930s. Surely, I would now find a photograph of a man so well regarded by his peers. Figure 1 illustrates my findings.

Basrur was listed as specializing in mineral chemistry, while Bijoor was classified as an organic chemist. A photograph of the former was available. The latter remained anonymous. Even more curiously, the Bangalore Academy's Year-Book which lists all deceased Fellows gives identical birthdays for the two B. Sanjiva Raos, 23 February 1895 and 1896. Matching names and birthdays appear a very strange coincidence, raising suspicions of a complete mix-up. The INSA website displayed an entry for B. S. Rao, with the initials expanded in parentheses as 'Bijoor Sanjiva', with a photograph strikingly similar to that of Basrur in Figure 1. To further muddy the waters, Bijoor was now listed as a specialist not only in natural products but also on oxides of sulphur, an area which in the classical traditions of the discipline would be described as inorganic chemistry (Figure 2).

The text entry was detailed. The giveaway was the reference to his service in Central College, Bangalore's oldest institution of higher education. In keeping with tradi-

tional practice, the photographs of all former Principals are displayed there, confirming that the available photograph is that of Basrur. In the list of deceased Fellows available on the website, INSA has a sole entry for B. S. Rao. While the date of death of Basrur is available that of Bijoor remains unknown at present. A biographical memoir of Basrur published by INSA⁹ lists publications of both Basrur and Bijoor, a truly secular list which transgresses the jealously guarded border, increasingly a line of actual control, between organic and inorganic chemistry. How could the publication lists of two different scientists get so mixed up? A careful reading of the acknowledgements section provides a possible answer. The author thanks one of Basrur's early students, by now a very senior professor at IISc, A. R. Vasudevamurthy, for the material in the memoir. A cursory glance at the list of publications reveals several references from *Chemical Abstracts*, which in the late 1970s existed as the only source of authentic bibliographic information. Presumably, an able bodied student (the bound volumes of the Abstracts were heavy enough to make a detailed literature survey a physically demanding task) was despatched to the IISc library, with instructions to compile a list of publications by B. Sanjiva Rao. The diligent searcher

Basrur Sanjiva Rao

FIA

Elected into the fellowship in 1934 under the Chemistry section

Year of Birth: 1895.

Council Service: 1938-55; Treasurer 1938-55

Specialization: Mineral Chemistry

Deceased: 3 March 1975



Bijoor Sanjiva Rao

Elected into the fellowship in 1936 under the Chemistry section

Year of Birth: 1896.

Council Service: 1936-37, 1956-58

Specialization: Organic Chemistry

Deceased

Contact:



Figure 1. Records of Basrur Sanjiva Rao and Bijoor Sanjiva Rao from the website of the Indian Academy of Sciences.

then unearthed the second B. Sanjiva Rao and constructed a composite list of publications, which now serve as a misleading archival source. The available records on Basrur Sanjiva Rao provide a picture of a very successful and well respected teacher and researcher, who served Central College, Bangalore retiring as its Principal, later moving in 1948 to IISc as Professor of Physical Chemistry. He served on the Council of IASc, as the treasurer from 1938 to 1955. Apart from the discrepancies in his list of publications in the INSA biographical memoir, there was little that was unusual, a sharp contrast to the records on his namesake, Bijoor Sanjiva Rao.

Helpful colleagues in the Organic Chemistry department of IISc, responded to my request for unearthing more information by locating an old photograph from 1932–33, which shows Bijoor seated prominently in the first row (Figure 3).

There was now a face to attach to a name and a molecule. I must add, parenthetically, that the photograph appears to have been taken on the occasion of the departure of the then Director, Martin Forster, a chemist and the last British Director, who would soon be succeeded by C. V. Raman. Forster, incidentally was the originator of a questionnaire, circulated at the Indian Science Congress of 1928, which sought opinions on the need for an interdisciplinary science journal in India. Four years later, in 1932, *Current Science* was born in Bangalore¹⁰. J. L. Simonsen who was the President of the Indian Science Congress in 1928 before he returned to England must be credited along with P. S. MacMahon as one of the founders of the Indian Science Congress Association in Calcutta. It is their letter written in 1910, proposing an Indian Association for the Advancement of Science that led to the birth of the Science Congress in 1914. Figure 3 shows views of a casket presented to Simonsen, by his associates, Bijoor Sanjiva Rao amongst, still carefully preserved at the Archives and Special Collections at Bangor University, Wales.

It was now clear that the search must focus on Bijoor Sanjiva Rao. Further details could be traced through the records of IISc Council proceedings and Annual reports. Bijoor Sanjiva Rao was appointed as an Assistant in the Department of General and Organic Chemistry, IISc in 1921, several years before Simonsen's arrival in Bangalore. The Annual Report of 1922–23 describes his work on essential oils. The report of 1928–29 describes his isolation of lon-

gifolene, a molecule which occupies a central position in the history of terpene chemistry, first isolated by Simonsen in 1920, at the Forest Research Institute and College, Dehradun¹¹. Morellin is described in the IISc Annual Report of 1929–30. These early records of research on terpenes might well have laid the foundations of later

work to emerge in the 1940s and 1950s from the organic chemistry department at IISc, eventually culminating in the flowering of research in terpene chemistry in the laboratory of Sukh Dev, at the National Chemical Laboratory, Pune and later at the Maltichem Research Centre in Baroda¹². Sukh Dev was both a student and a faculty

The screenshot shows the website of the Indian National Science Academy (INSA). The header includes the INSA logo and the text "Indian National Science Academy Since 1935". Below the header are navigation links: Home, Site Map, and Contact Us. The main content area is titled "Deceased Fellow" and features a portrait of Professor B. S. Rao. To the right of the portrait is a table with the following information:

Name	Professor BS Rao (Professor Bijoor Sanjiva Rao)
Gender	M
Birth	1896-02-23
Specialization	Natural Products; Sulphur Monoxide; Sulphur Compounds
Year of Election	1944
Demise	03-03-1975

Below the table is a "Summary" section with a detailed biography of Professor Rao, including his education, positions held, and research achievements. It mentions his DSc from the University of London in 1946, his roles as Professor of Inorganic and Physical Chemistry (1926), Principal (1946) at Central College, Bangalore, Professor of Inorganic and Mineral Chemistry (1947) at IISc, and Professor of Chemistry at Gauhati University. It also lists his academic and research achievements, other contributions to UNESCO and the INSA Council, and awards and honours.

Figure 2. Record of 'Professor B. S. Rao' on the website of the Indian National Science Academy, New Delhi.



Figure 3. (Top left) Department of General and Organic Chemistry, IISc, 1932–33. Bijoor Sanjiva Rao is third from right in the front row (seated). (Top right) An expansion of the image of Bijoor Sanjiva Rao. (Bottom left) Casket presented to J. L. Simonsen on his departure from IISc in 1928 by his students (Courtesy: Archives and Special Collections, Bangor University, Wales). (Bottom right) Inscription on the casket.

HISTORICAL NOTES

member at IISc in the 1940s and 1950s. Fittingly, the American Chemical Society recognized this major contribution from India, by awarding Sukh Dev the 1980 Ernest Guenther Award for the Chemistry of Natural Products.

Bijoor may have been well regarded by his colleagues, with the Professor of Biochemistry, V. Subrahmanyam, nominating him to the Fellowship of the Academy in Bangalore in 1935, followed by his elec-

tion in 1936. The archival records at IISc provide a glimpse of his expertise and a description of his qualifications in his own words as a witness for the defence in a case involving the illegal narcotic ganja (marijuana)¹³ (Figure 4). In June 1936, he was even 'in charge of the department of organic chemistry'. From 1939 onwards, Bijoor, who was now a Senior Assistant, struggled with ill-health and his struggles can only be imagined from the bland records

of repeated extensions of 'sick leave', granted by a sympathetic management. He left IISc in 1942. A one-line hand written note, unearthed in the course of this writing, asks the Indian Academy of Sciences to 'suspend his membership'. Here I can only speculate that this step was probably forced by his inability to pay the annual membership fee. It is also unlikely that Bijoor served on the Academy's Council in 1936–37. He certainly could not have served in the period 1956–58 (Figure 1). Despite the INSA record which mistakenly lists Bijoor, while displaying the photograph of Basur (Figure 2), it is almost certain that Bijoor was never elected a member of the National Institute of Sciences, which transformed into INSA in 1970. Bijoor Sanjiva Rao remains an anonymous presence in the history of Indian natural products chemistry, known only by the molecule he isolated, morellin. No records are yet available that reliably provide his date of birth or death. A sample of morellin, purified in the Biochemistry department of IISc by P. L. N. Rao and carefully preserved by his associate D. Rajagopal Rao, found its way to the latter's laboratory at the Central Food Technological Research Institute (CFTRI), Mysore, probably in the 1960s. It is from here that the sample shown in Figure 3 has been obtained, over half a century later. Even as this account was being written, the decades old crystal yielded excellent diffraction data, permitting the determination of the molecular structure by direct methods (Figure 5). Displaying the substance he isolated and the structure, now determined, is a small tribute to Bijoor Sanjiva Rao and the devoted band of morellin researchers who followed him at IISc, Bangalore.

Is morellin an important molecule? For those who research a large class of plant secondary metabolites¹⁴, termed as the 'caged xanthenes', morellin is indeed the first member to have been isolated and crystallized in the 1930s and the first to have its structure determined in the 1960s; truly a Bangalore molecule. Are there other examples of name degeneracy which have led to confusion in the scientific literature. There is indeed a famous, but probably forgotten example, from the 1980s, also with a Bangalore connection (Box 1). Is there a justification for a historical commentary on an apparently minor chapter in the development of organic chemistry in India? In asking myself, why did I embark on a hunt through archival records, many of which are misleading, in search of an

IN THE PRESIDENCY MAGISTRATE'S COURT, GEORGE TOWNE, MADRAS
Before K.R.Ry.H. Koil Pillai Avl., B.A., B.L.
Second Presidency Magistrate
J. 7.1458/35.
D.W.3 Mr. B. Sanjiva Rao age 41 years sworn. I am employed in the Indian Institute of Science, Bangalore for the last 18 years. I am a Fellow of the Indian Institute of Science. I am a graduate of the Madras University and M.Sc. The fellowship of the Indian Institute of Science is equivalent to D.Sc. of any Indian University. I am now in charge of the department of organic chemistry. The Institute is under the portfolio of the education member of the Viceroy's Executive Council. Sir J.V.Raman is the Director of the Institute. I have been doing a lot of Research work. I have published more than 35 original Memoirs in the course of my research work. I am acquainted with the work of detecting ganja and other drugs. Exhibit I was received in the Indian Institute of Science with a sealed packet complainant's lagiyam (M.O.5) from A fee of Rs.28/ was charged for analysing M.O.5 I took 3 days for analysing and for sending the opinion. I was the senior Assistant to the acting Professor till 2nd May 1936. The professor does no analysis work. He does not supervise the work. I obtained the Director's permission to come here and give evidence.

Figure 4. Excerpt from a statement made by Bijoor Sanjiva Rao in the court of the Presidency Magistrate on 10 June 1936 (Source: IISc Archives).

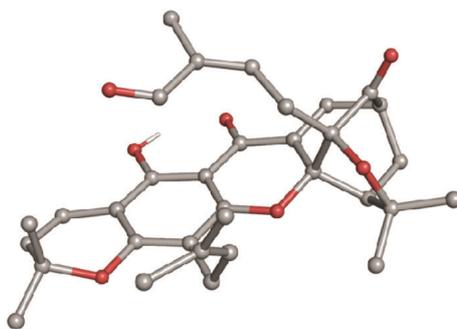
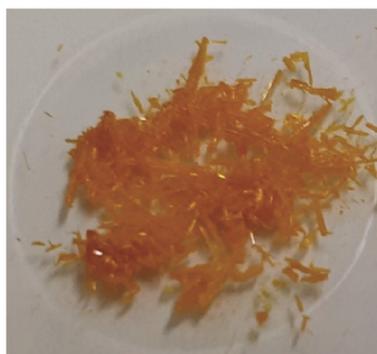


Figure 5. (Left) Crystalline sample of morellin from CFTRI, Mysore. (Right) Molecular structure of morellin determined from these crystals in 2021 (Image courtesy: Prema Vasudev).

Box 1. What's in a name: Will the real Chandrasekhar please stand up

Shakespeare's Juliet, in pining for Romeo, famously asked, 'What's in a name?' In modern science, the answer may well be 'everything'. In 1985, in the early days of scientometrics, Eugene Garfield wrote an essay highlighting the work of the 1983 physics Nobel laureate, the famous astrophysicist Subrahmanyam Chandrasekhar (1910–1995) of the University of Chicago. Using citation analysis to describe evolving research fronts, based on the laureate's work, Garfield identified liquid crystals as an area of interest in addition to astrophysics¹⁵. A perceptive colleague, S. Arunachalam, pointed out that this was a case of name degeneracy. In a Correction Note titled 'Will the real Chandrasekhar please stand up', Garfield acknowledged that the publications of Subrahmanyam Chandrasekhar, the astrophysicist, and that of Sivaramakrishna Chandrasekhar (1930–2004), the eminent liquid crystals researcher, then at the Raman Research Institute in Bangalore, who discovered discotic phases, had got mixed up, in the absence of the full names of authors¹⁶. Garfield noted: 'I suppose that if their names were Smith or Cohen, we might have been more diligent in checking the possibility of a homograph.'

image of an unknown scientist, long forgotten by those who followed, I was reminded of a stanza in Thomas Gray's, rather melancholy *Elegy Written in a Country Churchyard*:

*'Let not Ambition mock their useful toil,
Their homely joys, and destiny obscure;
Nor Grandeur hear with a disdainful smile
The short and simple annals of the poor.'*

For those who still see the pursuit of little nuggets of forgotten history of local science, as an unnecessary diversion from more pressing matters, Gray provides an answer:

*'For thee, who mindful of th' unhonour'd
dead
Dost in these lines their artless tale relate;
If chance, by lonely contemplation led,
Some kindred spirit shall inquire thy fate.'*

1. Venkataraman, K., *Proc. Indian Natl. Sci. Acad.*, 1973, **39**, 365–381.
2. Kartha, G., Ramachandran, G. N., Bhat, H. B., Madhavan Nair, P., Raghavan, V. K. V.

and Venkataraman, K., *Tetrahedron Lett.*, 1963, 459–472.

3. Balam, P., *Curr. Sci.*, 2021, **121**, 449–455.
4. Sanjiva Rao, B., *J. Chem. Soc. [London]*, 1937, 853–855.
5. See acknowledgements in reference 4.
6. Simonsen, J. L., *The Shaping of Indian Science*, Universities Press India, 2003, vol. 1, pp. 210–226.
7. Rao, P. L. N. and Verma, S. C. L., *J. Sci. Ind. Res.*, 1951, **10B**, 184–185.
8. Rao, P. L. N., Krishnamurthy, D. V. and Verma, S. C. L., *Die Naturwissenschaften*, 1954, 66–67.
9. Narayana Reddy, G. K., *Biographical Memoirs, Indian National Science Academy*, vol. 19; https://www.insaindia.res.in/BM/BM19_9415.pdf
10. Krishnan, R. and Balam, P., *Curr. Sci.*, 2007, **92**, 129–138.
11. Simonsen, J. L., *J. Chem. Soc. (London)*, 1920, **117**, 570–578.
12. Singh, V. and Srikrishna, A., *ARKIVOC*, 2003, (iii), 1–7.
13. Anonymous, *Connect (IISc)*, October 2018, **5(3)**, 47–48.
14. Han, Q.-B. and Xu, H.-X., *Curr. Med. Chem.*, 2009, **16**, 3775–3796.
15. Garfield, E., *Curr. Contents*, 1984, **51**, 3–12.

16. Garfield, E., *Curr. Contents*, 1985, **7**, 60–67.

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