



INDIAN SCIENCE ACADEMIES: DRIVE TOWARDS SCIENTIFIC RESEARCH FOR WOMEN

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“Life is not easy for any of us. But, what of that? We must have perseverance and above all confidence in ourselves. We must believe that we are gifted for something and that this thing must be attained”

- Marie Curie.

Abstract: In the modern world, Science and Technology have become indispensable with the scientific research playing a pivotal role in knowledge creation and development of innovative technologies. Scientific organizations are constantly contributing to the development of cooperation between research institutions and individual scientists within the fields of their competence. Mainstreaming gender equality in academic and scientific organisations is presently viewed as an important goal, whose ultimatum would be to enhance every individual woman's potentiality. At National level, three science Academies, viz., NASI, IASc and INSA are playing a vital role in increasing the scientific temper in the society. Hence, the present research paper aims to analyse the role of academics in promoting and encouraging women scientists to take up and pursue science as their career.

I. INTRODUCTION

Science is one of the most important intellectual and cultural forces of the twentieth century. Science generates information, changes attitudes, creates new values and is one of the major human enterprises. Technology is a major instrument of social and economic change. Many governments are convinced that research and its products provide the means to enrich an economic life that is no longer sustained by traditional manufacturing and services industries. Linking science to society, public understanding and the participation of citizens are essential to create societies where people possess necessary knowledge to make professional, personal and political choices to participate in the stimulating world of discovery. Scientific Organisations are constantly contributing to the development of cooperation between research institutions and individual scientists within the fields of their competence. With the passage of time many research institutions have been established and periodic gatherings of large number of trained scientists in various disciplines were welcomed to exchange their ideas and research work in respective fields. The intellectual cooperation in science was started for exchanging students, professors and researchers between universities and scientific institutions but the real diversification of potentialities of international cooperation became effective only during this 21st century.

After the First World War, initial steps were taken by some countries to unite their efforts in the peace keeping process and in intellectual life. During this period, the League of Nations was created which could be considered as the major international initiative to unite number of countries belonging to different regions of the world. They established a background for the United Nations Organisation which was initiated during the Second World War. The periods between the two World Wars

witnessed the emergence of important international scientific organisations with a force; first, the World Energy Council was formed in 1923 and second the International Council of Scientific Unions (ICSU) founded in 1931. After the establishment of these organisations, International and regional academies of sciences had started to play an amazing role in developing scientific communities in the world.

The history of scientific Organisation of working scientists in India can be traced since the beginning of twentieth century. The decade preceding Independence, with the intervention of the Second World War, saw science, scientific organisations and training applied to meet specific needs of a temporal nature. Even in the colonial environment, it witnessed the establishment of several research institutes, societies and other Organisations which stimulated scientific activities. During this period national professional societies were also set up in India, virtually in every major discipline. During the dawn of twentieth century, scientific societies began to be formed mainly for conducting meetings and conferences and for publishing research papers and reviews in their publications.

All human beings, both men and women, are free to develop their personal abilities and make choices without the limitations set by stereotypes, rigid gender roles and prejudices. Gender equality means different behaviour, aspirations and needs of women and men are considered, valued and favoured equally. Women's equal access to scientific and technological skills is their first and foremost right. The early 1970s and 1980s witnessed a renewed and expanded interest in the history of women in science. Gradually, in the later part of the 20th century, the doors of universities, scientific societies and research laboratories were thrown open to women. However, Gender bias has been characterizing the institutions, practices, ethos and substance of science for centuries. The crucial practice of discussion and debate about scientific ideas among peers was denied to woman. Women are conspicuously absent at the decision-making level. Despite these hurdles and dominance, time has come, where women scientists have become aware of their rights, abilities and opportunity they seek. At this juncture, UNO too has contributed its role paving the way for equal opportunities for women in the scientific career.

The UN Commission on the status of women has summarized in its world Survey on the 'Role of Women' (1989), a resolution zeroing in on 'equality' and has specified two main components: "Equality of opportunity" and "Equality of treatment". With the emergence and establishment of increasing number of research institutes encompassing in several areas, the need was felt for the existence of apex or coordinating agencies that would also act as catalysts for research activities to fulfill their goals and to redress their grievances and also to promote excellence. This urge nurtured into the establishment of various women scientists associations. The governments and non-governmental bodies and women scientists associations accelerated their efforts in increasing the participation of women in to the field of science and technology. Mainstreaming gender equality in academic and scientific organisations is presently viewed as an important goal, whose ultimatum would be to enhance every individual woman's potentiality.

II. ENTRY OF WOMEN IN SCIENTIFIC ACADEMIES

The story of women in science is not one of a simple progression over time. During Seventeenth and Eighteenth century many scientific societies were established, such as Royal Society in 1660 in England, The French Academy of Sciences in 1666, The Prussian Academy of Sciences in 1700, The Academy of Sciences of the Institute of Bologna in 1711 and The Imperial Academy of Sciences in Russia in 1725. These societies oversaw the production, evolution and reporting of new scientific knowledge both to their members and the public at large, established libraries and museum collections. They also held themselves responsible for defining and controlling scientific standards and for providing a protected, institutional space for scientific practice and also identified important areas for the observation of new experimental results and the discussions of new ideas. While women gained access to science, slowly men began to dominate them in their careers which lead to separate the discipline from informal amateur practice.

The Scientific academies refused membership to women till 1600s. The Royal Society at London founded in 1662 did not permit women by statute to become fellows of the Royal Society. After over 285 years, the society elected its first female member in 1945. (An exception was made for Queen Victoria, who was made a Royal fellow.) The “Academie des Sciences of Paris” was founded in 1666 and elected its first female member in 1962. Despite great resistance from male fellows, the first woman to attend a meeting of the Royal Society was Margaret Cavendish, the Duchess of Newcastle, in May 1667. Yet, she was an honorary member and her status in the scientific community remained unequal with men. It seemed as if women scientists had absented themselves from these scientific organisations. The first known women’s scientific society, “NatuurkundigGenootschap der Dames” (Women’s Society for Natural Knowledge), was in operation between 1785 and 1887 in the town of Middleburg, on the southern Dutch island of Walcheren in the province of Zeeland founded by forty-four proud elite women who wished to be educated in natural philosophy. The members of this society collected scientific instruments, books and organised scientific lectures for themselves. The meeting convened regularly at the MusaeumMedioburgense, being the home of their society. Just as this society was heading for a closure, American Matilda Cox Stevenson, who was rejected for membership from the Anthropological Society of Washington in 1885, formed the Women’s Anthropological Society of America with ten women in Washington. They met twice in a month, exchanged papers with one another and invited distinguished guests, to speak to them.

Throughout the 18th and 19th centuries, women demonstrated their abilities in science in competence with men, yet their works were not recognised and respected by the male community. Such women struggled against the scientific hierarchy of the sexes. Individual male scientists and scientific Organisations were also responsible, both intentionally and unintentionally for creating a climate that made women feel unconduciveand unwanted. The “Academie des Sciences of Paris”, The Royal Society of London, etc. did not allow women to participate or voice themselves into their meetings. Marie Curie was rejected for membership by the Academies in 1911, which year she won her second Nobel prize. Similar exclusions were experienced in the American National Academy of Sciences until 1925; in the Russian National Academy until 1939 and even in the home of Enlightenment Science, the Academies des Sciences in France, until 1962. Moreover, many male scientists consciously strive to keep women out of the profession. Thus, women were largely barred from scientific societies and educational institutions making their advancement within the profession. However, by the second half of the nineteenth century, the debate over the admission of women to scientific societies intensified and the dominant professional body of male scientists felt uneasy about the presence of women amateurs in their midst.

The Royal Geographical Society allowed women membership beginning from 1914, with much controversy. Many of its male members believed that the admission of women members would degrade the society to a social club and negate its serious character. Admission of women into the society and keeping them in the lower positions of power yet was another tactic male membersadopted to retain control over the society and ensured the predominantly masculine identity of the society. Although the Sex Disqualification (Removal) Act, 1919 disallowed barriers to the admission of women to learned societies based on sex, members of the Royal Society ignored the principles of the Act and simply refused to consider women scientists worthy of nomination. The United States National Academy of Sciences elected three women by 1944, the Soviet Academy of Sciences and Canada each elected one woman in 1946. The Paris Academy of Sciences did not include women as full members until the year 1979. The Academy of Exact, Physical and Natural Science in Spain did not admit women until 1986. Spanish scientific societies admitted women much earlier, but their numbers remained less as was done by other societies. Though women scientists were admitted, they were segregatedand excluded from the community of their peers. Absence from such venues made it difficult for women to keep abreast of new developments in their fields and be recognized of their own achievements.

Women who worked for the Council of Scientific and Industrial Research, an Australian scientific Organisation, in the 1930s and 1940s faced either termination of their employment upon marriage or tenuous and part-time employment, accompanied by low pay and low status. In addition, they were continually threatened by the possibility of dismissal. Despite these existing barriers to women’s participation in the professionalisation of science during the first half of 20th century, women scientists contributed to scientific team work greatly and made important scientific discoveries. With an increase in job opportunity, they

entered university positions and won awards for their achievements. The emergence and growth of a self – identified women's scientific movement stimulated curiosity, enthusiasm and the demand for more information, not only on the difference between men and women but also about the stature and aspirations of women in the scientific field. With the growing awareness of the under-representation of women in the scientific community and the need for implementation of new strategies was stressed by several international organisations such as WHO, UNESCO, UNICEF, etc. These organisations acknowledged the full and equal access and participation of women and girls in education, training and Science and Technology.

The gender dimension of Science and Technology has become one of the most important and debated issues worldwide. Gender has acted as a basis in shaping the careers of scientists for centuries. Dogmas of gender and science developed over different periods of time had resulted in the exclusion of women from science for a long time all over the world. The United Nations Commission on the Status of Women, was established in 1946, recognised the crucial importance of “access and participation of women and girls in education, training and science and technology, including for the promotion of women's equal access to full employment and decent work”. This stressed the mainstreaming of a gender perspective in Science, Technology and Innovative (STI) policies and programmes, with a view to replicating and scaling up successes. In the 1970s, UN shifted its focus towards the empowerment of women. UNO's four global women's conferences in Mexico (1975), Copenhagen (1980), Nairobi (1985) and Beijing (1995) on women created a new energy for an already emerging second wave of the worldwide women's movement. Women from around the world utilised these conferences as a place to recognise similarities and began to understand differences. As a result of the world conference held in Mexico City in 1975, the UN formally declared 1976-1985 as the Decade for Women. Almost all development agencies like International, Regional, National and UN specialised agencies engage them with the woman in focus. This system-wide mandate created enormous demands for information, resulting in an explosion of knowledge among women.

The Nairobi Forward-Looking Strategy of 1985 stressed that “*Women should be viewed as users and agents of change in science and technology and their technological and managerial skills should be enhanced to increase self reliance in industrial production and to promote innovations.*” At Beijing Declaration of 1995, the rhetoric became more forceful; it spoke of the need to “*Ensure women's equal access to economic resources, including land, credit, science and technology, vocational training, information, communication and markets, as a means to further the advancement and empowerment of women and girls, including through the enhancement of their capacities to enjoy the benefits of equal access to these resources.*” Equal access to science is not only a social and ethical requirement for human development, but also essential for realising the maximum potential. These conferences also changed the mind set of UN, by providing mandates which gave rise to the Convention for the Elimination of All Forms of Discrimination against Women (CEDAW) besides establishing the UN Development Fund for Women (UNIFEM) and the UN International Research and Training Institute for the Advancement of Women (INSTRAW). These international instruments highlighted and elicited strong visible differences among women in terms of location, priorities, class and race, all the conventional classifications of society, politics and economics. Concerns for women raised awareness in a broader and more general human approach during the process of development. This concern for women was significantly experienced. Empowerment of women in Science and Technology had been continuously stressed by UN World Conferences on Women. Women thereafter began to enter the mainstream of Science and Technology. These initiatives altered the situation of women and spread across countries, by raising awareness, building confidence, spreading ideas and creating alliances which changed the face of many countries. The UNO Conferences sought to mainstream gender equality in scientific research and increase the participation of women in science at the global level in a progressive manner.

III. NATIONAL ACADEMIES

In India, scientific organisations were established for the purpose of sharing and updating scientific knowledge among scientists and to promote scientific temper in the society. During the early period, primary objectives for which an association was established were the prosecution of and assistance to research, propagation of knowledge and experimental measures generally in connection with the causation, mode of spread and prevention of communicable diseases. Gender equity in science and technology will provide opportunities for women to influence R&D agendas within the private sector and research institutions. In India, several scientific academics are engaged in promoting high quality research and developmental activities in the scientific field. Hence, the empowerment of women scientists was analysed through the study of national academics such as NASI, IASc & INSA and their contributions.

3.1 The National Academy of Sciences

The impact of post worldwar and the world-wide economic depression caused a setback to publish scientific research globally and it was reflected in India too where scientists found it difficult to publish their research work since they had to be entirely dependent on foreign journals. It was in this background that the idea of establishing a forum for scientists, which would bring them together to discuss and find scientific solutions to the problems of the country, was mooted in 1929 by Prof. Meghnad Saha, a great scientist, patriot and then Professor of Physics at Allahabad University. His views were published in December 1929 issue of the Allahabad University magazine in an article entitled 'A Plea for an Academy of Sciences'. Thus, the National Academy of Sciences, India (initially called "The Academy of Sciences of United Provinces of Agra and Oudh") was founded in the year 1930, with the objectives to provide a national forum for the publication of research work carried out by Indian scientists and to provide opportunities for exchange of views among them.

The National Academy of Sciences, India has been effectively pursuing its mandate 'Science & Society' since its inception through its various scientific programmes/ activities by involving a large number of scientists, academicians, educationists and industrialists from all across the country. The Rules and Regulations of the Academy were based on those of the Royal Society of England and the Asiatic Society of Bengal. The Academy started with 57 ordinary Members and 19 Fellows, has now 1820 Members and 1856 Fellows from all parts of the country; including 17 Honorary Fellows and 106 Foreign Fellows from various disciplines of Science and Technology. From the inception of NASI, holds more than 120 women fellows. To highlight, Prof. Manju Sharma, who was trained as a plant scientist has contributed significantly to the scientific research in the field of biotechnology and has also led the post of Secretary at DST had been closely associated with NASI and rendering her valuable suggestions and guidance for the development of science in the country.

Table 1 Fellowship of National Academy of Sciences, India 2015

Subject	No. of Men	No. of Women	Total No	% of Men	% of Women
Mathematics	150	16	166	90.36	9.63
Physics	220	11	231	94.82	5.17
Chemical Science	188	5	193	98.94	1.05
Earth & Planetary Sciences	84	1	85	96.51	3.44
Engineering & Technology	159	3	162	98.14	1.85
Plant Science	253	19	272	93.01	6.98
Animal Science	122	16	138	88.4	11.59
General Biology	173	34	207	86.5	13.5
Medicine	140	32	172	80	20
Total	1489	137	1626	91.8	8.19

Source : Report of Fellowship of National Academy of Sciences, India 2015

3.2 Indian Academy of Sciences

Indian Academy of Sciences founded in 1934 by Sir C V Raman at Bangalore. It was registered as a Society on 27 April 1934 with the main objective of promoting the progress and upholding the cause of science. The Academy began functioning with 65 Founding Fellows. The Academy's contribution to science and society is also reflected through its policies, values and its range of activities. The Indian Academy of Sciences (IAS) has started the Associateship programme in 1983 to identify and encourage the promising young scientists. The Associateship is tenable for a maximum period of 5 years until the age of 35 or a minimum period of 3 years. There are 104 Associates on rolls of the Academy, of which 16 were Women Associates and 88, Men Associates during 2021. It is interesting to note that there has been a steady increase in the representation of women in the Academy's Fellowship. The gender composition in the Fellowship for the period from 1995 to 2007 is that the number of Women Fellows in 1995 was 22 and by the year 2007 it rose to 76 and further to 97 in 2021 which show an increase of women fellows from 2.98 % to 8.94 % . At present, total number of women fellow were 97 and honorary fellows were 47 in number. The Indian Academy of Sciences is, no doubt playing a vital role in the progress of enrolling women scientists in India.

Table 2 Fellowship of Indian Academy of Sciences, 2015

Subject	No. of Men	No. of Women	Total No	% of Men	% of Women
Mathematics	82	7	89	92.13	7.86
Physics	197	9	206	95.63	4.36
Chemical Science	181	2	183	98.8	1.09
Earth & Planetary Sciences	83	2	85	97.64	2.35
Engineering & Technology	145	1	146	99.3	0.68
Plant Science	55	2	57	96.49	3.5
Animal Science	38	14	52	73.07	26.92
General Biology	115	18	133	86.46	13.53
Medicine	61	24	85	97.64	2.35
Total	957	79	1036	90.15	9.83

Source : Report of Fellowship of Indian Academy of Sciences, 2015

Women in Science: The Initiative of IASc, highlights the issue of under representation of women in science. To know the status of women in science in the Indian context; the Council of the Indian Academy of Sciences constituted a committee called "Women in Science" in January, 2003. This Panel initiated a study entitled "Trained Scientific Women Power: How much are we losing and Why?". The study reveals that, several women students are sufficiently motivated to continue their scientific education up to their Ph.D. degree but their post-PhD., yet they remain disproportionately low.

The panel of Women in Science has started a new initiative of conducting a series of seminars and lectures on the topic "Women in Science : A Career in Science" with objectives of inspiring and motivating young women in science, to create an awareness on various career options available to young scientists and to explore avenues for entrepreneur development. This is a part of their role model programmes to showcase the achievement of women scientists. The Indian Academy of Sciences (IAS) is distinguished among other organizations because; one of the founder members was a lady botanist E.K. Janaki Ammal. She is well known for her outstanding contribution in cytogenetics and plant geography. WiS has also compiled a collection of essays on the lives of Indian women scientists in the form of a book titled 'Lilavati's Daughters: The Women Scientists of India'. The book contains brief biographical and autobiographical sketches of about one hundred women scientists from India. Covering a range of disciplines, women scientists in these essays talk about what brought them to science, what kept their interest alive and what helped them achieve some measures of distinction in their careers.

3.3 Indian National Science Academy

The Indian National Science Academy was established in January 1935 with the object of promoting science in India and harnessing scientific knowledge for the cause of humanity and national welfare. The foundation of the Academy, earlier known as the National Institute of Sciences of India (NISI), was the outcome of joint endeavours of several organizations and individuals and the Indian Science Congress Association (ISCA) playing a leading role in this regard. INSA is playing a lead role in empowering women in science. In this way, INSA had undertaken several research works to examine the status of women scientists in India. The important research works such as achievers, Gender – Sensitization in Indian science and Celebrating Indian Women in Science, etc., In the history of 85 years of INSA, at present Chandrima Shaha became the first-ever woman president to head this prestigious Academy. Shaha, previously served as the vice-president of INSA and the director of the National Institute of Immunology in Delhi. She is also the recipient of the D.P Burma Memorial Lecture Award in 2019. She has also been awarded the Shanti Swarup Bhatnagar Medal, INSA, in 2019. Under her able guidance and governance INSA has been carrying out various aspects of scientific research. The Academy has been committed to recognizing scientific excellence for the past several decades by identifying, among other things, outstanding Indian and overseas scientists and electing them to the Fellowship of the Academy. At present, INSA holds 944 fellows out of that 854 were men and 90 were women fellows.

Table 3 Fellowship of Indian National Science Academy, 2015

Subject	No.of Men	No.of. Women	Total No	% of Men	% of Women
Mathematics	67	6	73	91.78	8.95
Physics	127	5	132	96.21	3.78
Chemical Science	121	2	123	98.37	1.62
Earth & Planetary Sciences	67	3	70	95.71	4.28
Engineering & Technology	108	-	108	100	-
Plant Science	118	6	124	95.16	4.83
Animal Science	57	10	67	85.07	14.92
General Biology	100	9	109	91.74	8.25
Medicine	61	16	77	79.22	20.77
Multi disciplinary committees	8	1	9	88.88	11.11
Total	834	58	892	92.21	7.85

Source : Report of Fellowship of Indian National Science Academy, 2015

IV. LACK OF RECOGNITION

It is not only the fellowships of the Academies where enough number of women are represented, even in awards and other recognitions women scientists need to be better represented. Lack of recognition for women is best indicated in the trend of Nobel Prize winners. From 1901 -2021, out of 629 Nobel winners in the field of sciences, only 23 were women. Even, awards given by Indian science academies clearly show that very few women received such honorary awards. Young Scientists Platinum Jubilee awards in the field of Biological, Physical and Chemical science is given by NASI. From 2006 to 2020, under the category of Chemical sciences totally 36 scientists received the awards and among them only 6 were women scientists, under the division of Physical sciences for the same period, 64 scientists received the awards among them 6 were women. In Biological science, 103 scientists received the awards from them 24 were women. Likewise, INSA's Young Scientists award for the period between 2018 and 2021, 136 scientists and 27 women received this award. The statistics reveals that the number of female fellows in all the areas of Science and Technology is significantly less as compared to male scientists, which is a subject of great concern. The DST's National Task Force on Women in Science report, reflects that out of total Indian National Science Fellowships awarded, only 3.2% were women. The Inter Press Service News Agency published an alarming and heart rendering report in 2009 which revealed that women scientists are sidelined by male-centric selection committees for awards and for appointments to R&D positions in government funded organisations. Since 1958, only 15 women have received the prestigious Shanti Swarup Bhatnagar award which was instituted by CSIR in 2014.

Subject	No. of	No. of	Total	% of	% of
	Men	Women	No	Men	Women
Biological Sciences	78	3	81	96.29	3.7
Chemical Sciences	77	3	80	96.25	3.75
Earth Sciences	40	1	41	97.5	2.43
Engineering Sciences	66	2	68	97.05	2.94
Mathematical Sciences	55	2	57	96.49	3.5
Medical Science	50	4	54	92.59	7.4
Physical Sciences	81	0	81	100	0
Total	447	15	462	96.59	3.38
Source: Report of ShantiSwarupBhatnagar Awardees (1958 -2014), CSIR.					

It is to note that these awards are just dominated by men and women have been completely ignored. It is interesting to note that the gender ratio is more favourable for young scientists' awards and the best thesis award of ICAR, which is also awarded to a junior. Only very few women are recipients of this award from 2003 to 2019. In 2019, nearly 19 women won this ICAR award, which is considered to be the highest number of award winners between 2003 and 2019.

Table 5 ICAR Awards

Year	Total recipients	Women
2003	104	10
2007	103	13
2019	141	19
Source: Citations, ICAR Award Ceremony, Report of ICAR, 2020.		

This clearly shows that women do better while studying science, than in the later years when they take up as their science careers. The glass ceiling becomes tougher at the level of practicing science and recognition than at the level while studying science.

V. ANALYSIS OF THE STUDY

Women remain a minority in scientific organisations and are disadvantaged in terms of membership, rank and recognition. The denial of higher education to women and the social customs in the 17th, 18th and 19th centuries barred them from participation in the scientific revolution with some exceptions. In India, the three Academics of Sciences-Indian National Science Academy (INSA), the Indian Academy of Sciences (IASc) and the National Academy of Sciences, act as agents in scientific endeavours of women. These Academics do not have adequate number of women fellowships. The percentage of women in the fellowship for the IASc is 7%, for INSA it is 5% and for NASI it is 8%. Paradoxically, only two women President, Dr. Manju Sharma served as the president of NASI for the period 1995-96 and at present currently from 2020, INSA is headed by Chandrima Shaha. The Councils have had women members and vice-president, but the numbers have been limited in absolute and relative terms.

With the growing awareness of the under-representation of women in the scientific community, the need for implementing new strategies is inevitable. Substantial attention should be paid to bridge the gender inequality through scientific forum. There has been a considerable improvement in the entry of women in all sectors of employment in the country. Economic independence has contributed and boosted self-confidence and self-esteem of women. Science is a male-dominated area in India and it is also influenced by the Indian social norms. The early woman scientists lurked hesitatingly at the margins of Indian society. They had to fight against the bounds of tradition and male chauvinism and their entry into the scientific field witnessed tons of untold struggle and pain. Women involvement in the S&T endeavours is not just for gender parity but it brings freshness, new outlook, diversity, different governance and over all a better output from the whole programme. It is recognized that world over academies being the highest intellectual bodies can play a major role in attracting, involving and recognizing women scientists in their scientific endeavors. Hence, the Science academies should endorse inclusiveness of women in research activities to escalate their involvement. With the growing awareness of the under-representation of women in the scientific community and the need for new strategies to be put into place, several policies can be introduced like quantitative objectives, new administrative structures and

positive action. Systematic efforts are needed to bring gender issues into the mainstream. Women's involvement in Science and Technology should be considered as an essential component contributing towards the development of a nation.

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