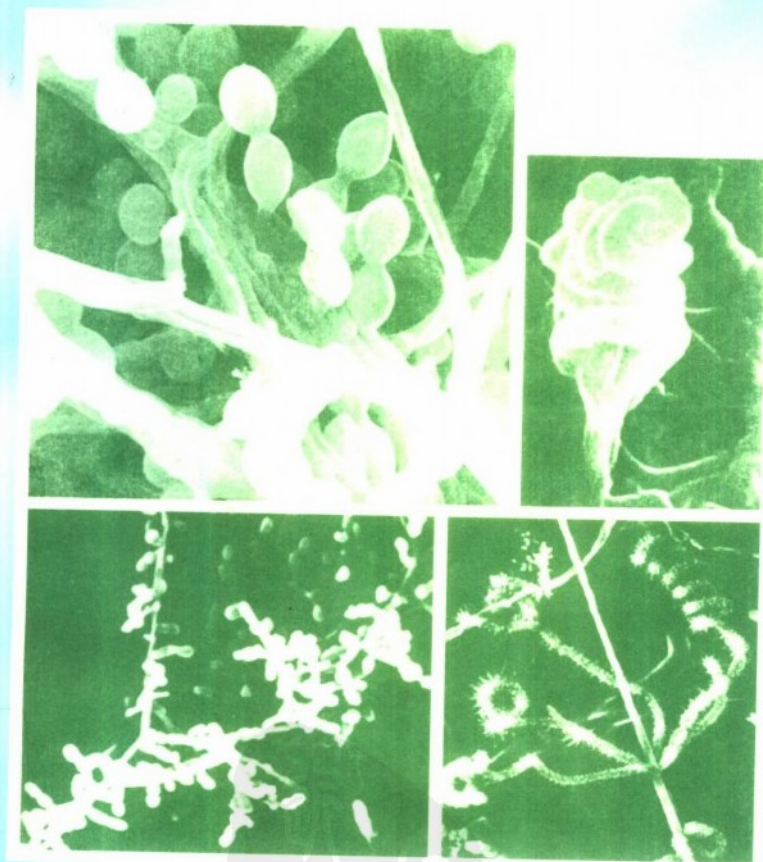


# ACTINOMYCETES RESEARCH

# 放线菌研究

姜成林 徐丽华 编



云南大学出版社

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姜成林 徐丽华 主编

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# 前 言

为了研究开发放线菌资源，在云南这片国际公认的生物多样性最丰富的地区，我室两三代科学工作者费尽心力，矢志不渝，先后行程二万五千多公里，汗水洒满了云南的每个角落，尔来已三十年整。这是平凡而又值得回味的三十年。姜成林教授撰写的“云南放线菌研究之回顾”作为本文集的序言，简略介绍了我室从事放线菌研究长期而艰难的历程，奠定我国放线菌生态学研究基础的创业过程以及所取得的成绩。本文集作为我室研究工作的一个阶段性小结，收集了自 1976 年以来我室在国内核心刊物发表的学术论文 46 篇，国外核心刊物等发表的论文 13 篇，即将在国内外核心刊物发表的 13 篇。其中有关放线菌分类研究的论文报告 21 篇，放线菌生态研究的 29 篇，微生物资源研究的 8 篇，方法学研究的 9 篇。在研究工作中，我们得到国家基金委，云南省基金委及各级组织的关怀和支持，作者深表谢意。

徐丽华

1998.2.8

## Foreword

Yunnan is the richest area in biodiversity, which is generally acknowledged at home and abroad. The scientific workers of three generations from our laboratory have used every conceivable stratagem and worked hard enough to study and exploit the resources of actinomycetes for a cool 30 years. The workers have sweated away at their work everywhere in Yunnan. Their route on travel is as long as 25,000 km!

The paper *Review on Study of Actinomycetes in Yunnan* written by Professor Jiang Chenglin is used as an article in lieu of a preface of the symposium. The paper briefly introduces the protracted tortuous course along which our laboratory has specialized in the study of actinomycetes, and the creative process and achievements based on which the foundation of the ecological study of actinomycetes has been established. The symposium is the summary conclusions of the past period. It includes 46 academic papers published in some authoritative journals at home and 13 ones in some authoritative journals abroad since 1976. And 13 papers will be published in some authoritative journals at home or abroad. The symposium contains 21 thesis reports, 29 papers on ecological study of actinomycetes, and 8 papers on study of microorganism resources, and 9 ones on study of the methodology. The National Funds for Natural Sciences, Yunnan Funds for Applied Basic Study and relative all - level organizations have been concerning about our study. The author sincerely acknowledges their concern and support.

**Xu Lihua**

**February 8, 1998**

## 云南放线菌研究之回顾（代序）

姜成林

1955年12月，中国科学院在北京召开了全国第一次抗生素学术会议。会议会刊发表了我国老一辈放线菌生物学家和抗生素专家阎逊初、蔡润生、尹幸耘、王岳、沈善炯、汪猷、童村等的论文16篇。这是奠基我国放线菌生物学研究和抗生素开发的主要标志。

云南的放线菌研究工作要晚十年。

1961-1966年，中国科学院昆明植物所土壤实验室张崇声先生等在进行云南西双版纳土壤微生物区系研究时，分离鉴定了部分放线菌。这是云南放线菌研究最早的记录。此项工作因遭到“文化大革命”的劫难而中断。1970年3月，为了执行支农任务，在当时一片混乱之中，本人受命组建农抗组，在3月24日的一个星期天，第一次专门从收集的土壤样品中分离出了放线菌，并从此走上了从事放线菌开发利用研究的艰难历程。参加这项工作的人数最多时竟有数十人之多，工作环境之糟糕是可以想象得到的。连本人当时也没有意识到要终身与放线菌这个微观世界结下不解之缘。这一时期的主要任务是初步建立研究条件，熟悉文献资料，奠定工作基础，工作十分艰难。

党的十一届三中全会的召开，给科学带来了希望。当时昆明植物所的领导吴征镒、张敖罗曾告诉我们：“如果你们要献身云南微生物资源开发利用的事业，建议你们坐几年的冷板凳，下功夫把分类搞起来”；阎逊初、阮继生先生着眼全国的放线菌研究和人才培养，也建议我们搞分类；我们经过两年多的系统研究和分析，终于在1978年7月，“放线菌分类研究”正式被确立为本室的研究方向。从此放线菌研究才踏上了稳健发展的道路。

整个七十年代，都是在艰难困苦中探求的时期，当然也是奠定基础的时期。

1979年本人起草关于“建议成立省微生物所”的报告，由张崇声、陈远腾、万象义、许坤一、江东福、姜成林签名呈报省委并李启明副书记，还得到吴征镒、曲仲湘、杨桂宫、潘清华、段金玉、张敖罗、刘智斌等的赞同和支持，不到半年就得到认可。1980年省政府正式批准成立云南省微生物研究所。该所的建立，聚集了当时中国科学院昆明植物所、动物所和云南大学从事微生物研究的同志50余人，为开发云南丰富的微生物资源创造了必要的前提。昆明植物所领导为了支持新成立的微生物所的研究工作，决定将本室使用的所有实验仪器及用品全部“陪嫁”，从而节约了两年极为宝贵的时间。搬迁工作仅用了一周时间，就能正常开展研究工作。

1980年3月徐丽华同志加入，开始了她长期卓有成效的放线菌研究生涯。她与同事们肝胆相照，同甘共苦，矢志不渝。自此本室的骨干力量基本形成，并步入放线菌研

究的结果期。

80年代,在国家自然科学基金委员会(以下简称国家基金委)的大力支持下,我室同志先后行程两万五千多公里,从全省不同地区的不同生态环境收集到了约5000份样品,并相继完成了云南土壤放线菌、湖泊放线菌及异常环境放线菌生态学的研究,在国内外核心刊物上发表了50多篇系列论文,尤其在1984~1986年,微生物学报几乎每期都有我室的论文发表,标志着我室的研究工作在我国微生物学研究中的重要地位。

### 一、我室在这一阶段对放线菌的主要研究成果

1. 从云南分离到的放线菌至少有29个属,约占全世界已发现的除放线细菌、多腔孢囊菌以外的放线菌总属数之半。可以肯定,随着分离方法的改进和研究工作的深入,还会发现更多的属。可见云南也是放线菌多样性极为丰富的一地区。

2. 云南的土壤放线菌区系可划分为热带区系,亚热带高原区系,滇西北高山区系和雪山区系。前两者的放线菌区系比较复杂,也比较相近,没有明显的界限。这与植物区系的划分不同。

3. 我们从大量实验结果中发现,随着原始植被的破坏,按原始林,次生林,荒地,旱地(耕作地)的顺序,放线菌的种类逐渐单调化。从微生物多样性的角度证明保护原始森林的极端重要性。进而提出保护原始环境以保护生物多样性的主张及相关的措施。根据大量实验得到的这些结论具有重要的理论意义和实用价值。

4. 越是干旱、贫瘠的土壤,放线菌的数量越少、种类也少,链霉菌占的比例也越大。

5. 从生态角度看,链霉菌属、小单孢菌属、马杜拉放线菌属、诺卡氏菌属是常见的放线菌,占70%以上。

6. 土壤中广泛分布着高温放线菌,其分布的上限在云南亚热带地区为海拔3500m左右,主要有链霉菌属、高温放线菌属、小单孢菌属和马杜拉放线菌属。

7. 湖泊水生放线菌生态系统的显著特征是小单孢菌占优势,占39%~89%。其次才是链霉菌。异龙湖等三个湖泊因干旱过二十多天致使放线菌种类急剧减少,进一步说明原始生态环境的改变将对微生物生态系统造成无法复原的严重后果。

8. 异常环境分布着特殊的放线菌种类,是重要的微生物资源。迄今人们对它们的认识尚少,开发潜力很大。

可以说,它们是迄今为止我国第一批规模浩大而系统的放线菌生态研究成果,甚至在国际上也是罕见的。这些工作奠定了我国放线菌生态学研究的基础。

放线菌分离方法始终是整个放线菌研究与开发的基础和核心问题之一。我们将其作为专门的研究课题,投入了大量的精力,也取得了很好的成果——我室是目前世界上掌握最先进分离方法的实验室之一。

与此同时,我室放线菌分类研究也得到了长足的进展——建立了较为系统的化学分类手段,发表二十多个新种,研究工作的水平基本与国内外同步。

## 二、九十年代以来, 本室研究工作取得的新进展

### 1. 基础研究和应用基础研究方面

(1) 早在 1987 年本人就致函京沪等地的同行, 建议合作研究开发云南丰富的放线菌资源, 并得到热烈响应。各单位分别拟定了各自的具体计划作复, 本人汇总写了项目建议书。并由阮继生先生与国家基金委反复协商, 经过两年多时间的协调、预审, 由于研究题目意义重大, 项目组成单位工作基础好、阵容强, 云南放线菌资源丰富, 终于在 1990 年 4 月论证通过了国家基金微生物学科第一个重大项目——“云南放线菌生态分布及其资源前期开发”。这是我国对一个省的微生物资源进行大规模研究与开发的第一个——也是迄今为止唯一的一个重大计划, 是云南放线菌研究的重要里程碑。通过近五年、60 多位同仁的艰辛劳动, 基本考察了云南的放线菌资源, 从两万多株放线菌中筛选出十多个有开发前景的抗生素产生菌, 为云南放线菌资源的开发利用奠定了坚实的基础, 开辟了广阔的研究领域。且使整个研究工作达到了国际水平。我组工作以 8A1B 的优异成绩通过验收。之后, 这项工作又继续得到云南省科委的大力支持, 使得我室放线菌生物活性物质的研究方向进一步得到明确和加强, 并被列入省重点研究计划。

(2) 90 年代以前, 我国学者尽管在微生物学报发表了几个放线菌的新属, 由于种种原因, 未被国际承认; 有的学者也在国外工作期间同外国同行共同发表过新属。本室在完成国家基金重大项目的过程中, 于 1991 年在国际公认的权威刊物 *Int. J. System Bacteriol.* 发表了完全由中国学者在国内进行的研究并第一个得到国际承认的放线菌新属——放线双孢菌属。1997 年日本出版的《放线菌图鉴》收录了该属。国内学者在其他一些地方的土壤样品中也证实了这个属的存在。国外学者还专门研究过这个属的分离问题。

(3) 1995 年, 与台湾学者合著出版了《放线菌分类学》(云南大学出版社, 昆明)。该著作得到国内外学者的好评, 认为是一本最新颖、最全面系统的放线菌分类学专著。日本著名的老资格放线菌分类学家清野说这是一本风格独特、与众不同的最新分类学著作, 并给以高度评价。

(4) 1997 年出版了国内外第一本《微生物资源学》(科学出版社, 北京)。该著对微生物资源学科的基本原理, 学科范围, 研究方法, 未来发展等首次进行了系统探索。它比较全面的论述了微生物(特别是放线菌)资源的特征, 开发利用的战略和策略, 明确提出了保护天然微生物资源的必要性和特殊性以及相关的措施。吴院士征镒先生在序言中就较为充分地指明了该著作在微生物资源学科形成中的作用和意义。

(5) 我室是国内最早开展放线菌分子生态研究并在国家基金列项的单位。目前我室在相关领域研究工作的深度和水平大体与国外相当。已建立了 DNA 分子测定程序等分子生物学研究手段及相关的信息系统, 开展了放线菌分子分类与分子生态研究, 本文集收录的即将在国外发表的六篇放线菌分子分类、分子生态的研究论文表明我室在这一领域所取得的实质性的研究成果。

(6) 研究方法始终是我室关注的重要问题之一。特殊放线菌的分离方法, 形态学研究, DNA 制备方法的改进, 数值分类程序的设计, 系统进化树构建程序的设计和进

等都是我们研究的对象，并且都获得了较满意的效果。

(7) 到目前为止，我室完成和发表的论文八十余篇，其中在国外刊物发表的二十多篇，国内核心刊物发表的四十多篇；获中国科学院、国家教委、云南省科技进步奖各一项。

## 2. 开发、应用研究方面

(1) 在今后较长一段时期内，烤烟仍将是我省重要经济支柱之一。而钾肥是提高烟叶质量的关键之一，我国钾肥供应又严重不足。发展微生物钾肥势在必行。我室在省科委山区开发部的支持和管理之下，从我省土地中分离到许多转化土壤钾的钾细菌，通过选育种研究及发酵工艺研究，再由有关的农科单位在全省几个地区连续三年进行了严格的烤烟同田对比试验，其增产效果在 67 - 440 元/亩，平均每亩增加产值 157 元 (13%)。迄至 97 年底已推广约 100 万亩。即使以每亩增产值 100 元来计算，农民得到的效益约 1 亿元；节约肥料成本约 1000 万元；生产厂家的直接效益约 50 万；三项效益之和为 11050 万元。同时还具有良好的生态效益。可见这项科研工作的投入产出比非常高。

(2) 受昆明市科委的委托，在有关单位的配合下，我室参与开发成功一种科技含量高，治疗效果好，经济效益显著的微生物新药，98 年将投产上市。

(3) “微生物湿法冶金”作为国家及省的五五攻关计划之一，为我室开辟了一个新的、实用价值高的研究领域。目前此项工作正在按计划进行。

随着研究工作的逐步深入和成果的不断积累，我室的国际交流也日益扩大，影响与日俱增。1993 - 95 年，我室与清华大学（台湾）等进行了卓有成效的合作，与欧美、日本等同行的合作也取得了一些进展；1993 年我室开始接收国外博士生或博士后进修。我室成员分别被美国微生物学会，纽约科学院，美国科学促进协会，日本放线菌协会、菌种联盟等学术组织邀请做会（成）员，多次被国内外邀请做博士的 Examiner, Supervisor, IFS 等基金会的 Advisor，世界名人录特约顾问编委，国际大型学术会议的 Organizer, Convener, Speaker，杂志编辑，全国学会理事等；《世界名人录》、《Who's Who in the World》等大型国际辞书收录了我室成员的业绩。国外杂志还专门报导过我室的工作。这些都进一步扩大了我国微生物学研究的国际影响，提高了我国学术研究的国际地位。

可以说今天的云南省微生物所放线菌实验室已经步入她的成熟期，成为我国放线菌研究的一块重要基地，人员结构比较合理，事业心强，后继有人；同时招收硕士生、博士生，能不断补充新鲜力量；学科比较配套，知识结构大体能适应研究工作的需要；现代研究手段大体建立，信息畅通；国际联系广泛，合作关系基本建立。

当然，这些成绩的取得，首先应归功于同志们艰苦奋斗的精神，脚踏实地的作风，少计较个人得失的人生哲学和良好的共事关系。我们的超时工作量估计要有 50% 左右。至今我室的研究员不但主持课题，而且仍然承担实验任务，在真才实学上下功夫，在取得实际进展上下功夫。几十年埋头苦干，宠辱皆忘，谈何容易！已故阎院士逊初先生曾经用“功到自然成”评价我们的工作，乃肺腑之言矣。科学研究是一门艺术，Idea 最重要。在处理远近关系，学科关系，基础研究与开发的关系，选题等方面，通过这些年科学研究的实践证明，我们的思路基本上是正确的，没有犯大的错误。我们必需牢记，国

家、省和云大基金会对我室工作长期、持续不断而有效的支持。国家基金自中国科学院基金开始，我室就连续不断地得到资助，而且几乎同时有两项。我室一共完成或正在进行的国家基金面上项目有五项、重大项目一项、国际合作项目一项，省应用基础研究基金一项、重点项目一项、国际合作项目三项，云南大学 211 工程基金重大项目一项。没有基金会的关怀和支持，我们的工作肯定寸步难行。我室工作长期得到吴征镒、段金玉、阎逊初、焦瑞身、阮继生等诸位先生及中国科学院沈阳应用生态研究所的关怀和指导，还有许宗雄、熊光滨、许文辉、黄东海、吴大刚、丁鉴、张忠泽及 Williams, Lechevalier 夫妇, Seino, Stackebrandt, Goodfellow, Mordarski, Shomura, Miyadoh, Locci, Bull 等等国内外朋友的鼎力相助，使我们的工作少走弯路，得益良多。云南省微生物所、云南大学、云南省科委、教委等各级组织为我们创造了能够安心工作的条件，全方位支持我们的工作，这也是成功的基本保证。

# Review of Study on Actinomycetes in Yunnan

(an article used in lieu of a preface)

The first national academic conference on antibiotics was held by the Chinese Academy of Sciences in Beijing in December of 1955. Sixteen papers on antibiotics were published in the Conference Journal. The authors were the biologists on actinomycetes and experts on antibiotics of the older generation in our country, including Yan Xunchu, Cai Runsheng, Yi Xingyun, Wang Yue, Shen Shanjiong, Wang You, Tong Cun and other scientists. The papers laid a main foundation for the biological study of actinomycetes and the exploitation of antibiotics.

Ten years later, Yunnan began its study on actinomycetes.

The isolation and identification of partial actinomycetes in soil were completed by Mr. Zhang Chongsheng who studied the microflora in soil of Xishuangbanna region from 1961 – 1966. He was from the Soil Laboratory, Kunming Botanical Institute, Chinese Academy of Sciences. This is the earliest record on study of actinomycetes in Yunnan. His study on actinomycetes was suspended by “the great cultural revolution”.

I was assigned to organize an antibiotics team to support agricultural production in March of 1970. Some actinomycetes were isolated from a special soil sample for the first time on March 24, 1970 (Sunday). I was on the long and hard course of study on exploitation and utilization of actinomycetes. Sometimes, a few dozens of people attended the work. You couldn't image how bad the working conditions were! At that time I did not realize I would deal with actinomycetes – the microworld all my life. The main task during that period was to create preliminary study conditions, be familiar with relative historical documents and data, and establish working foundation and so on.

The opening of the 3rd Plenary Session of the Eleventh Central Committee of the Communist Party of China brought hope to science. At that time, Wu Zhengyi and Zhang Aoluo (leaders of Kunming Botanical Institute) once told us: “If you want to devote yourselves to the cause of exploitation and utilization of microorganism resources in Yunnan, you should stay in your office for a few years. We recommend you should devote a lot of time and energy to the classification of actinomycetes.” Yan Xunchu and Ruan Jisheng also recommended us to do the classification work to train successors for the cause for the country. We studied and analyzed the study direction for over 2 years. The “Study on Classification of Actinomycetes” was finally determined as the objective of our laboratory in July of 1978. The study of actinomycetes has firmly gone on a development road since

then. 1970s was a hard and difficult period during which our foundation was established. I once wrote a report "Proposal on Establishment of the Yunnan Institute of Microbiology" in 1979. The proposal was signed by Zhang Chongsheng, Chen Yuanteng, Wan Xiangyi, Xu Kunyi, Jiang Dongfu and Jiang Chenglin, and submitted to the Yunnan Provincial Committee of the Communist Party of China. Then it also got agreement and support from Mr. Li Qiming (vice secretary of the committee). Wu Zhengyi, Qu Zhongxiang, Yang Guigong, Pan Qinghua, Duan Jinyu, Zhang Aoluo and Liu Zhibing. Only half a year later (1980), Yunnan Provincial Government officially approved the establishment of the Yunnan Institute of Microbiology. The institute attracted more than 50 experts who were engaged in microbiology from Kunming Botanical Institute and Kunming Zoological Institute of Chinese Academy of Sciences, Yunnan University. Therefore, the essential prerequisites of exploiting the rich microorganism resources in Yunnan had been created. The leaders of Kunming Botanical Institute donated all the experimental apparatuses and supplies as "dowry" (which had been used by our laboratory) to the newly established institute, that saved two precious years for us. It took us only a week for the moving of the articles, and then could be on normal operation. Ms Xu Lihua joined the institute in March of 1980, who has began her long-term and successful career of studying actinomycetes since then. She showed utter devotion to colleagues, shared weal and woe and vowed to adhere to her chosen course. The backbone force of the laboratory was formed at that stage. The study on actinomycetes began to enter a fruitful period.

With the help of the National Funds for Natural Sciences (NFNS) in 1980s, the experts of our laboratory began their 25,000 km journey, went through various areas of Yunnan province to collect more than 5,000 samples from different ecological environments. We successfully completed the study on ecology of actinomycetes in soil, in lakes and in abnormal environments. More than 50 serial papers were published in some authoritative journals at home and abroad. Almost every issue of Microbiological Sinica published our papers from 1984 - 1986, which shows our research plays an important role in the microbiology circle of our country.

## 1. Main achievements of our study on actinomycetes

(1) At least 29 genera of actinomycetes have been isolated in Yunnan, accounting for 50% of the total genera of actinomycetes isolated in the world (excluding antino-bacteria and multisporous bacteria). It may be concluded that a lot more genera will be found with the improvement of the isolation methods and further study. It is seen that actinomycetes in Yunnan is very rich and diversified.

(2) The microfloras of soil actinomycetes in Yunnan may be classified as the tropical microflora, subtropical plateau microflora, northwestern Yunnan mountain microflora and snow-mountain microflora. The former two microfloras are comparatively complicated and similar without noticeable differences. The classification of the microflora is different from that of botanical floras.

(3) Based on a lot of experimental results, we have found that the genera of actinomycetes become more and more monotonous in the order of virgin forests, secondary forests, waste land and dry

land (cultivated land) because the original vegetation is destroyed day by day. The protection of virgin forests is very important, which can be proved from the angle of diversity of microorganism. The protection proposal and corresponding measures should be taken to protect original environments for diversity of living things. These conclusions come from a lot of experiments.

(4) The more the soil is arid and barren, the less the number and varieties of actinomycetes will be, and the higher the proportion of streptomycetes will be.

(5) From the angle of ecology, *Streptomyces*, *Micromonospora*, *Actinomadura* and *Nocardia* can be seen everywhere, which account for over 70% of the total.

(6) Thermophilic actinomycetes widely distribute in soil. The upper limit of their distribution is 3,500m above sea level in the subtropical areas of Yunnan, including mainly *Streptomyces*, *Thermoaactinomycetes*, *Micromonospora* and *Actinomadura*.

(7) The ecological system of aquatic actinomycetes in lakes is characterized by the fact that micromonosporin is dominant, accounting for 39% - 89%. Streptomycetes rank the second. The fact that quick decrease of actinomycetes resulting from 20 days of drought in three lakes (including Yilong lake) further proves that the change of original ecological environments will cause serious results to the ecological system of microorganism which can not be recovered.

(8) Distributing in abnormal environments, unique actinomycetes are important resources of microorganism. They have great potential of exploitation. However, We know the resources preliminarily so far.

It may be said that the above achievements are the first batch of scientific results from the large - scale and systematically ecological study on actinomycetes in our country so far, which are even rare in the world. These results have established the foundation of the study on ecology of actinomycetes in our country.

As our special study topic, the isolation methods of actinomycetes has been a basic and key factor to exploit and study actinomycetes. We have spent a lot of energy on it and achieved some good results. At present, our laboratory is one of the laboratories which have mastered the most advanced isolation methods of actinomycetes in the world.

At the same time, our laboratory has made great progress in the aspect of classification actinomycetes. The comparatively systematic chemical classification methods have been established and by which more than 20 species have been found. The level of our study work synchronizes the level at home and abroad.

## 2. The Laboratory Has Made the Latest Progress since 1990s

### 1) In the aspects of basic study and applied basic study

(1) In as early as 1987, I wrote some letters to my colleagues who worked in Beijing and Shanghai to put forward a proposal that all of us should co - operate with each other to study and exploit the rich resources of actinomycetes in Yunnan. They agreed to my proposals completely. Each institute proposed its specific projects and replied to me, and then I compiled a proposal based on

their projects. Mr. Ruan Jisheng consulted with the National Funds for Natural Sciences (NFNS) many times to discuss the proposal. After more than two years of waiting, the NFNS demonstrated and approved the first major project on microbiology subject – “Ecological Distribution of Actinomycetes and Exploitation of the Resources at Earlier stage in Yunnan”, because the study project was very significant, the cooperative institutes had good background and a galaxy of talent and the resources of actinomycetes were rich in Yunnan. This project was the first major one, and has been the only major one so far in our country, which carry out so large – scale study and exploitation of microorganism resources at the level of the province. The project is an important milestone to the study of actinomycetes in Yunnan. More than 60 colleagues had worked hard for 5 years to investigate the resources of actinomycetes in Yunnan. They selected more than 10 antibiotics producing bacteria which were of good prospects from over 20 million actinomycetes. The results established a firm foundation for exploitation and utilization of the resources of actinomycetes in Yunnan and opened wide study fields. Our study level was coincident with the international one, and the achievements (8AIB) of our team was accepted. Afterwards, the Yunnan Commission for Science and Technology continued to support our study. That further consolidated and enhanced our direction of study on active substances of actinomycetes, and our project concerned was taken in the plan of provincial key projects.

(2) Before 1990s, though some Chinese scholars published several new genera of actinomycetes in *Microorganism Sinica*, they were not accepted abroad. Some scholars (who once worked abroad) with their foreign colleagues published new genera of actinomycetes. During the implementation of the major project on actinomycetes supported by the NFNS, We published new genus of actinomycetes – *actino – double – spore mycin* in an international authoritative journal – *Int. J. System Bacteriol* in 1991, which had been accepted in the world. The new genus was shown in the Japanese journal “*Graphical Identification On Actinomycetes*” in 1997. Some Chinese scholars also isolated the genus from some soil samples in other areas of China, and confirmed the existence of the genus. Some foreign scholars specially studied the isolation of the genus.

(3) We cooperated with some scholars from Taiwan to write the book “classification of Actinomycetes” which was published in 1995 (Yunnan University Press, Kunming). The book was well appraised by scholars at home and abroad. It is believed that the book is the latest special one on classification theory of actinomycetes, and it is an overall and systematical works. Shino (a senior Japanese classifier) appraised the works highly, “This is the latest classification and unique works.”

(4) The book “Resource Theory of Microorganism” was published at home in 1997 (Science Press, Beijing). The book first systematically describes the basic principle, scope, methods and prospects of the microorganism resource theory. It discusses the characteristics of microorganism resources, strategy and tactics of exploitation and application, puts forward the necessity and specials of protecting natural microorganism resources, and corresponding measures to be taken. Mr. Zhengyi (academician) fully indicates in the preface that the book is of importance and significance in the

process of forming the resource theory of microorganism.

(5) Our laboratory is the first one to study the molecular ecology of actinomycetes. And our project is ranked among the projects by the NFNS. At present, our laboratory's level in the correlative fields is generally coincident with that of foreign correlative laboratories. The means and correlative information systems such as the DNA molecular detection program for the studying of molecular biology have been established. The study of molecular classification and ecology of actinomycetes has been made. The six papers on molecular classification and ecology of actinomycetes are shown in the symposium, and are to be published abroad. The papers show that our laboratory have achieved essential results.

(6) Our laboratory has paid great attention to the studying methods. Our studying objectives include the isolation methods of special actinomycetes, morphology, improvement of DNA preparation method, design of data classification programs, design and improvement of reconstruction programs of the phylogenetic tree. And some satisfactory results have been achieved.

(7) More than 80 papers have been written and published so far, some 20 papers abroad, and some 40 at home. A prize was given by the Chinese Academy of Sciences, a prize by the State Education Commission, and a prize for science & technology progress by Yunnan province.

## **2. Aspects of exploitation and application**

(1) Tobacco will still be the important mainstay of economy in Yunnan province in future. And potash fertilizer is one of the key factors which can raise the quality of tobacco leaves while potash fertilizer is of shortage in our country. Development of potash fertilizer with microorganism is a necessary tendency. With the help and support of the Mountainous Development Department of Yunnan Commission for Sciences & Technology, our laboratory isolated many potash bacteria from some soil samples in Yunnan, which can convert potash in soil. Based on the study of seed selection and cultivation and ferment technology, some correlative agricultural scientific departments made comparison tests in tobacco fields in several areas of Yunnan province for 3 years. The results show that the increasing value is 67 - 440 RMB Yuan/mu. The average increasing value is 157 RMB Yuan/mu (13%). The method had been popularized in one million mu tobacco fields by the end of 1997. Calculating by increasing value of 100RMB Yuan/mu, tobacco farmers increased 100,000,000 RMB Yuan, saved 10,000,000RMB Yuan of fertilizer cost, and the producers earned 500,000-RMB yuan (pure profit). The total is 110,500,000 RMB yuan. And the ecological environment is also improved. It is seen that the ratio of income to investment is very high in the project.

(2) Entrusted by the Kunming Commission for Science & Technology, and cooperating with some institutions, our laboratory participated in developing successfully a new microorganism pharmaceutical medicine. Its scientific and technical contents are high, curative effect is good and economic result is noticeable. The medicine has been sold on the market since 1998.

### **(3) "Microorganism Wet Metallurgy"**

As one of the key projects of the ninth five - year plan of province and our country, the project

opens a new and high - value study field for our laboratory. The project is being performed according to the plan.

As our study is deepened and our scientific achievements are accumulated, the international exchanges of ours are expanding step by step. And our reputation is raising day by day. From 1993 to 1995, our laboratory successfully cooperated with Qinghua University( Taiwan). Our cooperation with some colleagues from Europe, USA and Japan has made some progress. Our laboratory began to admit foreign doctors and postdoctors for advanced studies in 1993. Some members of the laboratory were invited to join the American Microorganism Association, Newyork Academy of Sciences, American Science Improvement Association, Japan Actinomycetes Association, Japan Fungus Seeds Association and other academic organizations, and some were invited many times by some foreign institutes and organizations to become the Examiner and Supervisor of their doctors, and the Advisor of IFS Foundation, Special Advisory Compiler of "Great Names in the World", Organizer and Conven-er Speaker of some large - scale international academic conferences, editor of some magazines, and member of some national associations at home. The achievements of some members of our laboratory are shown in some international dictionaries such as " Great Names in the World" and " Who's Who in the World". Some foreign magazines specially reported our laboratory. All these has further enlarged the influence of our country's microbiology study in the world, which has raised the international position of our country's academic study.

It may be said that the Actinomycetes Laboratory of the Yunnan Institute of microbiology has entered into its mature period, and become an important base of studying actinomycetes in our country. The structure of its research personnel is comparatively reasonable. The personnel are ambitious and their successors are qualified. The laboratory also employs masters and doctors from time to time to increase its fresh force. The scientific subjects are reasonably matched with each other. The knowledge structure of the personnel can meet the requirements of performing the relative projects. The modern research means and cooperation relations have been established. The information flows quickly for us and our international contacts are very wide.

The above achievements are attributed to our research personnel's hard work, a down - to - earth style of work, selfless philosophy of life, and good relations between colleagues. We often work overtime and the time generally exceed 50% of our normal working hours. The professors of our laboratory not only undertake the study projects, but also perform experimental tasks. They completely concentrate on real ability and learning and actual progress. They have worked hard for a few dozen years, and remained indifferent whether granted favors or subjected to humiliation. How difficult it is! The late academician Mr. Yan Xunchu once appraised our work with the sentence " Constant effort yields sure success!" This is the words from the bottom of his heart! Scientific study is an art. Idea is the most important factor. The study practice of these years shows that our idea is generally correct in the selection of projects. We have reasonably dealt with near and distant relations, relations among various subjects, and relation between basic study and exploitation. No major mistake has occurred to us so far. We should never forget that the national funds, the provincial