

CURRICULUM VITAE

CHING-YAN LI

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Born: November 20, 1936, Taichung, Taiwan
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A. BACKGROUND

1. Education

1960 B.S. National Taiwan University, Taipei (Plant Pathology)
1963 M.S. Oklahoma State University, Stillwater (Plant Pathology)
1969 Ph.D. Oregon State University, Corvallis (Soil Microbiology)

2. Fields of Specialization

- a. Soil microbial ecology
- b. Physiological plant pathology
- c. Forest pathology
- d. Microbial physiology

3. Professional Experience

1961-1963	Research Technician, Department of Botany and Plant Pathology, Oklahoma State University, Stillwater.
1964-1969	Research Assistant, Department of Microbiology, Oregon State University, Corvallis.
1986-1998	Adjunct Associate Professor, Department of Forest Science, Oregon State University, Corvallis.
1999 – present	Adjunct Professor, Department of Forest Science, Oregon State University, Corvallis.

1994 to present	Adjunct Professor, Environmental Microbiology, Center for Biological Research, La Paz, Baja California, Mexico.
1969 -1977	Microbiologist, GS-11, USDA-Forest Service, Pacific Northwest Research Station, Corvallis, Oregon.
1977-1981 Pacific	Research Microbiologist, GS-12, USDA-Forest Service, Northwest Research Station, Corvallis, Oregon.
1981-1993	Research Microbiologist, GM-13, USDA-Forest Service, Pacific Northwest Research Station, Corvallis, Oregon.
1993-1998	Research Microbiologist, GM-14, USDA-Forest Service, Pacific Northwest Research Station, Corvallis, Oregon.
1998- 2004	Supervisory Microbiologist, GS-15, USDA-Forest Service, Pacific Northwest Research Station, Corvallis, Oregon.
2004 - present	Emeritus Research Microbiologist, USDA-Forest Service, Pacific Northwest Research Station, Corvallis, Oregon.

B. Honors and awards:

- (1) Distinguish Service Award, National Taiwan University, 1957.
- (2) Sigma Xi Society member elected in 1972.
- (3) Certificate of Merit and step increase award, USDA-FS, 1974, for distinguished achievements in root disease research.
- (4) Who's who in the West, 1978-1979.
- (5) Certificate of Award by the North American Truffling Society for discovery of nitrogen-fixing bacteria in hypogeous fungi, 1985.
- (6) Certificate of Merit and \$500 cash award, USDA-FS, 1988, for a concentrated effort at international cooperative research and maintaining the excellent quality of personal research.
- (7) Certificate of Gold Award, United Way of Benton county of Oregon, 1990, for superior achievement and outstanding leadership in the Combined Federal Campaign.
- (8) Outstanding Faculty and \$250 cash award, 1991, Department of Forest

Science, Oregon State University.

- (9) Certificate of Merit and \$1,000 cash award, USDA-FS, 1994, for aggressive outreach and recruitment, for creating unique training experiences and for personally creating a work, living, and social environment that reflects positively on the PNW Research Station as a multicultural organization.
- (10) National Research Council Science Research Fellow (Taiwan) directing research program of *Frankia* in *Alnus formosana* for the Taiwan Forestry Research Institute. October-December 1987.
- (11) National Research Council Science Research Fellow (Taiwan) directing research program of associative nitrogen fixation in *Eucalyptus* for the Taiwan Forestry Research Institute. October-December 1992.
- (12) Consultancy for the FAO of the United Nations on Biofertilizers program to the Tropical Forest Research Institute at Jabalpur, India. September-October 1994.
- (13) Consultant to the Polish Committee for Scientific Research funded research program of ecology and physiology of nitrogen-fixing endophyte *Frankia* of alders (*Alnus* spp.) in Poland, Nicolaus Copernicus University, Torun. 1995-1997.
- (14) STA (Science and Technology Agency of Japan) Research Fellow directing research program of *Frankia*-mycorrhizal interactions for the Forestry and Forest Products Research Institute, Tsukuba, Japan. May-July, 1997.
- (15) Fulbright Scholar, 2001 – 2002.
- (16) Distinguished Professor, named by the Mexican Academy of Science, 2003.

C. DOCUMENTATION OF ACCOMPLISHMENTS

1. Refereed publications:

- (1) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1967. Selective nitrogen assimilation by *Poria weirii*. *Nature* 213 (5087): 814.
- (2) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1968. Enzyme systems of

- red alder and Douglas-fir in relation to infection by *Poria weirii*. p. 241-249. In J. M. Trappe, J. F. Franklin, R. F. Tarrant, and G. M. Hansen (eds.), *Biology of Alder*. Pacific Northwest Forest and Range Exp. Sta., Portland.
- (3) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1969. A simple quantitative method of assaying soil for inhibitory fungi. *Soil Biology* 10: 6-7.
 - (4) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1969. Effect of phenolic and other compounds on growth of *Poria weirii* *in vitro*. *Microbios* 3: 305-311.
 - (5) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1970. Inhibition of *Poria weirii* and *Fomes annosus* by linoleic acid. *Forest Sci.* 16(3): 329-330.
 - (6) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1970. Separation of phenolic compounds in alkali hydrolysates of a forest soil by thin-layer chromatography. *Can. J. Soil Science* 50: 458-460.
 - (7) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1972. *Poria weirii*-inhibiting and other phenolic compounds in roots of red alder and Douglas-fir. *Microbios* 5: 65-68.
 - (8) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1972. Nitrate-reducing capacity of roots and nodules of *Alnus rubra* and roots of *Pseudotsuga menziesii*. *Plant and Soil* 34: 409-414.
 - (9) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1973. Formation of *p*-hydroxybenzoic acid from phenylacetic acid by *Poria weirii*. *Can J. Bot.* 51: 827-828.
 - (10) Trappe, J. M., C. Y. Li, K. C. Lu, and W. B. Bollen. 1973. Differential response of *Poria weirii* to phenolic acids from Douglas-fir and red alder roots. *Forest Science* 19: 191-196.
 - (11) Li, C. Y. 1974. Phenolic compound in understory species of alder, conifer, and mixed alder-conifer stands of coastal Oregon. *Lloydia* 37: 603-607.
 - (12) Li, C. Y. and W. B. Bollen. 1975. Growth of *Phellinus (Poria) weirii* on different vitamins and carbon and nitrogen sources. *Amer. J. Botany* 63: 838-841.
 - (13) Li, C. Y. 1978. Conversion of *p*-coumaric acid to caffeic acid and of *p*-hydroxyphenylacetic acid to 3,4-dihydroxyphenylacetic acid by *Alnus rubra*. *Lloydia* 40: 298-300.
 - (14) Li, C. Y. 1978. Fatty acids in soil under conifer, red alder, and mixed

- alder-conifer stands of coastal Oregon. *Soil Science* 125: 92-94.
- (15) Nelson, E. E., E. M. Hansen, C. Y. Li, and J. M. Trappe. 1978. The role of red alder in reducing losses from laminated root rot. p.273-282. *In Utilization and Management of Alder*. Pac. Northwest Forest and Range Exp. Stn., Portland, Oregon.
 - (16) Li, C. Y. and J. J. Kabara. 1978. Effects of Lauricidin on *Fomes annosus* and *Phellinus weirii*. *American Oil Chemical Society Monograph* 5: 45-50.
 - (17) Cromack, K. Jr., P. Sollins, W.C. Graustein, K. Speidel, A. W. Todd, G. Spycher, C. Y. Li, and R. L. Todd. 1979. Calcium oxalate accumulation in mats of the ectomycorrhizal fungus *Hysterangium crassum* (Tul. and Tul.) Fischer. *Soil Biol. Biochem.* 11: 463-469.
 - (18) Li, C. Y. 1979. Light and temperature induced sporocarp formation of *Phellinus weirii*. *Can. J. Forest Research* 9: 535-538.
 - (19) Rose, S. L., C. Y. Li, and A. S. Hutchins. 1980. A *Streptomyces* antagonist to *Phellinus weirii*, *Fomes annosus*, and *Phytophthora cinnamomi*. *Can. J. Microbiology* 26: 583-5587.
 - (20) Hutchins, A. S. and C. Y. Li. 1981. Relative capacities of filamentous and non-filamentous bacteria from two forest soils to inhibit *Phellinus weirii* in culture. *Northwest Science* 55: 219-224.
 - (21) Sollins, P., K. Cromack, Jr., R. Fogel, and C. Y. Li. 1981. Role of low-molecular-weight organic acids in the inorganic nutrition of fungi and higher plants, pp. 607-619. *In* D. Wicklow and G. Carroll (eds.). *The Fungal Community*. Mariel Dekker, New York.
 - (22) Li, C. Y. 1981. Phenoloxidase and peroxidase activities in zone lines of *Phellinus weirii*. *Mycologia* 73: 811-82.
 - (23) Li, C. Y. 1981. Fatty acid composition of *Phellinus weirii* and *Polyporus versicolor* isolates. *Microbios Letters* 16: 121-125.
 - (24) Li, C. Y. 1983. Melanin-like pigment in zone lines of *Phellinus weirii* colonized wood. *Mycologia* 75: 562-566.
 - (25) Li, C. Y. and E. E. Nelson. 1985. Persistence of benomyl and captan and their effects on microbial activity in field soils. *Bull. Environ. Contamination and Toxicology* 34: 533-538.
 - (26) Li, C. Y., C. Maser, Z. Maser, and B. A. Caldwell. 1986. The role of three

- rodents in forest nitrogen fixation in western Oregon: Another aspect of mammal-mycorrhizal fungus-tree mutualism. *Great Basin Naturalist* 46: 411-414.
- (27) Li, C. Y., C. Maser, and H. Fay. 1986. An initial survey of acetylene reduction and selected microorganisms in the feces of nineteen taxa of mammals. *Great Basin Natur.* 46: 646-650.
- (28) Li, C. Y. and L. L. Hung. 1987. Nitrogen-fixing (acetylene-reducing) bacteria associated with ectomycorrhizae of Douglas-fir. *Plant and Soil* 98: 425-428.
- (29) Li, C. Y. and M. A. Castellano. 1987. *Azospirillum* isolated from within sporocarps of the mycorrhizal fungi *Hebeloma crustuliniforme*, *Laccaria laccata*, and *Rhizopogon vinicolor*. *Trans. Brit. Mycol. Soc.* 88: 563-566.
- (30) Thies, W. G. and C. Y. Li. 1987. Movement of Lauricidin in Douglas-fir stumps infested by *Phellinus weirii*. *Northwest Science* 62: 16-20.
- (31) Li, C. Y. 1987. Association of nitrogen-fixing bacteria with mycorrhizal fungi and feces of forest-dwelling mammals in relation to forest productivity. p. 125-130. *In* T, Kiang, J. C. Yang & Y. P. Kao (eds.) *Forest Productivity and Site Evaluation*. Council of Agriculture, Taipei, Taiwan, Republic of China.
- (32) Li, C. Y., K. V. B. R. Tilak, and J. M. Trappe. 1988. Characterization of nitrogen-fixing *Azospirillum* isolated from within sporocarps of different ectomycorrhizal fungi associated with Douglas-fir. *Indian J. Microbiol.* 28: 315-319.
- (33) Tilak, K. V. B. R., C. Y. Li, and Iwan Ho. 1989. Occurrence of nitrogen-fixing *Azospirillum* from spores of vesicular-arbuscular mycorrhizal fungi. *Plant and Soil* 116: 286-288.
- (34) Friedman, J., C. Y. Li, and D. A. Perry. 1989. Actinomycetes inducing phytotoxic or fungistatic activity in a Douglas-fir forest and in an adjacent area of repeated regeneration failure in southwestern Oregon. *Biologia Plantarum.* 31: 487-495.
- (35) Amaranthus M. P., C. Y. Li, and D. A. Perry. 1990. Influence of vegetation type and madrone-soil inoculum on associative nitrogen fixation in Douglas-fir rhizosphere. *Can. J. Forest Res.* 20: 368-371.
- (36) Tilak, K. V. B. R. and C. Y. Li. 1990. Enhancement of spore germination of *Glomus fasciculatum* by cell-free extracts of non-symbiotic nitrogen-fixing bacteria. *Indian J. Experimental Biology* 28: 373-375.

- (37) Tilak, K. V. B. R., D. J. Bagyaraj and C. Y. Li. 1991. Nitrogen fixation by *Azospirillum* in the rhizoplane and endorhizosphere of western hemlock (*Tsuga heterophylla*) growing on decaying wood. J. Soil Biol. Ecol. 11: 19-23.
- (38) Li, C. Y., H. B. Massicotte and L. V. H. Moore. 1992. Nitrogen-fixing *Bacillus* sp. associated with Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) tuberculated ectomycorrhizae. Plant and Soil 140: 35-40.
- (39) Rojas, N. S., C. Y. Li, and D. A. Perry. 1992. Influence of soil and rhizosphere actinomycetes on *Frankia* infection, nitrogenase activity, and seedling growth of red alder (*Alnus rubra*). Soil Biol. Biochem. 24: 1043-1049.
- (40) Massicotte, H. B., L. H. Melville, C. Y. Li and R. L. Peterson. 1992. Structural aspects of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) tuberculate ectomycorrhizae. Trees 6: 137-146.
- (41) Strzelczyk, E., H. Rozycki and C. Y. Li. 1992. Effect of different carbon and nitrogen sources and vitamins on growth of *Azospirillum* spp. isolated from coniferous ectomycorrhizae and sporocarps of ectomycorrhizal fungi. Acta Microbiol. Polonica. 41: 193-201.
- (42) Bormann, B. T., F. H. Bormann, W. B. Bowden, R. S. Pierce, S. P. Hamburg, D. Wang, M. S. Snyder, C. Y. Li and R. C. Ingersoll. 1993. Rapid N₂ fixation in pines, alder, and locust: evidence from the sandbox ecosystem study. Ecology 74: 583-598.
- (43) Dahm, H., H. Rozycki, E. Strzelczyk and C. Y. Li. 1993. B-group vitamins production by *Azospirillum* spp. grown in medium of different pH at different temperatures. Zentral. Mikrobiol. 148: 195-203.
- (44) Pokojska, A., E. Strzelczyk, C. Y. Li, H. Rozycki and M. Szablewska. 1993. Effect of plant growth regulators on growth of ectomycorrhizal fungi. Crypt. Bot. 4: 8-13.
- (45) Strzelczyk, E., A. Pokojska, H. Rozycki, D. A. Perry, and C. Y. Li. 1993. Growth of mycorrhizal fungi in dixerenic cultures with bacteria in media of different composition. Acta Microbiologica Polonica 42: 41-50.
- (46) Strzelczyk, E., M. Kampert, and C. Y. Li. 1994. Cytokinin-like substances and ethylene production by *Azospirillum* in media with different carbon sources. Mikrobiol. Res. 149: 55-60.
- (47) Molina, R., D. D. Myrold and C. Y. Li. 1994. Root symbioses of red alder: Technological opportunity for enhanced regeneration and soil improvement, pp.

- 23-46. In (eds. D. E. Hibb, D. S. DeBell and R. Tarrant) The Biology and Management of Red Alder. Oregon State University Press, Corvallis.
- (48) Li, C. Y. and R. H. Crawford. 1994. The biological significance of coarse woody debris in forest ecosystems. pp. 3-12. In (Eds. F. W. Horng and J. C. Yang) Sino-America Forestry Technology Cooperation Workshop on Sustainable Management of Temperate and Subtropical Plantation Ecosystem. Council of Agriculture, Taiwan Forestry Research Institute, Taipei, Taiwan.
- (49) Chang, T. T., C. Y. Li and L. C. Wang. 1994. Nitrogen-fixing (acetylene reducing) bacteria associated with vesicular-arbuscular mycorrhizae of *Eucalyptus* in Taiwan. pp. 29-34. In (Eds. F. W. Horng and J. C. Yang) Sino-America Forestry Technology Cooperation Workshop on Sustainable Management of Temperate and Subtropical Plantation Ecosystem. Council of Agriculture, Taiwan Forestry Research Institute, Taipei, Taiwan.
- (50) Strzelczyk, E., M. Kampert, H. Rozycki and C. Y. Li. 1994. Effect of plant growth hormones on growth of *Azospirillum* sp in media with different carbon sources. Acta Microbiologica Polonica 43: 89-95.
- (51) Rozycki, H., M. Kampert, E. Strzelczyk, C. Y. Li, and D. A. Perry. 1994. Effect of different soil bacteria on mycorrhizae formation in Scots pine (*Pinus sylvestris* L.) - *in vitro* studies. Folia Forestalia Polonica, Series A - Forestry, No 36: 91-102.
- (52) Rozycki, H., E. Strzelczyk and C. Y. Li. 1996. Impact of B-group vitamins on the growth of *Azospirillum*. Acta Microbiologica Polonica 45: 203-212.
- (53) Koo, C. D., R. Molina, S. Miller and C. Y. Li. 1996. Effects of nitrogen and phosphorus fertilization on ectomycorrhiza development, N-fixation and growth of red alder seedlings. J. Korea Forestry Soc. 85: 96-106.
- (54) Li, C. Y., E. Strzelczyk, and A. Pokojaska. 1996. Nitrogen-fixing endophyte *Frankia* in Polish *Alnus glutinosa* (L.) Gaertn. Mikrobiol. Res. 151: 371-374.
- (55) Crawford, R. H., C. Y. Li, and M. Floyd. 1997. Nitrogen fixation in root-colonized large woody residue of Oregon coastal forests. Forest Ecology and Management 92: 229-234.
- (56) Hope, S. and C. Y. Li. 1997. Respiration, nitrogen fixation, and mineralizable nitrogen spatial and temporal patterns within two Oregon Douglas-fir stands. Can. J. Forest Res. 27: 501-509.
- (57) Li, C. Y., R. H. Crawford, and T. T. Chang. 1997. *Frankia* in decaying fallen

- trees devoid of actinorhizal hosts and soil. *Microbiological Research* 152: 167-169.
- (58) Strzelczyk, E., A. Pokojaska-Burdzie, and C. Y. Li. 1997. Effect of Cd²⁺, Zn²⁺ and Cu²⁺ on auxins production by *Azospirillum* strains. *Acta Microbiologica Polonica* 46: 263-270.
- (59) Dahm, H., C. Y. Li, and K. Januszek. 1997. Development of microorganisms and oxidation of some organic compounds in soil polluted with heavy metals. *Polish J. Soil Science* 30: 55-63.
- (60) Rozycki, H., E. Strzelczyk, and C. Y. Li. 1998. Preliminary studies on bacteria of soil and of the root zone of black [*Alnus glutinosa* (L.) Gaertn.] and grey [*A. incana* (L.) Moench.] alder seedlings. *Acta Microbiologica Polonica* 47: 91-103.
- (61) Chang, T. T. and C. Y. Li. 1998. Weathering of limestone, marble, and calcium phosphate by ectomycorrhizal fungi and associated microorganisms. *Taiwan J. Forest Science* 13: 85-90.
- (62) Rozycki, H., E. Strzelczyk, and C. Y. Li. 1999. Diazotrophic bacteria in rhizosphere soil and in root zone of Scots pine (*Pinus sylvestris* L.) and red oak (*Quercus robur* L.). *Applied Soil Ecology* 12: 239-250.
- (63) Rojas, N., C. Y. Li, D. A. Perry, and L. M. Ganio. 2001. *Frankia* and nodulation of red alder and snowbrush grown on soils from Dourlas-fir forests in the H.J. Andrews Experimental Forest of Oregon. *Applied Soil Ecology* 72: 141-149.
- (64) Li, C. Y. and E. Strzelczyk. 2000. Belowground microbial processes underpin forest productivity. *Phyton* 40: 129-134.
- (65) Strzelczyk, E. and C. Y. Li. 2000. Bacterial endobionts in the big non-mycorrhizal roots of Scots pine (*Pinus sylvestris* L.). *Microbiol. Res.* 155: 1-4.
- (66) Crawford, R. H., M. Floyd, and C. Y. Li. 2000. Degradation of serpentine and muscovite rock minerals and immobilization of cations by soil *Penicillium* spp. *Phyton* 40: 209-328.
- (67) Gierasimiuk, J., Rozycki H., Strzelczyk E., and Li, C. Y. 2001. Studies on fast- and slow-growing bacteria in the root-free soil, rhizosphere and mycorrhizosphere of nursery seedlings and 70-year-old Scots pine (*Pinus sylvestris* L.). Enumeration and identification. *Polish J. Soil Sci.* 34: 77-87.
- (68) Gerasimiuk, J., Rozycki H., Strzelczyk E., and Li, C. Y. 2001. Studies on fast- and slow-growing bacteria occurring in the root-free soil, rhizosphere and

- mycorrhizosphere of nursery seedlings and 70-year-old Scots pine (*Pinus sylvestris* L.) - nutritional requirements and physiological properties. *Folia Forestalia Polonica, Series A- Forestry*, No 43: 115-126.
- (69) Rojas, N., C. Y. Li and D. A. Perry. 2002. Interactions among soil biology, nutrition, and performance of actinorhizal plant species in an Oregon clearcut. *Applied Soil Ecology* 19: 13-26.
- (70) Bashan, Y., C. Y. Li., M. Moreno, V.K. Lebsky, and L. E. Bashan. 2002. Primary colonization of volcanic rocks by plants in arid Baja California, Mexico. *Plant Biology* 4: 392-402.
- (71) Puente, M. E., Y. Bashan, C. Y. Li, and V. K. Lebsky. 2004. Microbial populations and activities in the rhizosphere of rock-weathering desert plants, I. Root colonization and weathering of lava rocks. *Plant Biology* 6: 629-642.
- (72) Puente, M. E., C. Y. Li and Y. Bashan. 2004. Microbial populations and microbial activities in the rhizosphere of rock-weathering desert plants, II. Growth promotion of cactus seedlings. *Plant Biology* 6: 643-650.
- (73) Yamanaka, T., C.Y. Li, B.T. Bormann, and H. Okabe. 2003. Tripartite associations in an alder: effects of *Frankia* and *Alpova diplophloeus* on the growth, nitrogen fixation and mineral acquisition of *Alnus tenuifolia*. *Plant and Soil* 254:179-186.
- (74) Carrillo, A. E., C. Y. Li and Y. Bashan. 2002. Increased acidification in the rhizosphere of cactus seedlings induced by *Azospirillum brasilense*. *Naturwissenschaften* 89: 428-432.
- (75) Puente, M.S., Li, C.Y., and Bashan, Y. Rock weathering, plant growth-promoting bacteria from desert plants allow the growth of cactus seedling in rocks. *In: Plant growth-promoting rhizobacteria. Proceedings of the 6th International PGPR Workshop, Kozhikode (Calicut), Kerala, India. 5-10 October, 2003.*
- (76) Pokljska-Burdziej, A., E. Strzelczyk, H. Dahm, and C. Y. Li. 2004. Effect of endophyte *Pseudomonas fulva* on growth of pine seedlings (*Pinus sylvestris* L.), formation of mycorrhizae and protection against pathogens. *Phytopathologia Polonica* 32: 33-47.
- (77) Yamanaka, T., A. Akama, C.Y. Li, and H. Okabe. 2005. Growth, nitrogen fixation and mineral acquisition of *Alnus sieboldiana* after inoculation of *Frankia* together with *Gigaspora margarita* and *Pseudomonas putida*. *J. Forestry* 10: 21-26.

- (78) Puente, M. E., M. C. Rodriguez-Jaramillo, C.Y. Li, and Y. Bashan. 2005. Image analysis for quantification of bacterial rock weathering. *J. Microbiological Methods* (accepted).
- (79) Bashan, Y. Puente, M.E., Li, C.Y., Bethlenfalvay, G., de-Bashan, L.E., Moreno, M., Bacilio, M. Rojas, C.C. and Salazar, B. 2004. Plant growth promoting bacteria with special emphasis on desert reforestation. In: *Memories of the "Jornada académico-culturales 2004"*. Published by: University of Sonora, Santa Ana, Sonora. (In Spanish) (Accepted).
- (80) Li, C.Y., B.T. Bormann, and T.T. Chang. 2005. Restoration of degraded soil ecosystems and maintenance of long-term site productivity by actinorhizal plants. *In Jamaluddin Jamaluddin (ed.) Biofertilizers*. (Accepted).

2. Non-refereed publications:

- (1) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1967. Effect of pH and temperature on growth of *Poria weirii* *in vitro*. *Pac. N.W. Forest and Range Exp. Sta., U.S.D.A. Forest Service Res. Note PNW-66*, 5 p.
- (2) Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1968. Enzyme nitrate reductase of some parasitic fungi. *Pac. N.W. Forest and Range Exp. Sta., U.S.D.A. Forest Serv. Res. Note PNW-79*, 4 p.
- (3) Li, C. Y. 1969. Biological influence of red alder on *Poria weirii* and other root rot pathogens. *Diss. Abstr. 30 (5): 1982-B*.
- (4) Aho, P. E., K. Cromack, Jr., C. Y. Li and A. S. Hutchins. 1979. Concentration of oxalic acid and presence of calcium oxalate utilizing bacteria in *Echinodontium tinctorium* decay zone in *Abies concolor*. *USDA For. Ser. Res. Note PNW-328*, 8 p. *Pac. Northwest For. and Range Exp. Stn., Portland, Oregon*.
- (5) Nelson, E. E. and C. Y. Li. 1980. Preliminary test of two stump surface Protectants against *Fomes annosus*. *USDA For. Ser. Res. Note PNW-383*, 6 p. *Pac. Northwest For. and Range Exp. Stn., Portland, Oregon*.
- (6) Li, C. Y. and P. E. Aho. 1984. Effect of Lauricidin and ethylenediaminetetraacetic acid (EDTA) on growth of nine hymenomycetous fungi. *USDA For. Ser. Res Note PNW-411*, 7 p. *Pac. Northwest For. and Range Exp. Stn., Portland, Oregon*.
- (7) Maser, C., J. M. Trappe, and C. Y. Li. 1984. Large woody debris and long-term forest productivity. 6 p. *In Proceeding of Pacific Northwest Bioenergy System: Policies and Applications*. Bonneville Power Administration, Portland, Oregon.

- (8) Li, C. Y. and C. Maser. 1986. New and modified techniques for studying nitrogen-fixing bacteria in small mammal droppings. USDA For. Serv., Res. Note PNW-441. Pac. Northwest Res. Stn., Portland, Oregon.
- (9) Nelson, E. E. and W. G. Thies, and C. Y. Li. 1986. Are seed and cone pathogens causing significant losses in Pacific Northwest seed orchards. USDA For. Serv. Res. Note PNW-456, Pac. Northwest Res. Stn. Portland, Oregon.
- (10) Ho, Iwan and C. Y. Li. 1987. Microbial and chemical properties of log ponds in coastal Oregon. PNW Research Note-467, 8p. Pacific Northwest Forest Research Station, Portland, Oregon.
- (11) Niu, C. H., K. Cromack, Jr., and C. Y. Li. 1989. Association of nitrogen-fixing bacteria with ectomycorrhizae of Douglas-fir. p.253-254. *In* (Eds. D. A. Perry, R. Meurisse, B. Thomas, R. Miller, J. Boyle, J. Means, C. R. Perry and R. F. Powers) Proceedings of the Symposium on Maintaining the Long-Term Productivity of Pacific Northwest Forest Ecosystem. Forest Research Laboratory Press, Oregon State University, Corvallis.
- (12) Crawford, R. H. and C. Y. Li. 1994. Initial assessment of biological nitrogen fixation associated with large woody residues of Oregon coastal forests. COPE Report 7 (1): 5-6.
- (13) Li, C. Y. 1995. Establishment of soil microbial functional processes for enhancement of ecosystem productivity in tropical forests. 8 p. Report on consultancy for the FAO (Rome, Italy) of the United Nations on Biofertilizers program to ICFRE (India Council of Forestry Research and Education) Tropical Forest Research Institute, Jabapur, India.
- (14) Li, C. Y. 1996. The ecological significance of microorganisms associated with mycorrhizal fungi. NATS Current News 14(2): 4-5.

3. Published abstracts:

- (1) Li, C. Y. 1975. Conversion of *p*-coumaric acid to caffeic acid and of *p*-hydroxyphenylacetic acid to 3,4-dihydroxyphenylacetic acid by *Alnus rubra* in relation to resistance to *Phellinus (Poria) weirii* root rot. Bot. Soc. Amer. Abstr. 1975: 28.
- (2) Li, C. Y. 1976. The fatty acid composition of *Cenococcum graniforme* isolates. Bot. Amer. Soc. Abstr. 1976: 22-23.
- (3) Li, C. Y. and D. M. Knutson. 1976. Fatty acid composition of *Arceuthobium abietinum*. Bot. Amer. Soc. Abstr. 1976: 38.

- (4) Aho, P. E., K. Cromack, Jr., C. Y. Li, and Anita Hutchins. 1976. Concentration of selected nutrients and oxalic acid in sound and decayed *Abies concolor* wood. Northwest Scientific Association Abstr. 35: 15.
- (5) Li, C. Y. and P. E. Aho. 1981. Effects of Lauricidin and ethylenediaminetetraacetic acid (EDTA) on growth of several hymenomycetous fungi. Northwest Scientific Association Abstr. 87: 13.
- (6) Li, C. Y., M. A. Castellano, and J. M. Trappe. 1984. Acetylene-reducing nitrogen-fixing bacteria isolated from sporocarps of two ectomycorrhizal Basidiomycotina. Mycol. Soc. Amer. Newsletter 35(1): 32.
- (7) Li, C. Y. and M. A. Castellano. 1985. Dinitrogen-fixing bacteria isolated from interior of three ectomycorrhizal sporocarps. *In Proc. 6th N. Am. Conf. on Mycorrhizae* (ed. R. Molina). p. 264. Forestry Research Laboratory, Oregon State University. Corvallis.
- (8) Li, C. Y., M. C. Zhang, and L. L. Hung. 1985. *Azospirillum* associated with Douglas-fir ectomycorrhizae. Amer. Soc. Microbiology Northwest Abstr. 1986: 16.
- (9) Myrold, D. D. and C. Y. Li. 1986. Assimilation and dissimilation of nitrate by *Frankia* (Abstract). International Meeting on *Frankia* and Actinorrhizal Plants, August 17-20, 1986. University of Umea, Umea, Swede
- (10) Li, C. Y. and R. Molina. 1987. Growth enhancement of red alder by inoculation with *Frankia-Azospirillum* combination. p. 247 (Abstract). 87th Annual Meeting of the American Society for Microbiology, Atlanta, George
- (11) Li, C. Y. 1987. Diazotrophic bacteria in sporocarps of ectomycorrhizal fungi *Barssia oregonensis*, *Hysterangium setchellii*, *Leccinum scabrum* and *Rhizopogon parksii*. p. 205. *In* D. M. Sylvia, L. L. Hung & J. H. Graham (eds.), *Mycorrhizae in the Next Decade, Practical Application and Research Priorities*. Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.
- (12) Tilak, K. V. B. R., C. Y. Li and Iwan Ho. 1987. Recovery of nitrogen-fixing *Azospirillum* from spores of VA-mycorrhizal fungi. p. 223. *In* D. M. Sylvia, L. L. Hung & J. H. Graham (eds.), *Mycorrhizae in the Next Decade, Practical Application and Research Priorities*. Institute of Food and agricultural Sciences, University of Florida, Gainesville, Florida.
- (13) Tilak, K. V. B. R., C. Y. Li, and Iwan. Ho. 1987. Occurrence of nitrogen-fixing

- Azospirillum* on surface sterilized mycorrhizal roots of green onion (*Allium cepa*). p. 222. In D. M. Sylvia, L. L. Hung & J. H. Graham (eds.), Mycorrhizae in the Next Decade, Practical Application and Research Priorities. Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.
- (14) Amaranthus, M., C. Y. Li, and D. A. Perry. 1987. Nitrogen fixation within mycorrhizae of Douglas-fir seedlings grown on two different vegetative sites. p. 79. In D. M. Sylvia, L. L. Hung & J. H. Graham (eds.), Mycorrhizae in the Next Decade, Practical Application and Research Priorities. Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.
- (15) Li, C.Y., I. Ho, R. Crawford, and B. Bormann. 1994. Weathering of rock minerals in rhizospheres of the Sandbox Ecosystem. p. 462. 94th General Meeting of the American Society for Microbiology, May 23-27, Las Vegas, Nevada.
- (16) Li, C.Y. and B. Bormann. 2003. Weathering of basalt rock by red alder (*Alnus rubra* Bong.) inoculated with *Frankia* and ectomycorrhizal fungus *Alpova diplophloeus*. P. 426. 103rd General Meeting of the American Society for Microbiology, May 18-22, Washington, D.C.
- (17) Li, C.Y. and M.T. Holmes. 2005. Management of tree diseases through microbial application. 2nd Global Conference on Plant pathology, November 25-29, Udaipur, India

4. Scientific Presentations:

(A) Invited presentations.

- (1) "Enzyme systems of red alder and Douglas-fir in relation to infection by *Poria weirii*." Symposium on the Biology of Alder. University of Washington, Pullman. 1967.
- (2) "*Phellinus weirii* research in the Pacific Northwest of North American." Research Institute of Botany, Academia Sinica, and Department of Plant Pathology, National Taiwan University. 1976
- (3) "The role of alder in ameliorating sites infested with *Phellinus (Poria) weirii*." Symposium on the Utilization and Management of Alder. Ocean Shore, Washington. 1977.
- (4) "Effects of Lauricidin on *Fomes annosus* and *Phellinus weirii*." Symposium on the Pharmacological Effect of Lipids. St. Louis, Missouri. 1978.

- (5) "Pathogenesis of *Fusarium* on sugar pine at the J. Herbert Stone Forestry Nursery." Region 6's Forest Pest Management and State and Private Forestry, Portland, Oregon. 1981.
- (6) "Mushrooms and other fungi that contain nitrogen-fixing bacteria." Oregon Mycological Society, Portland, Oregon. 1985.
- (7) "Nitrogen-fixing bacteria associated with Douglas-fir ectomycorrhizae." Dept. of Forest Science, Oregon State University. 1985.
- (8) "Nitrogen-fixing bacteria and mycorrhizal fungi." BLM-PNW-OSU Research Programs on the Ecological Role of Fallen Trees. Corvallis, Oregon. 1986.
- (9) "Nitrogen-fixing bacteria in truffles." The North American Truffling Society, Corvallis, Oregon. 1985.
- (10) "Asymbiotic nitrogen-fixing bacteria associated with mycorrhizae." Department of Soil Science, Oregon State University. 1987.
- (11) "Association of nitrogen-fixing bacteria with mycorrhizal fungi, mycorrhizae, and animal feces in relation to plant productivity." Taiwan Forestry Research Institute, Taipei. 1987.
- (12) "Nitrogen fixing bacteria in mycorrhizae." National Culture Collection & Research Center, Hsinchu, Taiwan. 1987.
- (13) "The role of rhizosphere microbial interactions in long-term site productivity." Department of Plant Pathology and Entomology, National Taiwan University, Taipei. 1987.
- (14) "Associative nitrogen-fixing bacteria in mycorrhizae and plant productivity." Department of Agricultural Chemistry, National Taiwan University, Taipei. 1987.
- (15) "Asymbiotic nitrogen-fixing bacteria associated with mycorrhizae and mycorrhizal fungi." Institute of Botany, Academia Sinica, Nankai, Taiwan. 1987.
- (16) "Research on mycorrhizae-associated asymbiotic nitrogen-fixing bacteria." Chinese Students Association, Oregon State University. 1988.
- (17) "Role of asymbiotic nitrogen-fixing bacteria in mycorrhizosphere on mycorrhiza formation." The Third Joint Workshop of INDO-US Science and Technology Initiative on Agriculture, Bangalore, India. 1988.
- (18) "Microbial interactions in mycorrhizosphere and mycorrhiza formation." Indian

- Agricultural Research Institute, New Delhi, India. 1988.
- (19) “Microbial mediated site processes on forest productivity.” Institute of Biology, Nicolaus Copernicus University, Torun, Poland. 1990.
 - (20) “Associated soil microbes affect *Frankia* infection in actinorhizal plants.” Institute of Biology, Nicolaus Copernicus University, Torun, Poland. 1990.
 - (21) “Interactions between ectomycorrhizae, *Frankia*, and *Azospirillum*.” INDO-US Presidential Science and Technology Initiative (1982-1991) 4th workshop on Synergism of Mycorrhizae with Nitrogen-fixing Microorganisms. Maui, Hawaii. 1991.
 - (22) “Ecological significance of coarse woody debris in forest ecosystems.” Taiwan Forestry Research Institute, Taipei. 1993.
 - (23) “Functional importance of microbial interactions in mycorrhizosphere.” Taiwan Agricultural Research Institute, Taichung. 1993.
 - (24) “The biological significance of coarse woody debris in forest ecosystems.” Workshop of Sino-America Forestry Technology Cooperation on Sustainable Management of Temperate and Subtropical Plantation Ecosystem, Taipei, Taiwan. 1993.
 - (25) “Root symbioses of red alder: Technological opportunities for enhanced regeneration and soil improvement.” Symposium on the Biology & Management of Red Alder. Corvallis, Oregon. 1993.
 - (26) “Ecological functions of microbial associations in mycorrhizospheres.” Nicolaus Copernicus University, Torun, Poland. 1994.
 - (27) “Functional processes of plant-soil interactions and nutrient cycling.” Department of Forest Pathology and Mycology, Swedish University of Agricultural Sciences, Uppsala. 1994.
 - (28) “Microbial interactions and nutrient cycling in forest ecosystems.” Department of Plant Pathology, National Taiwan University, Taipei. 1994.
 - (29) “Managing forestry with regulation of structural and species diversity. The 3rd National Conference on Agriculture, National Council of Agriculture, Taipei, Taiwan. 1994.
 - (30) “Mycorrhizal fungi in coarse woody debris.” Tropical Forest Research Institute, Jabapur, India. 1994.

- (31) "Ecological significance of microbial interactions in rhizospheres." Tropical Forest Research Institute, Jabapur, India. 1994.
- (32) "The ecological functions of microorganisms in association with mycorrhizal fungi." North American Truffling Society, Corvallis, Oregon. 1995.
- (33) "Terrestrial processes regulating mobility and cycling of limiting nutrients in forest ecosystems." Department of Forestry Program, Faculty of Natural Resources and Environmental Studies, University of Northern British Columbia, Prince George, British Columbia. 1996.
- (34) "Belowground processes as a basis for forest productivity." Department of Forest Pathology and Mycology, Swedish University of Agricultural Sciences, Uppsala. 1996.
- (35) "Belowground microbial processes and forest productivity." Institute of Biology and Environment Protection, Nicolaus Copernicus University, Torun, Poland. 1996.
- (36) "*Frankia* and actinorhizal plants." Department of Microbiology, Nicolaus Copernicus University, Torun, Poland. 1996.
- (37) "Microbial processes as a basis of nutrient cycling in forest ecosystems." Forest Service National Workshop of Belowground Process. Washington, DC. 1996.
- (38) "Terrestrial processes regulating cycling and mobility of limited nutrients in forest ecosystems." Forestry and Forest Products Research Institute, Tsukuba, Japan. 1997.
- (39) "Ecological importance of *Frankia* and actinorhizal plants in ecosystem sustainabilty." Taiwan Forestry Research Institute, Taipei. 1999.
- (40) Two presentations. "Microbial interactions in mycorrhizosphere" and "Belowground microbial processes underpin forest productivity." COSTE ACTION E6---Eurosilva Forest Tree Physiology Research Workshop on Root-Soil interaction in trees, Gozd Martuljek, Slovenia. Sept. 6-14, 1999.
- (41) "Environmental applications of the plant growth-promoting bacterium *Azospirillum*." March 29-30, 2001, First International Symposium on Microbial Ecology of Soils, Universidad de Los Andes, Santafe de Bogot, Colombia. Bashan, Y., Gonzales-Bashan, L.E. Puente, M. E. Lebsky, V. K. Moreno, M., Rojas, A., Carrilli, A. E., Hernandez, J. P., Bacillo, M., Li, C. Y., and Bethlenfalvay, G.

- (42) “The role of *Azospirillum* as plant growth promoter.” May 9-11. 2001, 3rd International Congress on Environmental Microbiology, Bogota, Columbia. Bashan: Bashan Y., Gazalez-Bashan, L.E., Lebsky, V.K., Moreno, M., Puente, M.E., Rojass, A., Carrillo, A.E., Hernandez, J. P., Troyo, E., Li, C.Y., and Bethlenfalvay.
- (43) ”Soil genesis associated with microorganisms residing in cactus rhizosphere in arid zone.” July 2-7, 2001, 13th International Congress on Nitrogen Fixation, Hamilton, Ontario, Canada. Puente, M. E., Bashan, Y., Li, C. Y. Moreno M., Soeldner, A., de-Bashan, L. E., and Lebsky, V.K
- (44) “Managing Forestry with regulation of structural and species diversity.” Department of Forestry, Agricultural University of Krakow, Krakow, Poland. Oct.22, 2001.
- (45) “Ecological and functional processes of *Frankia* and actinorhizal plants in terrestrial ecosystems.” Department of Microbiology, Nicholas Copernicus University. Torun, Poland. Nov. 21, 2001.
- (46) “Plant growth-promoting bacteria and desert re-vegetation.” 2003 Arid Southwest Lands Habitat Restoration Conference, Palm Springs, USA. 3-7 Mar. 2003. Bashan, Y., Puente, M.E., Bethlenfalvay, G.J., Li, C.Y., Bacilio, M., Carrillo, A.E., Moreno M., Vazquez P., Holguin, G., and de-Bashan, L.E.
- (47) “Plant growth-promoting bacteria and desert re-vegetation.” Public Lands Restoration Conference. March 1-4, 2003, Palm Springs, California, USA. Bashan, Y., M. Esther Puente, G. Bethlenfalvay, C.Y. Li, M. Bacilio, A.E. Carrillo, M. Moreno, P. Vazquez, G. Holguin, and L.E. d-Bashan.
- (48) “Restoration of degraded soil ecosystems and maintenance of long-term site productivity by actinorhizal plants.” Taipei, Taiwan. Oct. 20, 2003.
- (49) “Land restoration and sustainable ecosystem productivity by actinorhizal plant.” Center for Biological Research of the Northwest, La Paz, Mexico. Feb. 24, 2004.
- (50) Bashan, Y., Puente, M.E., Li, C.Y., Bethlenfalvay, G., Moreno M., Bacilio, M., Rojas, C., and Salazar, B. 2004. “The use of native desert plants inoculated with plant growth-promoting bacteria, mycorrhizae and compost for desert reforestation and prevention of soil erosion. 16th National Congress of Botany, October 17-22, 2004, Oaxaca, Mexico.

(B) Volunteered papers and posters.

a. Papers:

- (1) Li, C. Y. 1975. Conversion of *p*-coumaric acid to caffeic acid and of *p*-hydroxyphenylacetic acid to 3,4-dihydroxyphenylacetic acid by *Alnus rubra* in relation to resistance to *Phellinus (Poria) weirii* root rot. The annual national meeting of the Botanical Society of America. Oregon State University, Corvallis.
- (2) Li, C.Y. 1976. The fatty acid composition of *Cenococcum graniforme* isolates. The annual meeting of the Botanical Society of America. Tulane University, New Orleans, Louisiana.
- (3) Li, C.Y.; Knutson, D.M. 1976. Fatty acid composition as a taxonomic tool for *Arceuthobium abietinum*. The annual national meeting of the Botanical Society of America, Tulane University, New Orleans, Louisiana.
- (4) Aho, P.E.; Cromack, K; Li, C.Y. 1976. Concentration of selected nutrients and oxalic acid in sound and decayed *Abies concolor* wood. The annual meeting of the Northwest Scientific Association. Cheney, Washington.
- (5) Li, C.Y.; Aho, P.E. Effects of Lauricidin and ethylenediaminetetraacetic acid (EDTA) on growth of several hymenomycetous fungi. The 54th annual meeting of the Northwest Scientific Association. Corvallis, Oregon.
- (6) Li, C.Y. 1984. Acetylene-reducing bacteria isolated from sporocarps of two ectomycorrhizal Basidiomycotina. The annual meeting of the Mycological Society of America. Colorado State University, Fort Collins.
- (7) Maser, C.; Trappe, J.M; Li, C.Y. 1984. Large woody debris and long-term forest productivity. Proceedings of Pacific Northwest Bioenergy Systems: Policies and Applications. The United States Department of Energy and Pacific Northwest and Alaska Bioenergy Program. Portland, Oregon.
- (8) Li, C.Y.; Zhang, C.M; Hung, L.L. 1985. *Azospirillum* associated with Douglas-fir ectomycorrhizae. The annual meeting of the Northwest Branch of the American Society of Microbiology, Washington State University, Pullman.
- (9) Myrold, DAD; Li, C.Y. 1986. Assimilation and dissimilation of nitrate by *Frankia*. Proceedings of the International Meeting on *Frankia* and Actinorhizal Plants. University of Umea. Umea, Sweden.
- (10) Li, C.Y.; Molina, R. 1987. Growth enhancement of red alder by inoculation with *Frankia-Azospirillum* combination. The annual national meeting of the American Society of Microbiology. Atlanta, Georgia.

- (11) Li, CAY; Ho, I. 1987. Microorganisms associated with hyphae of vesicular-arbuscular mycorrhizal fungus in *Allium cepa*. The annual meeting of the Northwest Scientific Association. Tacoma, Washington.
- (12) Carpenter, S.; Caldwell, B. A.; Li, C.Y. 1987. Heterotroph effects on log decomposition: fungi and free-living nitrogen fixing bacteria in *Ambrosia* beetle galleries. The annual meeting of the Mycological Society of America. Ottawa, Canada.
- (13) Flessner, T.R.; Darris, D.C.; Li, C.Y. 1992. Effect of fertilization and inoculation on growth of sitka alder (*Alnus sinuata* (Regel) Rydb.) seedlings for riparian plantings. Flessner presented at the annual Meeting of the Society for Range Management. Spokane, Washington.
- (14) Pardo, L.; Li, C.Y.; Bormann, B.T.; Bormann, F.H. 1992. Associative nitrogen fixation in two experimental *Pinus* ecosystems. Pardo presented at the annual meeting of the Ecological Society of America. Honolulu, Hawaii (8/9-13/92).
- (15) Li, C.Y.; Ho, I. 1992. Nodule and mycorrhiza formation in *Alnus rubra* by irrigation with a stream water. The annual meeting of the Northwest Scientific Association. Bellingham, Washington.
- (16) Li, C.Y.; Massicotte, H. 1992. Bacterial association with Douglas-fir (*Pseudotsuga menziesii*) tuberculate ectomycorrhizae. The annual meeting of The Mycological Society of America. Portland, Oregon.
- (17) Rojas, N.S. Li, C.Y.; Perry, D.A. 1995 Interactions among soil biology, nutrition, and performance of actinorhizal plants species in an Oregon clearcut. The tenth International Conference on *Frankia* and Actinorhizal Plants. University of California at David.
- (18) Yamanaka T., Okabe, H, and Li, C.Y. 1999. Effect of arbusculr mycorrhizal fungi and fluorescent *Psudomonas* on nodulation of *Alnus sieboldiana*. Annual Meeting of Japanese Forestry Society, Ehime University, Matsuyama, Japan.

b. Posters:

- (1) Li, C.Y.; Castellano, M. A. 1984. Nitrogen-fixing bacteria isolated from within sporocarps of three ectomycorrhizal fungi. The 6th North American Conference on Mycorrhizae, Bend, Oregon.
- (2) Niu, C.H.; Cromack, K.; Li, C.Y. 1987. Association of nitrogen-fixing bacteria with ectomycorrhizae in Douglas-fir. Symposium on Maintaining the Long-term

Productivity of Pacific Northwest Forest Ecosystems, Corvallis, Oregon.

- (3) Amarathus, M; Li, C.Y.; Perry, D.A. 1987. Nitrogen fixation within mycorrhiza of Douglas-fir seedlings growing on two different vegetative sites. North American Conference on Mycorrhizae, Gainesville, Florida.
- (4) Li, C.Y. 1987. Diazotrophic bacteria in sporocarps of ectomycorrhizal fungi *Barssia oregonensis*, *Hysterangium setchellii*, *Leccinum scarbum*, and *Rhizopogon parksii*. North American Conference on Mycorrhizae, Gainesville, Florida.
- (5) Li, C.Y.; Massicotte, H.B.; Moore, L.V.H. 1990. Nitrogen-fixing *Bacillus* sp. associated with Douglas-fir tuberculate ectomycorrhizae. North American Conference on Mycorrhizae, Jackson, Wyoming.
- (6) Massicotte, H.B., Melville, L.H., Li, C.Y.; Peterson, R.L. 1990. Structural aspects of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) tuberculate mycorrhizae. North American Conference on Mycorrhizae, Jackson, Wyoming.
- (7) Cazares, E; Li, C.Y. 1990. Diazotrophic bacteria in sporocarps of hypogeous mycorrhizal fungi. North American Conference on Mycorrhizae, Jackson, Wyoming.
- (8) Rojas, N.S.; Perry, D.A.; Li, C.Y.; Friedman, J. 1987. Soil and rhizosphere actinomycetes influence *Frankia* infection and nitrogenase activity of red alder. Symposium on Soil Biodiversity and Function, Oregon State University, Corvallis.
- (9) Li, C. Y.; Rojas, N. S.; Perry, D. A; Friedman, J. 1991. Soil and rhizosphere actinomycetes influence *Frankia* infection and nitrogenase activity of red alder. 13th North American Symbiotic Nitrogen Fixation Conference, Banff, Canada.
- (10) Hope, S.; Perry, D.A.; Li, C.Y. 1991. Biologic activity in two western Oregon Douglas-fir stands. Conference on Hydrologic, Geochemical and Biologic Interactions in Small Forested Catechments, New Hampshire.
- (11) Li, C.Y.; Crawford, R.H. 1991. Asymbiotic biological nitrogen fixation associated with coarse woody residues of Oregon coastal forests. Symposium on Minority Participation in Forestry and Forestry-related Sciences: A Need, A Goal, A Commitment, Huntsville, Alabama. Also presented on the Symposium on the Ecology and Management of Oregon Coast Range Forests, Gleneden Beach, Oregon, and the Fifth Internal Mycological Congress, Vancouver, British Columbia, Canada. 1994.

- (12) Rozycki, H.; Strzelczyk, E.; Li, C.Y. 1993. Effects of actinomycetes isolated from rhizospheres of Scots pine (*Pinus sylvestris* L.) on in vitro growth of ectomycorrhizal fungi. 9th North American Conference on Mycorrhizae, Guelph, Ontario, Canada.
- (13) Ho, I.; Zak, B.; Li, C.Y. 1993. Resistance of ectomycorrhizal fungi to *Rhizina* root rot. 9th North American Conference on Mycorrhizae, Guelph, Ontario, Canada.
- (14) Li, C.Y.; Ho, I.; Crawford, R.; Bormann, B. 1994. Weathering of rock minerals by microbes in rhizospheres of the sandbox ecosystem. 94th annual meeting of the American Society for Microbiology, Las Vegas, Nevada.
- (15) Ho, I.; Li, C.Y.; Bormann, B. 1994. Soil fungi active in weathering processes of basalt rocks. 5th International Mycological Congress, Vancouver, British Columbia, Canada.
- (16) Yamanaka, T., C.Y. Li, B.T. Bormann, and H. Okabe. 2000. Tripartite symbiosis among *Frankia*, *Alpova diplophloeus* and *Alnus tenuifolia*. Proceedings on Fungus-Plant Interactions from Parasitism to Symbiosis. 7th International Symposium of the Mycological Society of Japan, Tsukuba.
- (17) Yamanaka, T. C.Y. Li, B.T. Bormann, and H. Okabe. 2001 Tripartite associations in an alder: effects of *Frankia* and *Alpova diplophloeus* on the growth, nitrogen fixation and mineral acquisition of *Alnus tenuifolia*. 12th International Conference on *Frankia* and Actinorhizal plants, Carry-le-Rouet, France.
- (18) Holmes, M. T. and C. Y. Li. 2002. Fungal effects: multiple roles of soil fungi in early Douglas-fir forest and long-term ecological processes. 2002 annual meeting of Mycological Society of America, Corvallis, Oregon.
- (19) Puente, M.E., Lebsky, V.K., Bashan, Y., Li, C.Y., and Moreno, M. 2002. Biological factors in soil genesis of an arid zone of Mexico. 9th International Symposium on Nitrogen Fixation with non-legumes. Leuven, Belgium, September 1-5, 2002.
- (20) Pokojska-Burdziej, A., E. Strzelczyk, and C. Y. Li. 2002. The effects of endophytic bacteria: *Pseudomonas fulva* on the growth of Scots pine seedlings (*Pinus sylvestris* L.), mycorrhiza formation and protection against plant pathogens. 37th Microbiological Symposium: Role of Microorganisms in Environmental Changes.
- (21) Li, C.Y. and B.T. Bormann. 2003. Weathering of basalt rocks by red alder (*Alnus rubra* Bong.) inoculated with *Frankia* and ectomycorrhizal fungus *Alpova diplophloeus*. Annual meeting of the American Society for Microbiology,

Washington, D.C.

- (22) Yamanaka, T., A. Akama, C.Y. Li, and H. Okabe. 2003. Growth, nitrogen fixation and mineral acquisition of *Alnus sieboldiana* after inoculation of *Frankia* together with *Gigaspora margarita* and *Pseudomonas putida*. 4th International Symbiosis Society Congress, Halifax, Canada.
- (23) Bashan: Bashan Y., Gazalez-Bashan, L.E., Lebsky, V.K., Moreno, M., Puente, M.E., Rojas, A., Carrillo, A.E., Hernandez, J. P., Troyo, E., Li, C.Y., and Bethlenfalvay, G. 2001. The role of *Azospirillum* as plant growth promoter. 3rd International Congress on Environmental Microbiology, Bogota, Columbia.
- (24) Bashan, Y. Puente, M.E., Li, C.Y., Bethlenfalvay, G., de-Bashan, L.E., Moreno, M., Bacilio, M. Rojas, C.C. and Salazar, B. 2004. Plant growth promoting bacteria with special emphasis on desert reforestation. In: Memories of the “Jornada académico-culturales 2004”. Published by: University of Sonora, Santa Ana, Sonora. (In Spanish) (Accepted).
- (25) Bashan, Y., Puente M.E. and Li, C.Y. 2004. Soil formation from rocks aided by plant growth-promoting bacteria. 32nd National Congress of Soil Science. November 8-10, 2004, Leon, Guanajuato, Mexico (Invited lecture)

D SCHOLARSHIP AND CREATIVE ACTIVITY (In Chronological Order)

1 Development of ecosystem manipulation for biological control of root diseases

Plant species are known to produce fungitoxic compounds either in the healthy state or in response to infection by pathogens. The role in disease resistance of such naturally occurring antifungal substances presents a unique problem and seems to occupy a central position from the point of view of plant pathology. It is possible that this resistance has a biochemical basis and that highly active antifungal compounds are exuded from the roots into the soil. Reducing favorability of habitats for pathogens is one of the ways to minimize the disease incidence. In addition to the direct effects of red alder on soil in relation to inhibition of pathogens such as *Phellinus weirii*, alder appears to be associated with understory vegetations that are potential sources of pathogen-inhibiting substance. The high nitrogen content of soil under alder promotes strong development of these species, thereby fostering a soil environment hostile to pathogens of conifer roots. Nutritional requirements for the pathogen and the effects of environment of the pathogen were studied for determining the ability of the pathogen to establish itself on healthy roots *in situ*. The study of sporulation of the pathogen as influenced by environments has made studies of the pathogen sexuality and disease epidemiology possible and provided a basis for further

elucidating the life cycle of the pathogen. This research also has followed two major approaches to the problems of obtaining biocontrol. These were inoculation of antagonistic soil microorganisms and applications of safe and non-toxic compounds. [(1):1,2,4,5,7,8,9,10,11,12,13,14,15,16,18,19,20,22,24,30. (2):3,5,6. (3):1,5,17].

2 Demonstration of associative N₂ fixation in forests

This research discovered that nitrogen-fixing *Azospirillum* was associated with ectomycorrhizae, endomycorrhizae, and within the mycorrhizal fungi. Such conditions occurred within sporocarps of the fungi or within the mycorrhizal mantle. These discoveries have opened possibilities for understanding the role mycorrhizae-N₂-fixing microbes interaction in nitrogen cycling and developing information how management practices might be modified to optimize biological nitrogen fixation in the rhizosphere of second growth Douglas-fir.

Microaerophilic techniques were developed that demonstrated substantial associative nitrogen fixation occurred in a wide array of forest sites and could be one of sources of nitrogen accumulation in ecosystems. Thus, tree species with substantial associative nitrogen fixation can be used for land restoration or to develop silvicultural systems that are N self-sufficient. In addition, the research of N₂ fixation in coarse woody debris on forest floor provided baseline information on the rates of fixation before and after tree harvest, and provided forest managers guidelines for harvest and management practice on the quantity and quality of coarse woody debris for

retention on harvested sites to provide structural habitat for forest organisms and favorable soil structure

[(1):28,29,32,33,35,36,37,38,40,42,48,49,55,56,62;(2):7,11,12,13,14; (3):6,7,8,11,12,13,14].

3 Symbiotic N₂ fixing endophytes in actinorhizal plants

This research is one of the few in the Pacific Northwest studying symbiotic nitrogen-fixing endophyte *Frankia* in actinorhizal plants, because the organism is difficult to be isolated and cultivated. Red alder and snowbrush are important actinorhizal plants in the Pacific Northwest because of their high rates of symbiotic fixation of atmospheric nitrogen in forest ecosystems due to their endophyte *Frankia*. The actinorhizals can speed up soil development during primary succession. In addition, the *Frankia* can be inoculated for restoration of degraded ecosystems, reclamation of mine spoils, and land stabilization. Other uses of actinorhizal plants include improving the fertility of degenerated forest soil and the growth of associated tree species. The *Frankia* isolates have been requested by many countries for inoculation, including inoculation of sitka alder (*Alnus sinuata*) for riparian planting.

[(1):39,47,53,54,57,63,69,73,80;(3):9,10,16;(volunteered papers):15,17,22; posters:8,

9,16,21,22,25].

4 Research to link forest-dwelling mammals and soil productivity

This research demonstrated that feces of forest mammals contained, in addition to mycorrhizal fungal spores, N₂-fixing microbes and yeasts. The nutrient provided by the yeast in the feces was effective in promoting bacterial growth and nitrogenase activity. When these animals dig at the bases of trees, the organisms in their feces can inoculate rootlets with nitrogen-fixing bacteria, yeasts, and spores of mycorrhizal fungi. At times, actinomycetes also are present, which produce substances important in formation of soil humus, an important substrate for mycorrhiza formation. This research suggested another link in the chain of mutualism that unites forest small mammals, mycorrhizal fungi, N₂-fixers, and forest trees in maintaining ecosystem productivity [(1):26,27;(2):7,8].

5 Microbial weathering of primary mineral substrates in forests

This research showed that mycorrhizal fungi and associated microbes were capable of weathering rock minerals, thereby maintaining supply of inorganic nutrients to forest trees, especially in ecosystems developing on primary mineral substrates. Thus, active physiological processes of symbiotic mycorrhizal fungi and associated microbes represent crucial processes controlling soil weathering and governing ecosystem development and productivity [(1):17,21,61,66,70,71,72,73,77,78,79,80;(Invited presentations): 26,27,28,31,32,33,34,35,37,38,39,40,43,45,48,49; posters 14,15, 16,17,18,19,22,25,].

E. TEACHING, ADVISING AND OTHER ASSIGNMENTS

a. Course taught:

- (1) ST/Plant Bacteria Interactions (FS 699 004). Fall 1998. Student receive instruction and practice in weathering of primary minerals by Ponderosa pine

b. Advising

- (1) Visiting scientists and post docs

(a) Dr. K.V. B. R.Tilak, Division of Microbiology, Indian Agricultural Research Institute, New Delhi. 3 months. 1987, 1988.

(b) Dr. C. S. Singh, Division of Microbiology, Indian Agricultural Research Institute, New Delhi. 3 months. 1987, 1988.

(c) Dr. D. J. Bagyaraj, Department of Agricultural Microbiology, University of Agricultural Sciences, Bangalore, India. One month. 1998.

- (d) Dr. Edmund Strzelczyk, Department of Microbiology, Nicolaus Copernicus University, Torun, Poland. 2 weeks. 1989, 1991, 1994.
- (e) Dr. Jacob Friedman, Department of Botany, Tel Aviv University, Israel. 1986-1987.
- (f) Dr. McArthur Floyd, Department of Plant and Soil Science, Alabama A&M University, Normal. 2 weeks. 1993
- (g) Dr. Torgny Unestam, Department of Forest Mycology and Pathology, Swedish University of Agricultural Sciences, Uppsala. 3 months. 1995, 1996.
- (h) Dr. T. T. Chang, Division of Forest Protection, Taiwan Forestry Research Institute. 6 months. 1995.
- (i) Carmilla Sun, Department of Forest Mycology and Pathology, Swedish University of Agricultural Sciences, Uppsala. 3 months. 1996.
- (j) Dr. M. T. Holmes, USFS research associate. 1997-present.
- (k) Dr. Yoav Bashan, Department of Microbiology, the Center for Biological Research, La Paz, Baja California, Mexico. One week. 1997
- (l) Drs. Hiroaki Okabe and Takahi Yamanaka, Forestry and Forest Products Research Institute, Tsukuba, Japan. 2 weeks. 1998.
- (m) Dr. Myong-jong Yi, Department of Forestry, Kangwon National University, South Korea. 1998-1999.
- (n) Takashi Yamanaka, Research Microbiologist, Forestry and Forest Products Research Institute, Tsukuba, Japan. One year 1999 – 2000).
- (o) Maria Esther Puente, Microbiologist, Center for Biological Research of the Northwest, Baja California Sur., La Paz, Mexico. One year (2000 -2001)