REFERENCES

Alvarez-Morales, A., Dixon, R., and Merrick, M. Positive and negative control of the glnA ntrBC regulon in Klebsiella pneumoniae. EMBO J. 3 No 3 (1984) : 501-507.

Anchan Choonhahirun. Chemotaxonomy of some nitrogen-fixing bacteria isolated from the rhizosphere of rice (Oryza sativa L.) grown in Thailand. Master's Thesis, Chulalongkorn University, 1986.

Arnold, W., Rump, A., Klipp, W., Priefer, U.B., and Pühler. Nucleotide sequence of a 24,206-base-pair DNA fragment carrying the entire nitrogen fixation gene cluster of Klebsiella pneumoniae. J. Mol. Biol. 203 (1988) : 715-738.

Banfalvi, Z., Sakanyan, V., Koncz, C., Kiss, A., Dasha, I., and Kondorosi, A. Location of nodulation and nitrogen fixation genes on a high molecular weight plasmid of R. meliloti. Mol. Gen. Genet. 184 (1981) : 318-325.

Barraquio, W.L., and Wanatabe, I. Occurrence of aerobic nitrogen fixing bacteria in wetland and dryland plants. Soil Sci. Plant Nutr. 27 (1981) : 121-125.

Berndt, H., Lowe, D.J., and Yates, M.G. The nitrogen-fixing system of Corynebacterium autotrophicum : Purification and properties of the nitrogenase components and two ferrodoxins. Eur. J. Biochem. 86 (1978) : 133-142.

Biggins, D.R., and Postgate, J.R. Nitrogen fixation by cultures and cell-free extracts of Mycobacterium flavum 301. J. Gen.

Microbiol. 56 (1969) : 181-194.

Birnboim, H.C., and Doly, J. A rapid alkaline extraction procedure for screening recombinant plasmid DNA. Nucleic Acids Res. 7 (1979) : 1513-1523.

Bolivar, et al. Construction and characterization of new cloning vehicles II : A multipurpose cloning system. Gene 2 (1977) : 95-113.

Bulen, W.A., Burns, R.C., and Le Comte, J.R. Nitrogen fixation : hydrosulfite as electron donor with cell-free prepation of Azotobacter vinelandii and Rhodospirillum rubrum. Proc. Natl. Acad. Sci. USA 53 (1965) : 532-539.

Cannon, F.C., Riedel, G.E., and Ausubel, F.M. Overlapping sequences of Klebsiella pneumoniae nif DNA cloned and characterized. Mol. Gen. Genet. 174 (1979) : 59-65.

Carnahan, J.E., Mortenson, L.E., Mower, H.F. and Castle, J.E. Nitrogen fixation in cell-free extracts of Clostridium pasteurianum. Biochim. Biophys. Acta. 44 (1960) : 520-535.

Casey, C., and Davidson, N. Rates of formation and thermal stabilities of RNA:DNA and DNA:DNA duplexes at high concentration of formamide. Nucleic Acids Res. 4 No 2 (1977) : 1539-1552.

Curren, J., Baillic, D.L., and Webster, J.M. Use of genomic DNA restriction fragment length differences to identify nematode species. Parasitology 90 (1985) : 137-144.

Dixon, R., Cannon, F. and Kondorosi, A. Construction of a plasmid carrying nitrogen fixation genes from Klebsiella pneumoniae. Nature 260 (1976) : 268-271.

Dixon, R.A. The genetic complexity of nitrogen fixation. J. Gen. Microbiol. 130 (1984) : 2745-2755.

Döbereiner, J., Day, J.M., and Dart, P.J. Nitrogenase activity in the

rhizosphere of sugar cane and some other tropical grasses. Plant Soil 37 (1972 a) : 191-197.

_____, Day, J.M., and Dart, P.J. Nitrogenase activity and oxygen sensitivity of the Paspalum notatum-Azotobacter paspali association. J. Gen. Microbiol. 71 (1972 b) : 103-116.

Eady, R.R., Smith, B.E., Cook, K.A., and Postgate, J.R. Nitrogenase of Klebsiella pneumoniae : Purification and properties of the component proteins. Biochem. J. 128 (1972) : 655-675.

Eckhardt, J. A rapid method for the identification of plasmid deoxyribonucleic acid in bacteria. Plasmid 1 (1978) : 584-588.

Elmerich, C. Molecular biology and ecology of diazotrophs associated with non-leguminous plants. Biotechnology 2 (1984) : 967-978.

Emerich, D.W., and Burris, R.H. Nitrogenase from Bacillus polymyxa : Purification and properties of the component proteins. Biochim. Biophys. Acta. 536 (1978 b) : 172-183.

Epsin, G., Alvarez-Morales, A., Cannon, F., Dixon, R., and Merrick, M. Cloning of the glnA, ntrB and ntrC genes of Klebsiella pneumoniae and studies of their role in regulation of the nitrogen fixation (nif) gene cluster. Mol. Gen. Genet. 186 (1982) : 518-524.

Fuchs, R., and Blakesley, R. Guide to the use of type II restriction endonucleases. Methods in Enzymology 100 (1983) : 3-38.

Hirsch, P.R., Vanmontagn, M., Johnston, A.W.B., Brewin, N.J., and Scheel, J. Physical identification of bacteriocinogenic nodulation and other plasmids in strains of Rhizobium leguminosarum. J. Gen. Microbiol. 120 (1986) : 403-412.

Jariya Boonjawat, Anchan Choonhahirun, Saroch Pornputtkul, and Aurelle, H. Biochemistry of nitrogen-fixing bacteria associated with the rhizosphere of rice. BIOnifT Regional Symposium and

Workshop 1986.

Kado, C.I., and Liu, S.T. Rapid procedure for detection and isolation of large and small plasmid. J. Bacteriol. 145 (1981) : 1365-1373.

Keeney, D.R. Nitrogen management for maximum efficiency and minimum pollution. In F.J. Stevenson (ed.), Nitrogen in Agricultural Soil, pp. 605-649. ASA-CSSA-SSSA, Madison, 1982.

Kelly, M. The kinetics of the reduction of isocyanides, acetylenes and the cyanide ion by nitrogenase preparations from Azotobacter chroococcum and the effects of inhibitors. Biochem. J. 107 (1968 a) : 1-6.

_____, M. Some properties of purified nitrogenase of Azotobacter chroococcum. Biochim. Biophys. Acta. 171 (1969 a) : 9-22.

Kim, Y.-M., Ahn, K.-J., Beppu, T., and Uozumi, T. Nucleotide sequence of the nifLA operon of Klebsiella oxytoca NG13 and characterization of the gene products. Mol. Gen. Genet. 205 (1986) : 253-259.

Koch, B., Evans, H.J., and Russel, S. Reduction of acetylene and nitrogen gas by breis and cell-free extracts of soybean root nodules. Plant Physiol. 42 (1967) : 466-468.

Ladha, J.K., Barraquio, W.L., and Wanatabe, I. Immunological techniques to identify Azospirillum associated with wetland rice. Can. J. Microbiol. 28 (1982) : 478-485.

_____, Barraquio, W.L., and Wanatabe, I. Isolation and identification of nitrogen-fixing Enterobacter cloacae and Klebsiella planticola associated with rice plant. Can. J. Microbiol. 19 (1983) : 1031-1038.

Maniatis, T., Fritsch, E.F., and Sambrook, J. Molecular cloning : A laboratory manual Cold Spring Harbor, New York, 1982.

Robson, R.L. Detection and functions of indigenous plasmids of Azotobacter. 91st Ordinary Meeting of the Society for General Microbiology, Cambridge, 1981.

_____, Chesshyre, J.A., Whecler, C., Johnes, R., Woodley, P.R., and Postgate, J.R. Genome size and complexity in Azotobacter chroococcum. J. Gen. Microbiol. 130 (1984) : 1603-1612.

Rodriquez, R.L., and Tsit, R.C. Isolation and purification of E. coli chromosomal DNA. In Recombinant DNA Techniques, pp. 45-46. Addison-Wesley publishing company, Canada, 1983.

Sekigushi, T., and Nosoh, Y. Pyruvate-supported acetylene and sulfate reduction of cell-free extracts of Desulfovibrio desulfuricans. Biochem. Biophys. Res. Commun. 51 (1973) : 331-335.

Singh, M., Kreutzer, R., Acker, G., and Klingmüller, W. Localization and phisical mapping of a plasmid-borne 23-kb nif gene cluster from Enterobacter agglomerans showing homology to the entire nif gene cluster of Klebsiella pneumoniae M5a1. Plasmid 19 (1988) : 1-12.

Siriporn Sittipraneed. Level and nature of mRNA encoding α and β subunits of human chorionic gonadotropin in normal and molar pregnancies. Doctoral dissertation, Mahidol University, 1985.

Southern, E. Detection of specific sequences among DNA fragments separated by gel electrophoresis. J. Mol. Biol. 98 (1975) : 503-505.

Stewart, W.D.P., Haystead, A., and Pearson, H.W. Nitrogenase activity in heterocysts of blue-green algae. Nature 224 (1969) : 226-228.

Swanstrom, R., and Shank, P.R. X-ray intensifying screens greatly enhance the detection by autoradiography of the radioactive

isotopes ^{32}P and ^{125}I. Anal. Biochem. 86 (1978) : 184-192.

Uozumi, T., Barraquio W.L., Wang, P.L., Murai, F., Chung, K.S., and Bepper, T. Plasmids and nif genes in Rhizobia and nitrogen-fixing bacteria in the rhizosphere of rice. Proceedings of the Fourth International Symposium on Genetics of Industrial Microorganisms, Kyoto, 1982.

Wang, P.-L, Koh, S.K., Chung, K.-S., Uozumi, T., and Beppu, T. Cloning and Expression in E. coli of the whole nif genes of Klebsiella oxytoca, a nitrogen fixer in the rhizosphere of rice. Agric. Biol. Chem. 49 (1985) : 1469-1477.

_____. H.X., Yuan H.L., and You, C.B. Plasmid visualization and nif gene location in several nitrogen-fixing bacteria associated with rice plants. Acta. Agricul. Nucle. Sin. 3 (1989) : 213-220.

Wanatabe, I. Nitrogen fixation associated with wetland rice. In K.A. Malik, S.H. Mujtaba Nagvi and M.I.H. Aleem (eds.), Nitrogen and Environment, pp. 185-196. NIAB, Faisalabad, Pakistan, 1985.

Winter, H.C., and Arnon, D.I. The nitrogen fixation system of photosynthetic bacteria.I. Preparation and properties of a cell-free extract from Chromatium. Biochim. Biophys. Acta. 197 (1970) : 170-179.

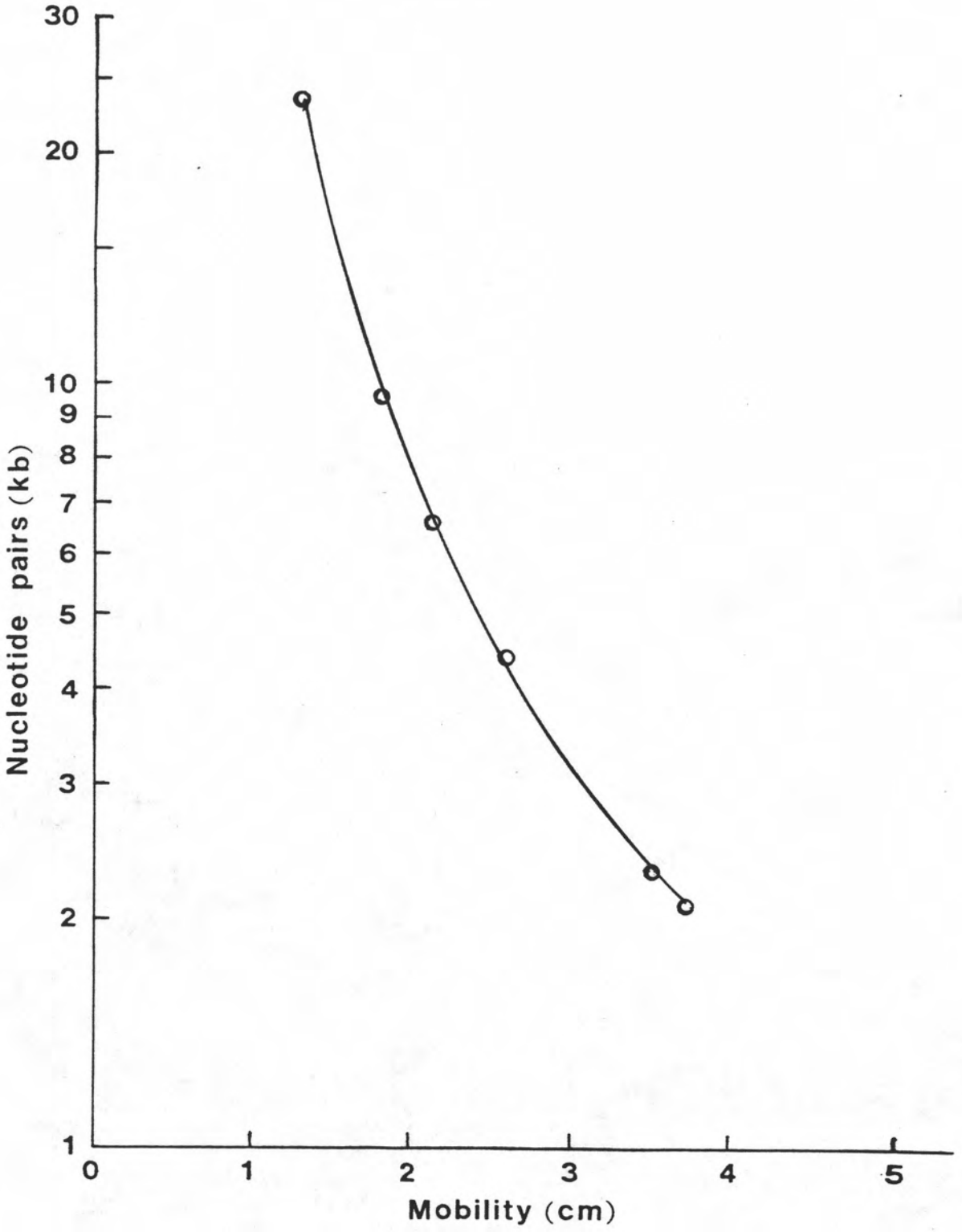
Yano, K., Anazawa, M., Murai, F., Fukuda, M., and Kuyohara, H. Indigenous plasmids of Azotobacteraceae and their functions. Proceeding of the Fourth International Symposium on Genetics of Industrial Microorganisms, Kyoto, 1982.

Yingpis Yodyotee. Physical characterization of nif structural genes in Azotobacter and Azospirillum spp. Master's Thesis, Chulalongkorn University, 1987.

You, C.B., and Wang, H.X. Rhizosphere nitrogen fixation in wetland rice. Acta. Phytophysiologics Sinica. 16 No 2 (1990) : 209-214.

APPENDIX

Appendix 1. Standard mobility curve of linear DNA fragments.



Appendix 2. Calculation of the specific activity of DNA probe.

Example : the specific activity of ^{32}P - pSA30.

From 30 µl reaction mixture of nick translation (500 ng DNA), 1 µl of mixture was drawn into 200 µl stop buffer and then 25 µl of these mixtures (201 µl) was counted for acid insoluble ^{32}P - pSA30 of 1.73×10^6 cpm.

Since the specific activity is defined as the counts of radioactivity in one minute (cpm) per one microgram of DNA, and the amount of pSA30 DNA in the reaction was 500 ng, so the total count of radioactivity in 1 µg of pSA30 was

$$1.73 \times 10^6 \text{ cpm} \times \frac{201 \text{ µl}}{25 \text{ µl}} \times \frac{30 \text{ µl}}{1 \text{ µl}} \times \frac{1000 \text{ ng}}{500 \text{ ng}} = 8.34 \times 10^8 \text{ cpm.}$$

Appendix 3. Calculation of the per cent recovery of DNA fragment from low-melting temperature agarose gel electrophoresis.

Example : the per cent recovery of Fa fragment.

The amount of Fa (3.32 kb) fragment obtained after extraction of 20 µg pSA30 (10.3 kb) cut with BamHI and HindIII from low-melting temperature agarose gel was 1.61 µg.

Since 20 µg of DNA was the total DNA of pSA30 before cutting, therefore the estimation amount of Fc in pSA30 before extraction was $20\ \mu g \times \frac{3.32\ kb}{10.3\ kb} = 6.45\ \mu g$

So, the per cent recovery of Fa fragment was $\frac{1.61\ \mu g}{6.45\ \mu g} \times 100 \approx 25.$

BIOGRAPHY

Miss Suwanna Suthisukon was born on November 1, 1960 in Bangkok, Thailand. She graduated with the Bachelor degree of Science in Medical Technology (2nd class honours) from Chulalongkorn University in 1982. She has been working in Department of Medical Technology, Faculty of Medicine, Chulalongkorn University since October 1985.