

THE BLUE-GREEN ALGAE COLLECTION AT IRRI

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1. INTRODUCTION

Interest in blue green algae (BGA) arises from:

- 1) academic curiosity for organisms that constitute the largest, most diverse, and most widely distributed group of photosynthetic prokaryotes performing oxygenic photosynthesis;
- 2) the possible usage of BGA as a source of useful biochemicals,
- 3) the high nitrogen content of some genera, especially *Spirulina*, and their possible use as food or feed (Venkataraman, 1983); and
- 4) the ability of a number of genera to fix atmospheric nitrogen, which has implications in the maintenance of the fertility of natural and cultivated ecosystems, especially in wetland ricefields.

The attention paid to biological N₂ fixation (BNF) in wetland rice fields in general, and to N₂ fixation by BGA in particular, results from the observation that moderate but constant yields have been obtained for decades when rice was grown without N fertilizer. Under such conditions soil N content generally remained stable, which indicates that exported N is replaced by mechanisms among which BNF is recognized to be the major one (Roger and Watanabe, 1986).

Biological N₂ fixation is vital to subsistence rice farming. The production of N fertilizers requires manufacturing facilities, energy supplies, and financial investments which are not available or affordable for in many rice growing countries. Agronomic practices utilizing BNF can be economically viable in many of these countries.

Among N₂-fixing microorganisms, only BGA are able to generate their own photosynthate from CO₂ and water. This trophic independence makes BGA especially attractive as a biofertilizer. Since De, in 1932, attributed the natural fertility of the tropical paddy field to BGA, many trials have been conducted to increase rice yield by inoculating the soil with BGA. Algal inoculation has been reported to have beneficial effects on grain yield in different agroclimatic conditions; however, many failures have also been observed. Therefore, a major goal of the current research on BGA in ricefields is to understand their ecology in order to develop cultural practices maximizing 1) the N input to the ecosystem by indigenous or inoculated strains and 2) the other possible beneficial effects of BGA such as the production of plant growth regulators.

Methods to achieve these goals indeed include the collection, unialgalization, eventually axenization, conservation, description, and culture of strains of BGA.

1.1. Why a BGA collection ?

For most eukaryotic organisms, and especially for cultivated plants, gene erosion is the major reason for establishing germplasm banks. For prokaryotic organisms, on the contrary, there is probably little risk of gene erosion and the major reason for establishing a collection comes primarily from the difficulties to isolate and characterize strains. Any culture of BGA represents not only a potential experimental material but also a considerable investment in money and scientist time, and a storage of all the information already collected in the difficult and time-consuming processes of collection, isolation, culture, and characterization of the organism. Therefore, it is important to preserve strains.

1.2. History of the collection

The collection of N₂-fixing blue green algae was initiated in 1979 together with a collaborative research program between ORSTOM and IRRI designed to study the ecology of BGA and their possible use as biofertilizer in wetland rice culture. In 1985, sixty-five strains of the ORSTOM collection in Senegal were transferred to IRRI. The actual collection (September 1990) comprises 204 strains originating from 21 countries. About 45% of the strains are from Africa and 40% from Asia (Table 1). The strains are classified into 12 taxa. Dominant genera are *Nostoc*, *Anabaena*, and *Calothrix* which reflects the rice field origin of the collection. It is a working collection composed of a selection of strains representative of ricefield BGA. Its major purpose is to have available a range of reference strains for field experiments, and to develop a simplified classification for agronomical and ecological studies. Therefore, most strains are maintained as unialgal material. A few axenic strains obtained from other laboratories (mainly the Pasteur Institute) are also maintained.

Table 1: Number and origin of the collection of blue-green algae. IRRI, 1990.

Genera	Africa		Asia		Europe	Other regions	TOTAL
	Senegal	Other	Philippines	Other			
<i>Anabaena</i>	13	5	7	15	5	5	50
<i>Calothrix</i>	23	2	11	7	1	1	45
<i>Fischerella</i>	4	2	4	3	1	0	14
<i>Gloeotrichia</i>	0	0	2	0	0	0	2
<i>Nodularia</i>	0	0	0	1	0	0	1
<i>Nostoc</i>	28	9	12	17	4	1	71
<i>Scytonema</i>	1	3	1	4	0	0	9
<i>Tolypothrix</i>	0	0	0	2	1	0	3
N ₂ fixing	69	21	37	49	12	7	195
Non-fixing	8	0	0	0	1	0	9
Total	77	21	37	49	13	7	204

2. TAXONOMIC ASPECTS

According to the classical definition of the term algae, which encompasses all oxygenic phototrophs of simple general structure, BGA have traditionally been placed under the International Code of Botanical Nomenclature. In 1977, Stanier and Cohen-Bazire emphasized the prokaryotic nature of BGA and stated that "the only logical treatment of the cyanobacteria (BGA) was to place them in the super kingdom Prokaryotae as a division, class, or order of bacteria" under the rules of the Bacteriological Code. At present there is no general agreement for placing BGA under a given code and most probably their future taxonomic treatment will take into account botanical and bacteriological criteria.

Traditional classifications (Geitler 1930-1932, Desikachary 1959) based almost entirely upon morphological features, frequently are of little help in identifying BGA at the species level and even, sometimes, at the genus level because, among other limitations, BGA exhibit polymorphism in response to changes in environmental conditions and age. The divergence of opinion which has resulted from the use of morphological criteria is enormous and has led to a superfluity of taxa which renders traditional taxonomy inadequate for ecological studies, the determination of a strain requiring time consuming investigations in contradictory taxonomical keys, with little chance of success. As an example, more than 350 species of *Anabaena* have been described on morphological basis whereas morphological criteria for this genus are the size and the shape of 2 or 3 kind of cells and the relative position of 2 of them (akinetes and heterocysts) !! The latest trends in BGA classification are directed towards evolving a system based on morphological and non-morphological characters that could include dynamic characters, physiological properties, fatty acid composition, pigment composition, isozymes, genome size, deoxyribonucleic acid base composition, and sequence-specific deoxyribonucleases. However, achievements in this field are still inadequate to evolve a new taxonomy and methods are hardly compatible with routine treatment of large numbers of soil samples required in ecological and agronomical studies.

Therefore, we have adopted for the BGA collection a classification limited to genus level. It uses mostly morphological criteria directly observed on the material growing on petri dishes, as recommended by Rippka *et al.* (1979). For nonN₂-fixing strains we use Rippka's classification. For N₂-fixing strains (Table 2), we have added additional genera to those described by Rippka *et al.*, by taking into account the ability to form mucilaginous colonies of defined shape in situ, because this character is associated with resistance to grazing (Grant *et al.*, 1985) and is therefore of major ecological significance. Taxa with this ability are the unicellular (*Aphanothece*, *Gloeothece* ...), *Nostoc*, , and *Gloeotrichia* groups.

Table 2. Definition of N₂-fixing taxa of BGA of the collection ^a

"Unicellular" N₂-fixing group :

- ***Gloeocapsa***: Unicellular strains growing on BG-11 medium without nitrogen. Reproduces by binary fission in two or three planes. Forms rounded mucilaginous colonies (> 0.5 mm in diameter) on agar medium. In situ, forms large (1-4 cm) floating mucilaginous colonies .

"Anabaena" group :

- ***Anabaena*** : Heterocystous strains with a thin mucilaginous sheath not clearly visible without preparation in ordinary microscopy, without branching, do not form mucilaginous colonies of definite shape. Hormogonia of the same size as the filament. In situ, forms a fragile film at the surface of the water or grow within the floodwater.
- ***Nodularia*** = *Anabaena* having disk-shaped vegetative cells.
- ***Cylindrospermum*** = *Anabaena* having heterocysts exclusively terminal and formed at both ends of the trichome, and akinetes always adjacent to the heterocyst.

" Nostoc" group :

- ***Nostoc*** : Heterocystous strains with a thick mucilaginous sheath not clearly visible without preparation in ordinary microscopy, without branching, forming mucilaginous colonies of definite shape. Hormogonia are thinner than the mature filament. In situ, forms floating mucilaginous macrocolonies.

"Aulosira" group :

- ***Aulosira*** : Heterocystous strains with a dense sheath clearly visible without preparation in ordinary microscopy, without branching. In situ, forms a resistant papyraceous film at the surface of the soil or floodwater.

"Scytonema" group :

Heterocystous strains with false branching, without polarity, forming penicillate colonies on agar medium. In situ, grows adpressed on soil or epiphytically. Currently, we have not observed growth visible to the naked eye in a rice field.

- ***Scytonema*** : with square heterocysts and both geminate and Y-shaped branching.
- ***Tolypothrix*** : with rounded heterocysts and only Y-shaped branching.

"Calothrix" group :

- ***Calothrix*** : Heterocystous strains with false branching, with polarity, frequently with tapering, forming velvet-like patches on agar medium. In situ, grows adpressed on soil or epiphytically.
- ***Gloeotrichia*** : Heterocystous strains, with polarity, tapering, and terminal spores. Forms mucilaginous colonies of definite shape in situ. When grown on BG -11₀ , usually loses its ability to form mucilage and looks like a *Calothrix*.

"Fischerella" group :

- ***Fischerella*** : Heterocystous strains with true branching, forming penicillate colonies on agar medium . In situ, grows adpressed on soil or epiphytically. Currently, we have not observed growth visible to the naked eye in a rice field.

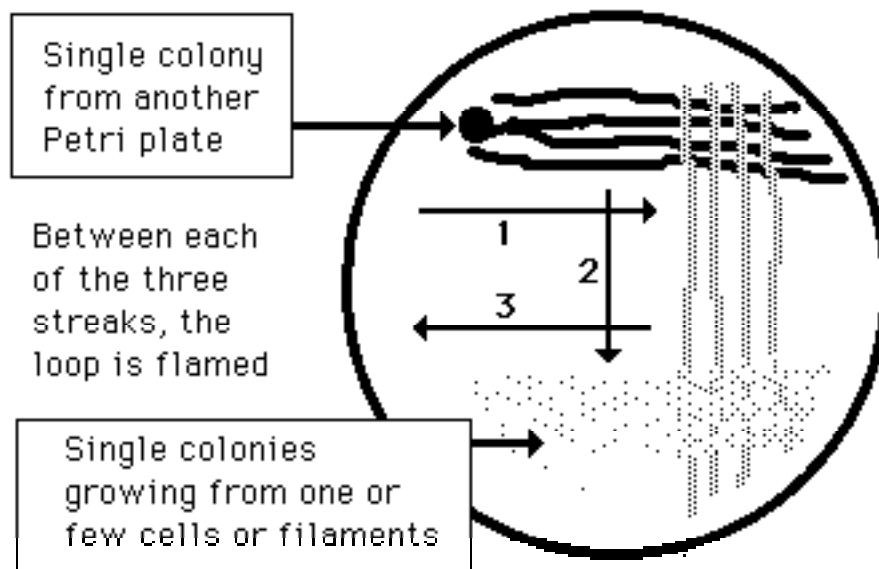
^a: All features refer to strains grown from soil or water sample dilutions plated on solidified BG-11₀ medium (without N).

3. METHOD OF ISOLATION AND CONSERVATION

Strains are isolated by picking isolated colonies from plates used for the enumeration of BGA, using higher dilutions. They are then made unialgal by streaking on agar medium (Fig 1).

All strains are maintained by subculturing in liquid medium and on agar slants. Some unialgal strains including those frequently used in inoculation experiments are also maintained as soil-based inoculum and/or dry powder inoculum.

Fig. 1. Schematic representation of streaking for BGA unialgalization



3.1. Conservation by subculturing

In our experience, the BG-II medium (Rippka et al., 1979), and its N-free modification BG-110 used for N₂-fixing strains, have proven to be the most useful in the isolation and culture of BGA from ricefields.

For liquid cultures the level of the medium in the flask should not be too high to allow a good supply of CO₂. We use 100 ml of medium in 250-ml erlenmeyer flasks or 50 ml in 125-ml flasks, which corresponds to about 2 cm of medium. Generally, BGA grow slowly and generation times of about 24 hours are common. Therefore, frequent transfers are avoided by using very small inocula. Cultures are examined at intervals for color changes, especially bleaching and contaminations. Transfers are done when necessary (usually once every 2 months) by inoculating a loopful of culture into the medium. Newly -inoculated flasks are kept under dim light for 24 hours and are then placed 25 cm under 20-watt fluorescent tubes in open shelves at laboratory temperature. The old cultures are kept as long as necessary to safeguard against possible losses of newly-transferred cultures.

For agar slants we use BG-II and BG-110 solidified with 1% Bacto agar.

Conservation by repetitive subculturing might lead to changes in strain properties after long-term cultivation under artificial conditions in the laboratory. Some strains in the collection exhibit abnormal cells.

3.2. Conservation as dry material

The resistance of BGA to desiccation allows preservation as dried material; however methods of preservation by desiccation are not yet fully established.

3.2.1. *Conservation as soil-based inoculum*: Soil-based inocula are produced, in erlenmeyer flasks or on petri plates, on soil previously autoclaved at 120° C for 30 minutes for three consecutive days. The material is dried at room temperature and kept at laboratory temperature in plastic bottles. When the strain is needed, suspension-dilutions of the algal flakes are plated on petri dishes and isolated colonies are then grown in liquid medium. Such material exhibited good viability. Out of 70 strains tested, 67 could be regrown after 20 months. However about 30% of the strains was contaminated with algae from the soil, mostly diatoms, which indicates that special attention should be paid to the sterilization of soil to be used as preserving support.

3.2.2. *Conservation as dry powder*: BGA produced in mass culture are harvested by decantation, dried at room temperature, and ground. This material is kept at room temperature in plastic bottles. This method has been proven successful with all of the 10 strains of heterocystous BGA we have currently tested for long-term conservation. Dried and powdered cultures could regrow after 8 years of storage.

A simple set-up for mass culture production is described in Appendix 9.1.

3.2.3. *Conservation on paper strips*: Cultures grown in 125-ml erlenmeyer flasks are decanted and deposited on 1 x 5 cm strips of sterile Whatman chromatography paper n°3. The paper strips with the BGA culture are dried in a sterile hood at room temperature and then placed in a small envelope to avoid contamination. This method is less efficient for long-term conservation than soil-based inocula or dried and powdered cultures. Among 136 N₂-fixing strains transferred on paper strips, 30 strains were lost after 16 months of storage and 129 after 30 months. However, the method is very convenient for mailing cultures.

4. CODE

Strains are named according to a six-digit code. The two first letters indicate the taxon (genus or group), the second and third digits are a ranking number within the taxon, the two last letters indicate the country of origin. Because of the controversial aspects of BGA taxonomy, we do not use specific names.

i.e. Ab 05 Sn means *Anabaena* n° 05 originating from Senegal. Codes for taxa and countries are as follows:

GENUS	Abbreviation	COUNTRY	Abbreviation
Anabaena	Ab	Australia	Au
Calothrix	Cx	Austria	As
Fischerella	Fi	Canaria Islands	Cn
Gloeotrichia	Gl	China	Ch
Oscillatoria	Os	Chile	Cl
Nostoc	Ns	Egypt	Eg
Lyngbia = LPP	LP	England	En
Nodularia	Nd	India	In
Phormidium = LPP	LP	Iran	Ir
Plectonema = LPP	LP	Japan	Jp
Pseudanabaena	Ps	Madagascar	Mr
Scytonema	Sc	Malaysia	Ms
Synechococcus	Sy	Mali	Ml
Tolypothrix	Tx	Netherlands	Ns
		Portugal	Pr
		Philippines	Ph
		Senegal	Sn
		Sri Lanka	SL
		Sweden	Sw
		Thailand	Th
		USA	US
		Unknown	XX

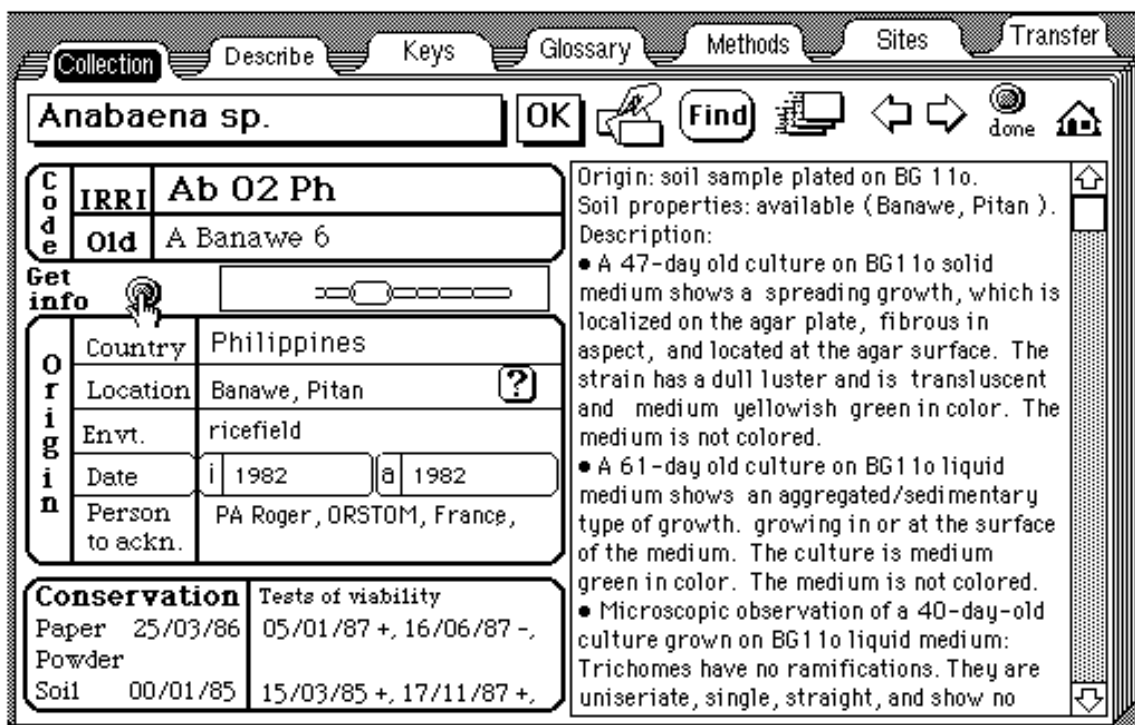
5. COMPUTERIZED INFORMATION ON THE STRAINS: HYPERCARD STACKS ON BGA

Information on the BGA collection is compiled in a set of six HyperCard stacks for Apple MacIntosh®.

- The main stack "Collection" (236 Kbyte, 206 cards) provides information on the strains. Each card corresponds to a strain and includes, when available:
 - name of the strain, IRRI's code, other code when applicable,
 - country of origin, location in the country and environment the strain was isolated from,
 - year of isolation, year of acquisition in IRRI's collection,
 - information on strain conservation by methods other than subculturing on liquid medium and agar slants,
 - origin of the strain (soil sample, culture, ..),
 - information on soil properties of the environment the strain was isolated from, description of a culture on liquid medium, description of a culture on solid medium, and microscopic description of the strain.
 - additional notes
 - bibliographic references on the strain or its environment

Each card contains function buttons which permit navigation between cards and stacks, sorting, browsing, finding specific information by keywords, and compiling all the information contained in a card in a merge process that produces a standardized text transferable to a word processing program. An example of a card of the "Collection" stack and the corresponding compiled information is given in fig 2.

Fig. 2: Example of a card of the stack collection and the compilation of the information contained in the card as a standardized text * .



* Navigating between stacks is possible from any card by clicking on the tabs at the top of the stacks. A return arrow in cards of other stacks allows to return to the last card of the "Collection" stack. The second row of buttons allows sorting cards, finding a strain, browsing, and moving to the previous or next card. Clicking the "Get info" button compile information from the card in the "Transfer" card. The information compiled from this card is presented thereafter. The question mark button in the field "Location" indicates that detailed information on the site of collection is available in the stack "Sites" and allow to go to the card describing Banawe, Pitan.

Fig. 3: Example of the compilation of the information contained in a card as a standardized text (card is presented in Fig. 2).

IRRI BGA collection, strain Ab 02 Ph.

This strain, identified as *Anabaena* sp., was added to the collection in 1982. It was isolated by PA Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982. This strain was preserved on paper strips on 25/03/86. Viability tests are as follows: 05/01/87 +, 16/06/87 -. It is not preserved as dry powdered culture. It was preserved as soil based inoculum on 00/01/85. Viability tests are as follows: 15/03/85 +, 17/11/87 +.

Origin: soil sample plated on BG-110.

Soil properties: available (from stack sites, Banawe, Pitan).

Visual description:

- A 47-day old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is translucent and medium yellowish green. The medium is not colored.
- A 61-day old culture in liquid medium shows an aggregative sedimentary type of growth, growing in or at the surface of the medium. The culture is medium green. The medium is not colored.

Microscopic observation (52-day-old culture on solid medium):

Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long to very long rounded, 3-4 microns wide, and 4-15 microns long. Most apical cells are rounded. Abnormal vegetative cells and heterocysts are numerous. Heterocysts are mostly intercalary, either single or in chains. They are from short to very long barrel-shaped, 6-7 microns wide, and 7-20 microns long. Spores are mostly intercalary, in chains, and smooth. They are short barrel-shaped, 5-6 microns wide and 4.5-7 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

This strain forms numerous abnormal cells and heterocysts on solid medium. Old cultures show very contorted and aggregated filaments with numerous abnormal cells.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986) Nitrogen fixing phototrophic organisms in Ifugao rice terraces (Philippines). *Phil. Agric.* 69: 599-609.

- The stack "Describe" (101 Kbyte, 19 cards) is an on-screen tool to describe (1) cultures of strains growing on solid and liquid media (aspect and color), and (2) their morphological features under the microscope (morphology of the trichome, ramifications, shapes and sizes of different kind of cells etc.). It works as multiple choice buttons on automatically connected cards. Merge functions are attached to each button. A description of the strain is built up in the first card of the stack and can be transferred to the card of a strain in the "Collection" stack at the end of the description session. Terminology used for the description of various features is directly connected to definitions in the "Glossary" stack for on-screen help.
- The stack "Keys" (160 Kbyte, 69 cards) provides on-screen taxonomic keys for genera of BGA encountered in ricefields.
- The stack "Glossary" (53 Kbyte, 95 cards) provides definitions of specific terms or concepts including terms used for the description of BGA in the stack "Describe". Definitions are illustrated, when needed, with schematic drawings.
- The stack "Methods" (25 Kbyte, 8 cards) provides general information on routine methods for the maintenance, mailing, and revival of the strains. It provides also information on methods for estimating BGA abundance and activities in ricefields.
- The stack "Sites" (20 Kbytes, 12 cards) provides information on the environments from which the strains were isolated.

The stacks are user-friendly, with on-screen help and many additional features that can easily be discovered while experimenting with the program.

6. DESCRIPTION OF THE STRAINS OF THE IRRI BGA COLLECTION

Cultures for visual and microscopic observations were grown in liquid and on solid BG-11₀ media. Isolated colonies on agar plates were obtained by streaking across the solidified medium (Fig.1). The Hypercard stack "Describe" was used for describing the strains in a standardized manner. The descriptions use a limited number of terms which definitions are given in an appended glossary. When available, soil properties of the site from which a strain originated are given in the appendix.

ANABAENA

Strain Ab 01 Ch

This strain, identified as *Anabaena* sp., was added to the collection in 1982. It originates from China. It was isolated by Bai Ke-zhi from an azolla plant. It is most probably an epiphytic BGA rather than a symbiont.

Visual description:

- A 47-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is translucent and light green. The medium is not colored.
- A 61-day-old culture in liquid medium shows flocculent growth. It is mucilaginous and medium yellowish green. The medium is not colored.

Microscopic observation (40-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are long angular, 2.5-3.5 microns wide, and 2.5-4.5 microns long. Most apical cells are pointed. Heterocysts, spores, and hormogonia were not observed.

Strain Ab 02 Ph

This strain, identified as *Anabaena* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitán, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitán)

Visual description:

- A 47-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is translucent and medium yellowish green. The medium is not colored.
- A 61-day-old culture in liquid medium has an aggregative sedimentary type of growth, growing in or at the surface of the medium. The culture is medium green. The medium is not colored.

Microscopic observation (52-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are from long to very long rounded, 3-4 microns wide, and 4-15 microns long. Most apical cells are rounded. Abnormal vegetative cells and heterocysts are numerous. Heterocysts are mostly intercalary, either single or in chains. They are from short to very long barrel-shaped, 6-7 microns wide, and 7-20 microns long. Spores are mostly intercalary, in chains, and smooth. They are short barrel-shaped, 5-6 microns wide, and 4.5-7 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

This strain forms numerous abnormal cells and heterocysts on solid medium. Old cultures show very contorted and aggregated filaments with numerous abnormal cells.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ab 03 In

This strain, identified as *Anabaena azollae*, was added to the collection in 1988. It originates from India. The culture came from the Banaras Hindu University collection.

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is opaque and medium green. The medium is not colored.
- A 20-day-old culture in liquid medium shows a medium-green incohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Gliding motility of the trichomes is observed. Vegetative cells are short barrel-shaped, 6-7 microns wide, and 3.5-6 microns long. They are vacuolated. Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are short barrel-shaped, 7-7.5 microns wide, and 6-7 microns long. No spores were observed. Hormogonia are vacuolated, have pointed apical cells and the same width as the filaments. They have no heterocysts and show motility.

Notes:

Contaminated with *Oscillatoria*.

Most probably an azolla epiphyte.

Characteristically forms pairs of spores adjacent to the heterocyst.

Strain Ab 04 Eg

This strain, identified as *Anabaena* sp., was added to the collection in 1987. It was isolated by F. Ghazal from a ricefield soil collected from the Nile delta, Egypt, in 1987.

Soil properties: available

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has glossy luster, is opaque and medium green. The medium is not colored.

- A 20-day-old culture in liquid medium shows medium-yellowish-green homogeneous growth. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are short angular, 4-4.5 microns wide, and 2-3.5 microns long.

Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are long barrel-shaped, 5-6 microns wide, and 6.5-7.5 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show motility.

Strain Ab 05 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Reynaud (ORSTOM) from a ricefield soil collected from Riniao, Senegal, in 1972.

Visual description:

- A 21-day-old culture on solid medium shows colonial growth. Most colonies are smaller than 0.5 mm, irregular-shaped viewed from the top and flat from the side. The margin is smooth. The culture has intermediate luster, is opaque and dark brown. The medium is not colored.

- A 20-day-old culture in liquid medium shows medium-brown homogeneous growth.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 2.5-3 microns wide, and 4.5-6.5 microns long.

Most apical cells are rounded. Only detached, mostly bipolar heterocysts are observed. They were long ellipsoidal, 5-5.5 microns wide, and 5.5-7 microns long. Free, smooth spores are observed. They are long ellipsoidal, 5.5-6 microns wide, and 7-8 microns long. No hormogonia were observed.

Strain Ab 06 US

This strain, identified as *Anabaena* sp., was added to the collection in 1979. It originates from USA. The culture was provided by C. van Baalen of USA.

Visual description:

- A 47-day-old culture on solid medium shows generalized spreading growth, diffuse in aspect, located on the agar surface. It has glossy luster, is translucent and light yellowish green. The medium is not colored.

- A 61-day-old culture in liquid medium has an aggregative sedimentary type of growth, growing in or at the surface of the medium. It is light yellowish green. The medium is not colored.

Microscopic observation (40-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Gliding of the trichomes is observed. Vegetative cells are isometric rounded, 4-5 microns wide, and 4-5 microns long.

Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are isometric rounded, 6-6.5 microns wide, and 6-7 microns long. Spores are mostly intercalary, in chains, and smooth. They are long rounded, 6-7 microns, and 7-8 microns long. Hormogonia have the same width as the filaments.

Strain Ab 07 Ch

This strain, identified as *Anabaena cylindrica*, was added to the collection in 1982. It originates from China. The culture was provided by Bai Ke-Zhi of China.

Visual description:

- A 47-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and dark green. The medium is not colored.

- A 61-day-old culture in liquid medium shows dark-green homogeneous growth. The medium is not colored.

Microscopic observation (61-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 5-7 microns long.

Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long barrel-shaped, 5-6 microns wide, and 6-7 microns long. Spores are mostly intercalary, in chains, and smooth. They are long ellipsoidal, 5.5-6.5 microns wide, and 13-15 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 08 US

This strain, identified as *Anabaena flos-aquae* ATCC #22664, was added to the collection in 1982. It originates from USA. It was isolated by J. W. Newton.

Visual description:

- A 61-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and dark yellowish green. The medium is not colored.
- A 61-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is dark yellowish green. The medium is not colored.

Microscopic observation (40-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 4-5 microns wide, and 4-6 microns long. Most apical cells are rounded. Abnormal vegetative cells, distorted and very long, are observed. Heterocysts are mostly intercalary and single. They are long rounded, 4-5 microns wide, and 5-7 microns long. Spores are mostly intercalary, single, and smooth. They are long rounded, 5-6 microns wide, and 7.5-8.5 microns long. Hormogonia have the same width as the filaments. They have terminal heterocysts and show no motility.

Strain Ab 09 En

This strain, identified as *Anabaena flos-aquae*, was added to the collection in 1982. It originates from England.

Visual description:

- A 27-day-old culture on solid medium shows colonial growth. Colonies are about 0.5-5.0 mm in size, irregular-shaped viewed from the top and flat from the side. They have finger-like expansions. The culture has intermediate luster, is opaque and dark yellowish green. The medium is not colored.
- A 30-day-old culture in liquid medium shows dark-yellowish-green flocculent growth. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 3-4 microns wide, and 4-6 microns long. Most apical cells are rounded. Abnormal vegetative cells, very long and peanut-shaped, are observed. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 3.5-4 microns wide, and 4.5-6 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 10 Th

This strain, identified as *Anabaena* sp., was added to the collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Sakon Nakon Research Station, Thailand. The soil sample was collected from an azolla plot with no fertilizer applied.

Visual description:

- A 25-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and medium green. The medium is not colored.
- A 61-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is dark yellowish green. The medium is not colored.

Microscopic observation (40-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 3-4 microns wide, and 4-6 microns long. Most apical cells are rounded. Abnormal vegetative cells, distorted and long, are observed. Heterocysts are mostly intercalary and single. They are long angular, 4-5 microns wide, and 6-7 microns long. Spores are mostly intercalary, in chains and smooth. They are long rounded, 4-5 microns wide, and 6-7 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 11 Ph

This strain, identified as *Anabaena* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitan 3)

Visual description:

- A 21-day-old culture on solid medium shows colonial growth. Colonies are 1-1.5 mm in size, irregular-shaped viewed from the top and flat from the side. The margin is rough. The culture has intermediate luster, is opaque and dark brownish green. The medium is not colored.
- A 20-day-old culture in liquid medium shows medium-yellowish-green flocculent growth.

Microscopic observation (21-day-old culture grown on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 5-5.5 microns wide, and 5-7 microns long. Most apical cells are rounded. Abnormal vegetative cells, elongated and irregular, are observed. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 5-6 microns, and 7-8 microns long. No spores were observed. Hormogonia have the same width as the filaments. They show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ab 12 Ph

This strain, identified as *Anabaena* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Luisiana, Laguna, Philippines, in 1983.

Soil properties: available (Luisiana)

Visual description:

- A 25-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and medium green. The medium is not colored.

- A 61-day-old culture in liquid medium shows light-yellowish-green flocculent growth. The medium is not colored.

Microscopic observation (65-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric rounded, 5-6 microns wide, and 5-6 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric rounded, 6-7 microns wide, and 7-8 microns long. Spores and hormogonia were not observed.

- Microscopic observation of a 40-day-old culture in liquid medium shows similar features except for the following: trichomes are straight; gliding of the trichomes is observed; and most apical cells are pointed.

Bibliographic reference on the strain or its environment: Reddy PM, Roger PA, Ventura W, Watanabe I (1986)

Strain Ab 13 In

This strain, identified as *Anabaena* sp., was added to the collection in 1982. It originates from India. The culture was provided by J.C. Thomas of India.

Visual description:

- A 47-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and medium yellowish green. The medium is not colored.

- A 62-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Microscopic observation (47-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are short barrel-shaped, 4-5 microns wide, and 3-4 microns long. Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are long barrel-shaped, 5-6 microns wide, and 6-7 microns long. No spores were observed. Hormogonia have the same width as the filaments. They

have no heterocysts and show motility.

Strain Ab 14 Ms

This strain, identified as *Anabaena* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Tikang Batu, Kedah, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 47-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is opaque and dark green. The medium is not colored.

- A 62-day-old culture in liquid medium shows medium-yellowish-green flocculent growth. The medium is not colored.

Microscopic observation (65-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, either single or in bundles, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 4.5-5.5 microns wide, and 4.5-5.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long barrel-shaped, 6.5-8 microns wide, and 8.5-10 microns long. Spores and hormogonia were not observed.

- Microscopic observation of a 26-day-old culture in liquid medium shows similar features except for the following:

trichomes are wavy; gliding of the trichomes is observed; heterocysts are isometric barrel-shaped, 4-5 microns wide, and 4-5 microns long; hormogonia have the same width as the filaments and terminal heterocysts, and show no motility.

Strain Ab 15 Ms

This strain, identified as *Anabaena* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Teroi, Kedah, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 47-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It is light yellowish green. The medium is not colored.

- A 62-day-old culture in liquid medium forms a medium-yellowish-green cohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (26-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Gliding of the trichomes is observed. Vegetative cells are isometric angular, 4-5 microns wide, and 4-5 microns long.

Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric rounded, 5-6 microns wide, and 6-7 microns long. Spores and hormogonia were not observed.

Strain Ab 16 Ms

This strain, identified as *Anabaena* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Kuala Kurau, Perak, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 75-day-old culture on solid medium shows cohesive growth with rough margin. It has intermediate luster, is opaque and dark brown. The medium is brownish.
- An 85-day-old culture in liquid medium shows dark-brown flocculent growth. The medium is brownish. Even in a 2-week-old culture, the medium is already colored.

Microscopic observation (75-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are very long rounded, 2.5-3 microns wide, and 5-8 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 5.5-6 microns wide, and 6-7.5 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

Motility is observed in liquid medium.

Strain Ab 17 US

This strain, identified as *Anabaena* sp., was added to the collection in 1982. It originates from USA. The culture was provided by J.W. Newton.

Visual description:

- A 47-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and dark green. The medium is not colored.
- A 62-day-old culture in liquid medium shows dark-green flocculent growth. The medium is not colored.

Microscopic observation (26-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long rounded, 2.5-3.5 microns wide, and 4-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long rounded, 3.5-4 microns wide, and 5.5-6.5 microns long. Spores and hormogonia were not observed.

Strain Ab 18 Ns

This strain, identified as *Anabaena oscillarioides*, was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a soil sample collected from a saline marshy area in the Netherlands.

Visual description:

- A 47-day-old culture on solid medium shows generalized spreading growth, coiled in aspect, located on the agar surface. It has glossy luster, is opaque and medium green. The medium is not colored.
- A 62-day-old culture in liquid medium shows medium-green flocculent growth. The medium is not colored.

Microscopic observation (26-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric angular, 5-5.5 microns wide, and 5-6 microns long. Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are long barrel-shaped, 5.5-microns wide, and 7.5-8.5 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have terminal heterocysts and show no motility.

Strain Ab 19 Pr

This strain, identified as *Anabaena* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a marsh soil collected in Portugal in 1982. The soil sample was provided by J. Margraf.

Visual description:

- A 47-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. It has intermediate luster, is opaque and light yellowish green. The medium is not colored.
- A 28-day-old culture in liquid medium shows irregular, mucilaginous colonies, growing in or at the surface of the medium, which breaks when shaken. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (26-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are isometric barrel-shaped, 5-6.5 microns wide, and 5-7 microns long. Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 7-8 microns wide, and 9-10 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility. An older culture (65 days) had no spores.

Notes: Old liquid cultures have high mucilage content.

Strain Ab 20 Ph

This strain, identified as *Anabaena* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Philippines.

Visual description:

- An 80-day-old culture on solid medium shows colonial growth. Colonies are 5-8 mm in size, rounded viewed from the top and low convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium green. The medium is not colored.
- A 40-day-old culture in liquid medium shows medium-green homogeneous growth. The medium is not colored. The culture produces large quantities of mucilage.

Microscopic observation (80-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 1.5-2 microns wide, and 2-3 microns long. Most apical cells are rounded. Heterocysts are mostly single and both intercalary and terminal. They are long ellipsoidal, 1.5-2 microns wide, and 2.5-3 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 21 In

This strain, identified as *Anabaena subcylindrica*, was added to the collection in 1980. It originates from India. The culture was provided by J.C. Thomas.

Visual description:

- A 47-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has glossy luster, is translucent and light yellowish green. The medium is not colored.
- A 63-day-old culture in liquid medium shows irregular, compact colonies, 5-10 mm in size, growing in or at the surface of the medium. The culture is dark green. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 5-6 microns wide, and 4-6.5 microns long. Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are long barrel-shaped, 5.5-6.5 microns wide, and 8.5-10 microns long. No spores were observed. Hormogonia have the same width as the filaments and are motile. They have no heterocysts when shorter than 9 cells.

Strain Ab 22 Ph

This strain, identified as *Anabaena* sp., was added to the collection in 1979. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Luisiana, Laguna, Philippines, in 1979.

Soil properties: available (Luisiana)

Visual description:

- A 25-day-old culture on solid medium shows generalized growth, coiled in aspect. It has glossy luster, is opaque and medium green. The medium is not colored.
- A 41-day-old culture in liquid medium forms a medium-green incohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, straight, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are short barrel-shaped, 7-8 microns wide, and 5.5-7 microns long. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are isometric rounded, 7-8 microns wide, and 7-8 microns long. No spores were observed. Hormogonia are tapered at both ends, but the central cells are of the same width as the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Reddy PM, Roger PA, Ventura W, Watanabe I (1986)

Strain Ab 23 Ph

This strain, identified as *Anabaena* sp., was added to the collection in 1979. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected at IRRI, Philippines, in 1979.

Soil properties: available (IRRI farm, upper MN)

Visual description:

- A 21-day-old culture on solid medium shows colonial growth. Most colonies are smaller than 0.5 mm, irregular-shaped viewed from the top and flat from the side. The margin is smooth. The culture has glossy luster, is opaque and medium green. The medium is not colored. The culture shows very poor growth. Colonies are dark at the center and translucent at the edge.
- A 20-day-old culture in liquid medium shows medium-green flocculent growth.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 4.5-5 microns wide, and 4-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long

barrel-shaped, 5.5-6.5 microns wide, and 7-8 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

Motility (oscillation) of the trichomes is observed in a 29-day-old liquid culture.

Strain Ab 24 Mr

This strain, identified as *Anabaena* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Mahitsi Experimental Station, Madagascar, in 1986. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Soil properties: available

Visual description:

- A 25-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, irregular-shaped from the top and low convex from the side. The margin is rough. The culture has intermediate luster, is opaque and dark green. The medium is not colored.
- A 41-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is dark yellowish green. The medium is not colored.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 2-4 microns wide, and 3-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are isometric rounded, 5 microns wide, and 5 microns long. Free, single, and ornamented spores are observed. They are long ellipsoidal, 2 microns wide, and 2 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 25 Ch

This strain, identified as *Anabaena variabilis*, was added to the collection in 1980. It originates from China. The culture was provided by Bai Ke-Zhi of China.

Visual description:

- A 47-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and medium green. The medium is not colored.
- A 63-day-old culture in liquid medium shows dark-yellowish-green homogeneous growth. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 2-3 microns wide, and 3-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long rounded, 3.5-4 microns wide, and 4.5-6 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 26 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRR collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 75-day-old culture on solid medium shows cohesive microcolonial growth. Most colonies are smaller than 0.5 mm, irregular-shaped viewed from the top and flat from the side. The margin is rough. The culture has intermediate luster, is opaque and dark green. The medium is not colored.
- A 48-day old-culture in liquid medium shows dark-green homogeneous growth. The medium is not colored.

Microscopic observation (75-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 4.5-7 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 5-5.5 microns wide, and 5.5-7 microns long. No spores were observed. Hormogonia have the same width as the filaments and show no motility.

Strain Ab 29 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRR collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil collected from Bambey, Senegal.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 47-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and medium yellowish green. The medium is not colored.
- A 62-day-old culture in liquid medium shows medium-yellowish-green homogeneous growth. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, wavy, and single. No tapering was observed. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are short barrel-shaped, 5-6 microns wide, and 3-5 microns long. Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are isometric rounded, 8-9 microns wide, and 8-9 microns long. Spores are mostly intercalary, in pairs adjacent to heterocysts, and smooth. They are long ellipsoidal, 10-11 microns wide, and 15-16.5 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

This strain has a marked ability to form characteristic spores in pairs on both sides of the heterocyst. When the culture ages, spores become free.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Ab 30 In

This strain, identified as *Anabaena cycadae*, was isolated from a *Cycas* and was added to the collection in 1988. It originates from the Banaras Hindu University, India. The culture was provided by J.K. Ladha.

Visual description:

- A 90-day-old culture on solid medium shows cohesive growth with smooth margin. It has glossy luster, is opaque and medium green. The medium is not colored.
- A 20-day old culture in liquid medium shows medium-yellowish-green homogeneous growth.

Microscopic observation (90-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3-4 microns wide, and 4-6 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 4.5-5.5 microns wide, and 5.5-7 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have terminal heterocysts and show no motility.

Strain Ab 31 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil collected from Bambey, Senegal, in 1973.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 47-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. The culture has intermediate luster, is translucent and medium yellowish green. The medium is not colored.
- A 30-day-old culture in liquid medium shows medium-yellowish-green flocculent growth. The medium is yellowish.

Microscopic observation (28-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are long angular, 3.5-4.5 microns wide, and 3-5 microns long. Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 7-8 microns wide, and 8-9 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show motility.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Ab 32 SL

This strain, identified as *Anabaena* sp., was added to the collection in 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasooriya.

Visual description:

- A 25-day-old culture on solid medium shows colonial growth. Colonies are 2-5 mm in size, rounded viewed from the top and globular from the side. The margin is smooth. The culture has glossy luster, is opaque and medium green. The medium is not colored.
- A 41-day-old culture in liquid medium shows medium-yellowish-green homogeneous growth. The medium is not colored.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 5-6 microns wide, and 8-21 microns long. Cells adjacent to heterocysts are only 4 microns in length. Most apical cells are rounded. Abnormal vegetative cells, like those of Ab 09 En, are observed. Heterocysts are mostly terminal and single. They are long ellipsoidal, 6 microns wide, and 8 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have terminal heterocysts and show no motility.

Strain Ab 33 Mr

This strain, identified as *Anabaena* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from RBL, Madagascar, in 1976. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Soil properties: available (Madagascar RBL).

Visual description:

- A 25-day-old culture on solid medium shows colonial growth. Colonies are 0.5-1 mm in size, rounded viewed from the top and low convex from the side. The margin is smooth. The culture has intermediate luster, is opaque and medium green. The medium is not colored.
- A 41-day-old culture in liquid medium forms a medium-green incohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 5 microns wide, and 5-8 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 6 microns wide, and 6-8 microns long. Free spores, in chains and ornamented, were observed. They are long ellipsoidal, 5-6 microns wide, and 6-9 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 34 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Casamance, Senegal, in 1974.

Visual description:

- A 28-day-old culture on solid medium shows colonial growth. Colonies are 0.5-1.0 mm in size, irregular-shaped viewed from the top and flat from the side. They have finger-like expansions. The culture has intermediate luster, is opaque and medium yellowish green. The medium is not colored.
- A 63-day-old culture in liquid medium shows medium-yellowish-green homogeneous growth.

Microscopic observation (32-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are isometric angular, 2.5-3.5 microns wide, and 2-4 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 4.5-5.5 microns wide, and 6-7 microns long. Spores and hormogonia were not observed.

Strain Ab 35 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Casamance, Senegal, in 1974.

Visual description:

- A 47-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and medium green. The medium is not colored.
- A 63-day-old culture in liquid medium shows medium-yellowish-green flocculent growth. The medium is not colored.

Microscopic observation (32-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 3-4 microns wide, and 3-6 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long rounded, 4.5-5.5 microns wide, and 6-8 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

On a 32-day-old solid culture, cells are long angular, about 4 x 3-6 microns. In an older solid culture (75 d), cells are isometric barrel-shaped, 5 x 5 microns.

Strain Ab 36 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Casamance, Senegal, in 1972.

Visual description:

- A 32-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and dark reddish brown. The medium is not colored.
- A 63-day-old culture in liquid medium shows dark-reddish-brown flocculent growth. The medium is reddish.

Microscopic observation (32-day-old culture on solid medium):

- Trichomes have no ramifications. They are single, wavy, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 5-7 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and in pairs. They are long rounded, 4-5 microns wide, and 7-8 microns long. Few abnormal heterocysts (very long and sausage-like) are observed. Spores and hormogonia were not observed.

Strain Ab 37 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1972.

Visual description:

- A 32-day-old culture on solid medium shows cohesive growth with rough margin. It has intermediate luster, is opaque and dark green.

- A 63-day-old culture in liquid medium shows dark-green flocculent growth.

Microscopic observation (32-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 5-9 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 6-7 microns wide, and 5.5-9 microns long. Spores and hormogonia were not observed. In an older culture (75 d), hormogonia of the same size as the filaments are observed.

Strain Ab 38 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a soil collected from Fanaye, Senegal.

Visual description:

- A 29-day-old culture on solid medium shows colonial growth. Colonies are 2-4 mm in size, rounded viewed from the top and flat from the side. The margin is rough. The culture has intermediate luster, is opaque and dark brownish green. The medium is not colored.

- A 48-day-old culture in liquid medium shows dark-brownish-green homogeneous growth. The medium is not colored.

Microscopic observation (53-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3.5-5 microns wide, and 3.5-7 microns long. Most apical cells are pointed. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 3.5-5 microns wide, and 5-7 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 40 Sn

This strain, identified as *Anabaena* sp., was added to the collection in 1985. It originates from Senegal. It was isolated by P.A. Roger (ORSTOM) in 1974.

Visual description:

- A 28-day-old culture on solid medium shows cohesive growth with rough margin. It has intermediate luster, is opaque and dark green. The medium is not colored.

- A 63-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is dark green.

Microscopic observation (32-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric rounded, 2.5-3.5 microns wide, and 2.5-4 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 4-5 microns wide, and 4.5-6 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

In an older culture, the cells are long barrel-shaped.

Strain Ab 41 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Ntiago, Senegal.

Visual description:

- A 40-day-old culture on solid medium shows cohesive growth with smooth margin. It has glossy luster, is opaque and medium green. The medium is not colored.

- A 75-day-old culture in liquid medium shows medium-yellowish-green homogeneous growth.

Microscopic observation (40-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 4-6 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 5-6 microns wide, and 8-9 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

Observation of an older culture (75 d) reveals short to isometric barrel-shaped vegetative cells.

Strain Ab 42 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil in 1974.

Visual description:

- A 40-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has dull luster, is opaque and medium brownish green. The medium is not colored.

- A 65-day-old culture in liquid medium forms a medium-brownish-green cohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (40-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3-4 microns wide, and 3-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 3.5 microns wide, and 5-6 microns long. Spores are mostly intercalary, in chains, and smooth. They are long rounded, 4-5 microns wide, and 7-8 microns long. Hormogonia have the same width as the filaments. They have terminal heterocysts and show no motility.

Notes:

This strain forms a very high number of spores. Apparently most of the vegetative cells may become spores. Ageing filaments form spores and become contorted.

In young cultures, heterocysts are mostly terminal.

Strain Ab 43 Th

This strain, identified as *Anabaena* sp., was added to the collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Sakon Nakon Station, Thailand, in 1985. The soil sample, provided by Dr. I. Watanabe, came from an azolla plot with 0-36-24 NPK applied.

Visual description:

- A 25-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, rounded viewed from the top and low convex from the side. The margin is smooth. The culture has glossy luster, grows evenly, is opaque and medium green. The medium is not colored.
- A 41-day-old culture in liquid medium has an aggregative sedimentary type of growth, growing slightly addressed at the bottom of the flask. The culture is medium green. The medium is not colored.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are short barrel-shaped, 2-4 microns wide, and 4-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 4-5 microns wide, and 6-7 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 44 MI

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by T. Traore (ENS, Bamako) from a ricefield soil collected from Bamako, Mali, in 1975. The soil sample was neutral and very rich in organic matter.

Soil properties: available

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. The culture has glossy luster, is opaque and dark brownish green. The medium is not colored.
- A 34-day-old culture in liquid medium forms a medium-brownish-green incohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (34-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are isometric angular, 3-4 microns wide, and 3-5 microns long. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are long ellipsoidal, 3-4 microns wide, and 5-6 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

- Microscopic observations of a 21-day-old culture on solid medium are the same as those in liquid medium except for the following: vegetative cells are long barrel-shaped, 4-4.5 microns wide, and 4-7 microns long; most apical cells are rounded; heterocysts are long barrel-shaped, 5-5.5 microns wide, and 6-10 microns long; hormogonia have terminal heterocysts and show no motility.

Notes:

This strain was found to grow abundantly after rice harvest as black, glossy patches in depressions on wet soil. It was identified as a *Cylindrospermum* from samples collected in the field. After subculturing, the strain lost its ability to form spores.

Bibliographic reference on the strain or its environment: Traore TM, Roger PA, Reynaud PA, Sasson A (1978).

Strain Ab 45 Pr

This strain, identified as *Anabaena* sp., was added to the collection in 1983. It originates from Portugal. It was isolated by P.A. Roger (ORSTOM) from a soil sample provided by J. Margraf.

Visual description:

- A 29-day-old culture on solid medium shows cohesive growth. It has glossy luster, is opaque and medium green. The medium is not colored.

- A 48-day-old culture in liquid medium shows medium-green homogeneous growth. The medium is not colored.

Microscopic observation (54-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 2-3 microns wide, and 4-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 5 microns wide, and 6-7 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 46 Sn

This strain, identified as *Anabaena* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM) in 1974.

Visual description:

- A 21-day-old culture on solid medium shows colonial growth. Colonies are 0.5-2 mm in size, rounded viewed from the top and low convex from the side. The margin is smooth. The culture has glossy luster and is medium green. The medium is not colored.

- A 48-day-old culture in liquid medium shows medium-yellowish-green homogeneous growth. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric angular, 3.5-4 microns wide, and 3-4.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long rounded, 4-4.5 microns wide, and 4-5 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 47 XX

This strain, identified as *Anabaena* sp. PCC #7120, was added to the collection in 1983. It was isolated by R. Rippka of Pasteur Institute, France.

Visual description:

- A 40-day-old culture on solid medium shows cohesive growth with smooth margin. It has intermediate luster, is opaque and medium yellowish green. The medium is not colored.

- A 65-day-old culture in liquid medium shows medium-green flocculent growth. The medium is not colored.

Microscopic observation (40-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 2.5-3.5 microns wide, and 2.5-3.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 4-4.5 microns wide, and 5-7 microns long. Free, smooth spores are observed. They are long ellipsoidal, 4.5-5.5 microns wide, and 6.5-7.5 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

This strain is used by numerous authors for laboratory studies.

Bibliographic reference on the strain or its environment: Rippka R, Duruelles J, Waterbury J B, Herdman M, Stanier R Y. 1979.

Strain Ab 48 En

This strain, identified as *Anabaena cylindrica* PCC #7122, was added to the collection in 1983. It originates from England. It was isolated by R. Rippka of Pasteur Institute, France, from a freshwater pond in 1939.

Visual description:

- A 40-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. Colonial growth is likewise observed. The colonies are 0.5-3.0 mm in size, rounded viewed from the top and low convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium green. The medium is not colored.

- A 28-day-old culture in liquid medium shows medium-green flocculent growth. The medium is not colored.

Microscopic observation (40-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 3.5-4 microns wide, and 4-6 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long rounded, 5-6 microns wide, and 8-9 microns. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Rippka R, Duruelles J, Waterbury J B, Herdman M, Stanier R Y. 1979.

Strain Ab 49 SL

This strain, identified as *Anabaena* sp., was added to the collection in June 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 21-day-old culture on solid medium shows colonial growth. Isolated colonies are 4-15 mm in size, irregular-shaped viewed from the top and low convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium green. The medium is not colored. This strain forms characteristic colonies which look like an aggregate of soap bubbles.

- A 34-day-old culture in liquid medium forms round, fluffy, mucilaginous colonies, 2-5 mm in size, growing in or at the surface of the medium. The culture is medium green. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 5-5.5 microns wide, and 5-6 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 7-8 microns wide, and 8-10 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

A 34-day-old culture in liquid medium shows isometric barrel-shaped heterocysts, 6.5-7.5 microns wide and 6.5 microns long.

Strain Ab 50 SL

This strain, identified as *Anabaena* sp., was added to the collection in 1979. It originates from Sri Lanka. It was isolated by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 32-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, rounded viewed from the top and low convex from the side. The margin of the colonies is aura-like (spreading). The culture has glossy luster, is opaque and dark green. The medium is not colored.

- A 48-day-old culture in liquid medium shows medium-brownish-green flocculent growth. The medium is not colored.

Microscopic observation (30-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are from isometric to long barrel-shaped, 3.5-4 microns wide, and 3.5-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are isometric rounded, 6 microns wide, and 6 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Ab 51 XX

This strain, identified as *Anabaena variabilis* ATCC # 29413, was added to the collection in 1988. The culture was provided by K.T. Shanmugam. This strain is the parent strain of a nitrogen-excreting mutant, SA-1, used in several IRR1 experiments on inoculation.

Visual description:

- A 50-day-old culture on solid medium shows colonial growth. Most colonies are smaller than 0.5 mm, irregular-shaped viewed from the top and flat from the side. The margin is rough. The culture has intermediate luster, is opaque and medium yellowish green. The medium is not colored.

- A 30-day-old culture in liquid medium shows medium-yellowish-green homogeneous growth. The medium is not colored.

Microscopic observation (33-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 2-3 microns wide, and 3-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long rounded, 3-3.5 microns wide, and 3-5 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have terminal heterocysts and show no motility.

Strain Ab 52 XX

This strain, identified as *Anabaena* sp., was added to the collection in 1988. It is a nitrogen-excreting mutant of SA-0. The culture was provided by K.T. Shanmugam.

Visual description:

- A 50-day-old culture on solid medium shows colonial growth. Most colonies are smaller than 0.5 mm, irregular-shaped viewed from the top and flat from the side. The margin is rough. The culture has intermediate luster, is opaque and medium green. The medium is not colored.

- A 50-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium green. Older cultures may become of the incohesive-mat type, growing partly addressed at the bottom of the flask.

Microscopic observation (50-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 2-3 microns wide, and 3-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long rounded, 3-3.5 microns wide, and 4-5 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

CALOTHRIX

Strain Cx 01 Th

This strain, identified as *Calothrix* sp., was added to the collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from an INSFFER azolla trial plot in Thailand.

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-brown cohesive mat growing addressed at the bottom of the flask.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, very short, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are angular with variable size. Most apical cells are triangular. Heterocysts are mostly terminal, single, and narrower than the adjacent vegetative cell. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Strain Cx 02 SL

This strain, identified as *Calothrix* sp., was added to the collection in 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium brownish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-green cohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are angular with variable size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Strain Cx 03 Sn

This strain, identified as *Calothrix scopulorum*, came from the ORSTOM collection and was added to the IRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM) in 1976.

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are variable in shape and size. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are variable in shape and size. Spores are mostly terminal, in chains adjacent to heterocysts, and smooth. Spores are variable in shape and size. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Strain Cx 04 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil located in Bambey, Senegal, in 1972.

Soil properties: available (IRAT experimental farm)

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has glossy luster, is translucent and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-brown cohesive mat, growing addressed at the bottom of the flask. It also forms a few floating clumps. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show marked tapering. A thick, hyaline, homogeneous sheath is observed at the apex of the trichome. Motility of the trichomes is not observed. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. Spores are mostly terminal, in chains adjacent to heterocysts, and smooth. They are

variable in shape and size. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Notes:

Quite thick, short filaments are observed which are not typical of *Calothrix* strains.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Cx 05 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985.

It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil located in Bambey, Senegal, in 1972.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 20-day-old culture on solid medium shows colonial growth. Colonies are filamentous, irregular-shaped viewed from the top and flat from the side. They are 1-10 mm in size. The culture has intermediate luster, is opaque and medium brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-brown cohesive mat growing adpressed at the bottom of the flask. It also forms few floating clumps, 1-2 mm in diameter. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show marked tapering. A thick, hyaline, homogeneous sheath is observed at the apex of the trichome. Motility of the trichomes is not observed. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal, either single or in pairs. They are variable in shape and size. Spores are mostly terminal, in chains adjacent to heterocysts, and smooth. Spores are variable in shape and size. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Cx 06 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil located in Bambey, Senegal, in 1972.

Soil properties: upland sandy soil (Dior).

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium green. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are variable in shape and size. Most apical cells are triangular. Heterocysts are single and both intercalary and terminal. They are variable in shape and size. Spores are terminal, in chains adjacent to heterocysts, and smooth. They are variable in shape and size. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Cx 07 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985.

It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil located in Bambey, Senegal, in 1972.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. It has intermediate luster, is opaque and medium brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-brown cohesive patchy mat growing adpressed at the bottom of the flask. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are very short, uniseriate, single, entangled, and show slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Cx 08 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985.

It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil located in Bambey, Senegal, in 1972.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 20-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has intermediate luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-green incohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are variable in shape and size. Most apical cells are triangular. Heterocysts are mostly terminal and single. They are variable in shape and size. Spores are mostly terminal, in chains adjacent to heterocysts, and smooth. They are variable in shape and size. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Cx 09 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil located in Bambey, Senegal, in 1972.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-brown patchy mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are very short, uniseriate, single, entangled, and show no tapering. A thick, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are short barrel-shaped, 6-7 microns wide, and 4-7 microns long. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are long ellipsoidal, 6-7 microns wide, and 7-8 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Cx 10 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil located in Bambey, Senegal, in 1972.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 20-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a dark-green cohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are very long, uniseriate, single, entangled, and show marked tapering. They are about 3 microns wide in the middle of the trichome. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are angular in shape with variable size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Cx 11 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Reynaud (ORSTOM) from a ricefield soil collected from Riniao, Senegal, in 1972.

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are variable in shape and size. In medium-to-long filaments, cells are difficult to distinguish from each other. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommerques Y (1978).

Strain Cx 12 SL

This strain, identified as *Calothrix* sp., was added to the collection in 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium brown. The medium is not colored.
- A 61-day-old culture in liquid medium forms a dark-brown cohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (11-day-old culture in liquid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are from short angular to long angular, 4-5 microns wide, and 2.5-7 microns long. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are isometric rounded, 6-7 microns wide, and 6-7 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Notes:

Filaments are 5.5-8 microns in diameter. No ramifications are observed on solid medium.

Strain Cx 13 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Vinding, Senegal, in 1972.

Visual description:

- A 20-day-old culture on solid medium shows colonial growth. Colonies are filamentous, irregular-shaped viewed from the top and flat from the side. They are 1-10 mm in size. The culture has dull luster, is opaque and dark green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-green incohesive mat, growing partly addressed at the bottom of the flask and partly afloat. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have few Y-shaped ramifications. They are uniseriate, single, entangled, and show marked tapering. A thin, hyaline, homogeneous sheath is present. The width of the trichomes in the central portion is about 4 microns. Motility of the trichomes is not observed. Vegetative cells are variable in shape and size. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are variable in shape and size. Spores are mostly terminal, in chains adjacent to heterocysts, and smooth. Spores are variable in shape and size. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Cx 14 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from M'Bane, Senegal, in 1972.

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, burrowing into the agar. It has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-green cohesive mat growing addressed at the bottom of the flask. It also forms a few free penicillate colonies. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most of the trichomes are 100-700 microns long. The width of the trichomes ranges from 9 to 11 microns at the apex, and from 7 to 9 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are triangular. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia have the same width as the filaments. They have terminal heterocysts and show no motility.

Strain Cx 15 MI

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from ENS, Bamako, Mali, in 1972.

Soil properties: available

Visual description:

- A 25-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has glossy luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium has an aggregative sedimentary type of growth, growing partly addressed at the bottom of the flask. The culture is medium brown. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show slight tapering. No sheath was observed. Motility of the trichomes is not observed. Most trichomes are 50-500 microns long. The width of the trichomes ranges from 3 to 7 microns at the apex, and from 3 to 4 microns at the middle. Vegetative cells are variable in shape and

size. They are barrel-shaped at the apex of the trichome, becoming long angular along the rest. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are variable in shape and size. Spores are terminal, single, adjacent to heterocysts, and smooth. They are long ellipsoidal, 7-8 microns wide, and 10-11 microns long. Hormogonia are thinner than the filaments with isometric barrel-shaped cells. They have terminal heterocysts and show no motility. Bibliographic reference on the strain or its environment: Traore TM, Roger PA, Reynaud PA, Sasson A (1978).

Strain Cx 16 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IIRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM) in 1972.

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium brownish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms an incohesive mat growing in or at the surface of the medium. It is dark brownish green. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 50-800 microns long. The width of the trichomes ranges from 6 to 8 microns at the apex, and from 3.5 to 4 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are variable in shape and size; most are triangular. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Strain Cx 17 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IIRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM) in 1972.

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It is dark brownish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat, growing both at the surface of the medium and addressed at the bottom of the flask. The culture is dark greenish brown. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 1500 microns long. The width of the trichomes ranges from 7 to 9 microns at the apex, and from 4 to 5 microns at the middle. Vegetative cells are angular with variable size. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are variable in shape and size; most are triangular. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Strain Cx 18 Cl

This strain, identified as *Calothrix desertica* PCC 7102, was added to the collection in 1985. It originates from La Perdata, Antofagasta, Chile. It was isolated by R. Rippka of the Pasteur Institute, France.

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, burrowing into the agar. It has dull luster, is opaque and medium yellowish green. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 100-900 microns long. The width of the trichomes ranges from 9 to 10 microns at the apex, and from 6 to 7 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are single or in pairs. When in pairs, trichomes show symmetrical tapering. No spores were observed. Hormogonia have the same width as the filaments. They have terminal heterocysts, are markedly tapered, and show no motility.

Bibliographic reference on the strain or its environment: Rippka et al. 1979.

Strain Cx 19 Sn

This strain, identified as *Calothrix*, came from the ORSTOM collection and was added to the IIRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1974.

Visual description:

- A 40-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium greenish brown. The medium is not colored.
- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and dark yellowish brown. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 50-200 microns long. The width of the trichomes ranges from 5 to 6 microns at the apex, and is about 4 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal and single. A few pairs of heterocysts with symmetrical tapering were observed. They were isometric rounded. No spores were observed. Hormogonia are slightly thinner than the filaments. They have no heterocysts and show no motility.

Notes:

False, Y-shaped ramifications are observed in a 40-day-old culture on solid medium.

Strain Cx 20 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'oh, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Apalnga'oh).

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, burrowing into the agar. It is dark brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat, growing both at the surface of the medium and addressed at the bottom of the flask. It is dark brown.

Microscopic observation (25-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 100-500 microns long. The width of the trichomes ranges from 4 to 6 microns at the apex, and from 3 to 4 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Cx 21 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'oh, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Apalnga'oh).

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and dark yellowish brown.
- A 20-day-old culture in liquid medium forms a yellowish-brown incohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 100-400 microns long. The width of the trichomes ranges from 5 to 8 microns at the apex, and is 3 microns at the middle. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. Spores are mostly terminal, single, adjacent to heterocysts, and smooth. They are long barrel-shaped, 6-7 microns wide, and 8-9 microns long. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Notes:

The very narrow filaments are interrupted by large, intercalary heterocysts.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Cx 22 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'oh, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Apalnga'oh).

Visual description:

- A 25-day-old culture on solid medium shows generalized spreading growth, diffuse in aspect, burrowing into the agar. It has intermediate luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-brown cohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 50-300 microns long. The width of the trichomes ranges from 5 to 7 microns at the apex, and is 3 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. Spores are mostly terminal, single, adjacent to heterocysts, and smooth. They are long barrel-

shaped, 8-9 microns wide, and 11-13 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Cx 23 CI

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRR collection in 1985. It originates from the Canaria Islands. It was isolated by P.A. Reynaud of ORSTOM, France.

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and dark brownish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask. Part of the culture is an incohesive mat floating in or at the surface of the medium. The culture is medium brownish green. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 50-100 microns long. The width of the trichomes ranges from 4.5 to 6 microns at the apex, and from 4.5 to 5 microns at the middle. Vegetative cells are variable in shape and size. Most are angular with variable size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are isometric rounded. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Cx 24 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'oh, Banawe, Philippines, in 1982.

Soil properties: available

Visual description:

- A 25-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and dark brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat, growing both at the surface of the medium and addressed at the bottom of the flask. It is dark brown. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, wavy, and show slight tapering. A thick, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 50-300 microns long. The width of the trichomes ranges from 6 to 7 microns at the apex, and from 5 to 6 microns at the middle. Vegetative cells are variable in shape and size; most are barrel-shaped. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size; most are rounded. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Cx 25 As

This strain, identified as *Calothrix* sp., was added to the collection in 1988. It originates from Austria. It was isolated by P.A. Roger (ORSTOM) from a solonetz collected from Neusiedlersee in 1988. The soil sample (IV) was provided by S. Zechmeister-Boltenstern (Wien Univ.).

Soil properties: Solonetz. The surface soil is sandy loam with medium humus content.

Visual description:

- A 25-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and is medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a patchy mat growing addressed at the bottom of the flask, and a few free penicillate colonies (1-3 mm). The culture is medium yellowish brown. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are 50-150 microns long. The width of the trichomes ranges from 6 to 7 microns at the apex, and from 5 to 6 microns at the middle. Vegetative cells are variable in shape and size; most are barrel-shaped. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size; most are rounded. They are often of the same width or narrower than the vegetative cells. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Wollenweber B. and Zechmeister-Boltenstern S. (1989).

Strain Cx 26 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Calauan, Laguna, Philippines, in 1985.

Soil properties: available (Calauan)

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, burrowing into the agar. It has dull luster, is opaque and medium brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms an incohesive mat, growing both at the surface of the medium and adpressed at the bottom of the flask. The culture is medium yellowish brown. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50-700 microns long. The width of the filaments ranges from 5 to 6.5 microns at the apex, and from 5 to 5.5 microns at the middle. Vegetative cells are variable in shape and size; most are angular. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia have the same width as the trichomes. They have terminal heterocysts and show no motility.

Notes:

This strain has characteristics of both *Calothrix* and *Scytonema*.

Bibliographic reference on the strain or its environment: Reddy PM, Roger PA (1988).

Strain Cx 27 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing adpressed at the bottom of the flask, and an incohesive mat growing at the surface of the medium. The culture is dark brown. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, entangled, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50-1000 microns long. The width of the filaments ranges from 5 to 6 microns at the apex, and from 3.5 to 4 microns at the middle. Vegetative cells are variable in shape and size; most are angular, while some are barrel-shaped. Most apical cells are rounded. Heterocysts are both intercalary and terminal, either single or in pairs. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts and show no motility.

Notes:

The strain shows characteristics of both *Calothrix* (polarity and terminal heterocysts) and *Scytonema* (rectangular heterocysts).

Division by septa is not observed at the distal parts of the trichomes.

Strain Cx 28 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Roger (ORSTOM) in 1977.

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, burrowing into the agar. It has dull luster, is opaque and dark brownish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing adpressed at the bottom of the flask, and an incohesive mat growing at the surface of the medium. The culture is medium greenish brown. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are single, entangled, show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50-900 microns long. The width of the filaments is about 8 microns at the apex, and 3 to 4 microns at the middle. Vegetative cells are variable in shape and size; most are angular. The cells adjacent to the heterocysts are vacuolated; no division by septa are observed except towards the distal parts of the trichome. Most apical cells are rounded. Heterocysts are mostly terminal, single, and variable in shape and size. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Strain Cx 29 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Palao, Kiangan, Philippines, in 1982.

Soil properties: available (Kiangan, Palao 3).

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, diffuse in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-brown cohesive mat growing adpressed at the bottom of the flask. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50-150 microns long. The width of the filaments ranges from 5-6 microns at the apex, and from 2.5-3 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal, either single or in pairs. They are variable in shape and size and narrower than the adjacent cells. No spores were observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts, which are usually of the same size as the vegetative cells, and show no motility.

Strain Cx 30 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitan 3)

Visual description:

- A 24-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and dark greenish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask, and an incohesive mat growing at the surface of the medium. The culture is dark brownish green. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 5-150 microns long. The width of the filaments ranges from 5 to 6 microns at the apex, and from 4.5 to 5 microns at the middle. Vegetative cells are variable in shape and size. Those near the heterocysts are barrel-shaped, becoming angular towards the distal parts of the trichomes. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size and narrower than the adjacent vegetative cells. No spores were observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Cx 31 Ph

This strain, identified as *Calothrix*, was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitan 3)

Visual description:

- A 24-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and penicillate from the side. They are 2-4 mm in size. The culture has dull luster, is opaque and dark yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium brown. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, wavy, show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50-600 microns long. The width of the filaments ranges from 5 to 6 microns at the apex, and from 3 to 4 microns at the middle. Vegetative cells are variable in shape and size, with most distal parts of the trichome showing no septa. Most apical cells are rounded. Heterocysts are terminal, either single or in pairs. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Cx 32 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1979. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from IRRI, Philippines, in 1979.

Soil properties: available (IRRI, Upper MN).

Visual description:

- A 24-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has intermediate luster, is opaque and dark yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a dark-brown cohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 100-500 microns long. The width of the filaments ranges from 5 to 6.5 microns at the apex, and from 3.5 to 4 microns at the middle. In addition to normal *Calothrix*-type filaments, the culture has long, nonheterocystous, narrow and highly granular filaments. Vegetative cells are variable in shape and size; most are angular. Most apical cells are rounded. Abnormal vegetative cells, distorted and swollen, were observed. Heterocysts are mostly terminal and single. They are isometric

rounded, 4-5 microns wide and 4-6 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Santiago-Ardales S, Watanabe I (1985).

Strain Cx 33 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield Isoil collected from Apalnga'oh, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Apalnga'oh 2).

Visual description:

- A 24-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, burrowing into the agar. It has dull luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a dark-greenish-brown mat, growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, entangled, show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 100-900 microns long. The width of the filaments ranges from 6-7 microns at the apex, and from 3.5-4.5 microns at the middle. Vegetative cells are variable in shape and size. In the distal parts of the filaments, most septa are not visible. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Notes:

Filaments are tapered and shorter (100 μ) in liquid medium than on solid medium, where size is highly variable.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Cx 34 Ph

This strain, identified as *Calothrix* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'ho, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Apalnga'oh 2).

Visual description:

- An 80-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and dark brown. The medium is not colored.
- A 40-day-old culture in liquid medium forms a dark-yellowish-brown cohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (80-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Heterocysts are mostly terminal and single. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Cx 35 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM) in 1981.

Visual description:

- A 24-day-old culture on solid medium shows cohesive growth with filamentous margin. It has glossy luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-brown cohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Most filaments are 50-400 microns long. The width of the filaments ranges from 5 to 7 microns at the apex, and from 3.5 to 4.5 microns at the middle. Vegetative cells are long angular, 3.5-4.5 microns wide, and 3.5-6 microns long. Most apical cells are rounded. Abnormal vegetative cells, elongated and distorted, were observed. Heterocysts are both intercalary and terminal, either single or in chains. Intercalary heterocysts are isometric barrel-shaped, 4.5-5 microns wide, and 4-6 microns long. Terminal heterocysts are variable in shape and size. They are both rounded and ellipsoidal, 4.5-5.5 microns wide, and 5-6 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts and show no motility.

Strain Cx 36 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 24-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and dark brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a dark-greenish-brown cohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50-500 microns long. The width of the filaments ranges from 6 to 7.5 microns at the apex, and from 4 to 5.5 microns at the middle. Vegetative cells are variable in shape and size. They are mostly angular, 4.5-5.5 microns wide, and 3-6.5 microns long. Most apical cells are rounded. Heterocysts are both intercalary and terminal, either single or in chains. Intercalary heterocysts are mostly barrel-shaped, 5.5-6.5 microns wide, and 6.5-9 microns long. Terminal heterocysts are variable in shape and size. They are mostly truncated rounded, 7 microns wide and 5-6 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts and show no motility.

Strain Cx 37 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a saline sandy soil collected from Retba, Senegal, in 1975.

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, burrowing into the agar. It has dull luster, is opaque and medium green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask, and an incohesive mat growing at the surface of the medium. The culture is medium green. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50- 500 microns long. The width of the filaments ranges from 6 to 7 microns at the apex, and from 4 to 5 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are isometric rounded, 5-6 microns wide, and 4-5 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Reynaud PA, Roger PA (1981).

Strain Cx 38 Ms

This strain, identified as *Calothrix* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Kuala Kurau, Perak, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, ropey in aspect, burrowing into the agar. It has dull luster, is opaque and medium brown. The medium is not colored.
- A 20-day-old culture in liquid medium shows medium-yellowish-brown flocculent growth. The medium is not colored.

Microscopic observation (42-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 100-900 microns long. The width of the filaments ranges from 7 to 8 microns at the apex, and from 5-6.5 microns at the middle. Vegetative cells are variable in shape and size. Those near the heterocysts are barrel-shaped, becoming angular towards the distal parts of the trichomes. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are truncated rounded, 5.5-7.5 microns wide, and 5-6 microns long. Spores were not observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts and show no motility.

Strain Cx 39 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a saline sandy soil collected from Retba, Senegal, in 1975.

Visual description:

- A 20-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has dull luster, is opaque and medium brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask, and an incohesive mat growing at the surface of the medium. The culture is dark yellowish brown. The medium is not colored.

Microscopic observation (20-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 100-700 microns long. The width of the filaments ranges from 5 to 7 microns at the apex, and from 4 to 5 microns at the middle. Vegetative cells are variable in shape and size; most are long angular. Most apical cells are rounded. Abnormal, bottle-shaped heterocysts are observed. Heterocysts are both intercalary and terminal, either single or in pairs. They are variable in

shape and size. Intercalary heterocysts are either rounded or rectangular. No spores were observed. Hormogonia are slightly thinner than the trichomes. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Reynaud PA, Roger PA (1981).

Strain Cx 40 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1975.

Visual description:

- An 18-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask, and an incohesive mat growing at the surface of the medium. The culture is dark yellowish green. The medium is not colored.

Microscopic observation (18-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50-200 microns long. The width of the filaments ranges from 4 to 5 microns at the apex, and from 3 to 3.5 microns at the middle. Vegetative cells are variable in shape and size. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are variable in shape and size. No spores were observed. Hormogonia are slightly thinner than the filaments. They have no heterocysts and show no motility.

Strain Cx 41 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1975.

Visual description:

- An 18-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, burrowing into the agar. It has dull luster, is opaque and medium green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask, and an incohesive mat growing at the surface of the medium. The culture is medium green. The medium is not colored.

Microscopic observation (18-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 100-1000 microns long. The width of the filaments ranges from 6 to 7.5 microns at the apex, and from 4.5 to 5.5 microns at the middle. Vegetative cells are variable in shape and size. They are either angular or barrel shaped, sometimes without clearly visible septa. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are variable in shape and size; rounded when terminal, and either rectangular or rounded when intercalary. No spores were observed. Hormogonia have the same width as the trichomes. They have terminal heterocysts and show no motility.

Notes:

This strain presents characteristics of both *Calothrix* and *Scytonema*.

Strain Cx 42 Ms

This strain, identified as *Calothrix* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Bumbong Lima, Penang, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has dull luster, is opaque and dark yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a medium-yellowish-brown cohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- False, Y-shaped ramifications are present. They are uniseriate, single, wavy, show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 100-300 microns long. The width of the filaments ranges from 5 to 7 microns at the apex, and from 3.5 to 5 microns at the middle. Vegetative cells are variable in shape and size. They are mostly angular, 3.5-4 microns wide, and 2.5-4.5 microns long at the apex and at the middle of the filaments. At the distal portions, they are mostly barrel-shaped, 7-5 microns wide, and 4-8 microns long. Most apical cells are pointed. Heterocysts are single and both intercalary and terminal. Intercalary heterocysts are short barrel-shaped, 5-7.5 microns wide, and 5-6 microns long. Terminal heterocysts are truncated rounded, 5-6 microns wide, and 4.5-5 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts and show no motility.

Strain Cx 43 Ms

This strain, identified as *Calothrix* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Serbarang Perai, Penang, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has dull luster, is opaque and dark greenish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat, growing both at the surface of the medium and addressed at the bottom of the flask. The culture is dark brownish green. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 100-700 microns long. The width of the filaments ranges from 5.5 to 6 microns at the apex, and from 4 to 5 microns at the middle. Vegetative cells are variable in shape and size. They are mostly angular, 4-4.5 microns wide, and 3.5-6 microns long at the apex. At the distal portions of the filaments, they are mostly barrel-shaped, 5-6 microns wide, and 5-8 microns long. Most apical cells are pointed. Heterocysts are mostly terminal and single. Terminal heterocysts are variable in shape and size; most are truncated rounded. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts.

Strain Cx 44 Sn

This strain, identified as *Calothrix* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Reynaud (ORSTOM) from a ricefield located in Riniao, Senegal.

Visual description:

- A 24-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has intermediate luster, is opaque and medium yellowish brown. The medium is not colored.
- A 22-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask, and also shows flocculent growth. The culture is medium yellowish brown. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most filaments are 50-500 microns long. The width of the filaments ranges from 4.5 to 5 microns at the apex, and from 5 to 6 microns at the middle. Vegetative cells are variable in shape and size. They are mostly barrel-shaped, 4-5 microns wide, and 5-6 microns long at the apex of the filament. At the distal portions, they are mostly angular, 4-4.5 microns wide, and 4-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary, either single or in pairs. They are isometric rounded, 4.5-7 microns wide, and 5-7 microns long. Free, single, and smooth spores were observed. They are long ellipsoidal, 7-8 microns wide, and 9-11 microns long. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Notes:

A few short filaments with slight tapering (*Calothrix*-like) were observed. However, long filaments with neither sheath nor tapering were more numerous.

Strain Cx 45 In

This strain, identified as *Aulosira fertilissima*, was added to the collection in 1989. It originates from India. It was isolated by B.D. Kaushik of IARI, India.

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. It has dull luster, is opaque and dark brown. The medium is not colored.
- A 38-day-old culture in liquid medium forms a cohesive mat growing in or at the surface of the medium, as well as addressed at the bottom of the flask. The culture is dark brown. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, entangled, and show marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are long angular, 4-4.5 microns wide, and 5-6.5 microns long. Most apical cells are rounded. Heterocysts are mostly terminal and in pairs. They are isometric rounded, 6-6.5 microns wide, and 6-7 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Notes:

A 24-day-old culture in liquid medium shows no ramifications, has slight tapering and long rounded heterocysts.

FISCHERELLA

Strain Fi 01 Sn

This strain, identified as *Fischerella* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Djibelor Experimental Station, Senegal, in 1974.

Soil properties: available

Visual description:

- A 21-day-old culture on solid medium shows colonial growth. Colonies are filamentous, irregular-shaped viewed from the top and burrowing from the side. They are about 2-6 mm in size. The culture has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium shows medium-yellowish-green flocculent growth. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. Secondary axes are uniseriate, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is observed in both axes. Vegetative cells are highly vacuolated and variable in shape and size. They are mostly barrel-shaped, 8-10 microns wide, and 8-18 microns long in primary branches. In secondary branches, they are angular near the tip; no discernable divisions are observed at the base of branching. Most apical cells are rounded. Heterocysts are intercalary and single. They are variable in shape and size. They are mostly barrel-shaped, 6-13 microns wide and 9-21 microns long in primary branches, and 5.5-6.5 microns wide and 15-15.5 microns long in secondary branches. No spores were observed. Hormogonia have the same width as the trichomes at the apex of secondary branches. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Garcia J, Raimbault M, Jacq V, Rinaudo G, Roger PA (1974).

Strain Fi 02 SL

This strain, identified as *Fischerella* sp., was added to the collection in 1986. It originates from Sri Lanka. The culture was provided by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 25-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are 3-6 mm in size. The culture has intermediate luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms penicillate colonies, 2-4 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (25-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, helical, and show no tapering. No sheath is observed. The width of the primary axes ranges from 5 to 6 microns. Secondary axes are uniseriate, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is observed. The width of the secondary axes ranges from 3 to 4 microns. Vegetative cells are variable in shape and size. They are mostly barrel-shaped, 5-6 microns wide, and 2.5-6 microns long in primary branches, and mostly angular, 3 microns wide, and 3-5 microns long in secondary branches. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are variable in shape and size; most are angular, 3.5-6 microns wide, and 4.5-12 microns long. Spores and hormogonia were not observed.

Notes:

An old culture showed no multiseriate filaments.

Strain Fi 03 Sn

This strain, identified as *Fischerella*, came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1974.

Visual description:

- A 27-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 2-10 mm in size. The culture has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms penicillate colonies, 1-10 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, becoming multiseriate in some places. They are wavy and show no tapering. Secondary axes are uniseriate, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is observed in both axes. Vegetative cells are vacuolated and variable in shape and size. They are mostly barrel-shaped, 7.5-9 microns wide, and 8-11.5 microns long in primary branches. The multiseriate portions are 8-9.5 microns wide. In secondary branches, they are long angular near the base (8-9 microns wide) becoming short angular towards the apex (4.5-5 microns wide); the length ranges from 4.5 to 5.5 microns. Most apical cells are rounded. Heterocysts are intercalary, single, and usually found only in primary branches. They are barrel-shaped, 5-6.5 microns wide, and 8-13 microns long. Spores and hormogonia were not observed.

Strain Fi 04 Mr

This strain, identified as *Fischerella* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from RBL, Madagascar in 1986. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Visual description:

- A 27-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 1-3 mm in size. The culture has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms penicillate colonies, 1-5 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, becoming multiseriate in some places. They are wavy and show no tapering. Secondary axes can also be multiseriate. They are wavy and show slight tapering. A thin, hyaline, homogeneous sheath is observed in both axes. Vegetative cells are vacuolated and variable in shape and size. They are discoid (6-7 microns wide and 2-3.5 microns long) to barrel-shaped (7-8.5 microns wide and 5-7 microns long). Rounded cells (which could be spores) are formed at the apex of secondary branches. The multiseriate portions are 9-14 microns wide. Most apical cells are rounded. Heterocysts are intercalary, single, and found only in primary branches. They are mostly barrel-shaped, 5-7.5 microns wide, and 6-10 microns long. Hormogonia were not observed.

Strain Fi 05 Ph

This strain, identified as *Fischerella* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitan 3).

Visual description:

- A 32-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top view and burrowing from the side. They are 1-2 mm in size. The culture has dull luster, is opaque and medium green. The medium is not colored.
- A 20-day-old culture in liquid medium has an aggregative sedimentary type of growth. Large penicillate colonies, 2-4 mm in size, are also observed. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (32-day-old culture liquid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. No sheath is observed. The width of the primary axes ranges from 5 to 6 microns. Secondary axes are uniseriate, entangled, and show slight tapering. A thin, hyaline, homogeneous sheath is observed. The width of the secondary axes ranges from 3 to 3.5 microns. Vegetative cells are variable in shape and size. They are short barrel-shaped, 4-5.5 microns wide, and 4-5.5 microns long in primary branches. In secondary branches, septa are hardly or not visible at all. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are variable in shape and size; they are mostly rounded in primary branches (4-5 microns wide and 4-5 microns long) and angular in secondary branches (3-3.5 microns wide and 5-7 microns long). No spores were observed. Hormogonia have the same width as the trichomes. They have no heterocysts and show no motility.

Bibliographic references on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Fi 06 Ph

This strain, identified as *Fischerella* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Palao, Kiangan, Philippines, in 1982.

Soil properties: available (Kiangan, Palao1).

Visual description:

- A 29-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 1 to 3 mm in size. The culture has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms penicillate colonies, 1-6 mm in size, growing in or at the surface of the medium. The culture is dark yellowish green. The medium is not colored. The colonies were initially addressed at the bottom of the flask, but became detached after shaking.

Microscopic observation (32-day-old culture solid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. No sheath is observed. The width of the primary axes ranges from 5 to 6 microns. Secondary axes are uniseriate, entangled, and show marked tapering. A thin, hyaline, homogeneous sheath is observed. The width of the secondary axes ranges from 2.5 to 3.5 microns. Vegetative cells are variable in shape and size. They are mostly barrel-shaped in primary branches (4-5.5 microns wide and 5-7 microns long) and mostly angular in secondary branches (2-2.5 microns wide and 3-5 microns long). Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are variable in shape and size; most are long rounded, 3-4 microns wide, and 6-8 microns long. Larger heterocysts are observed in primary branches. No spores were observed. Hormogonia have the same width as the trichomes at the apex of secondary branches. They have no heterocysts and show no motility.

Strain Fi 07 Sn

This strain, identified as *Fischerella* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Roger (ORSTOM) in 1974.

Visual description:

- A 29-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial from top view and burrowing from side view. They are from 1 to 5 mm in size. The culture has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms penicillate colonies, 2-4 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (29-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. No sheath is observed. The width of the primary axes ranges from 4 to 5 microns. Secondary axes are uniseriate, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is observed. The width of the secondary axes ranges from 2.5 to 3 microns. Vegetative cells are variable in shape and size. They are mostly barrel-shaped in primary branches (4-5 microns wide and 5-7 microns long) and short angular in secondary branches (2-2.5 microns wide and 2-3 microns long). The primary branches are mostly with septa that are hardly or not visible at all. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are mostly long angular, 3.5-4.5 microns wide, and 8-11 microns long. No spores were observed. Hormogonia have the same width as the trichomes at the apex of secondary branches. They have no heterocysts and show no motility.

Strain Fi 08 Ph

This strain, identified as *Fischerella* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Lawig, Lamut, Philippines, in 1982.

Soil properties: available (Lamut, Lawig 1).

Visual description:

- A 28-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 2 to 5 mm in size. The culture has dull luster, is opaque and medium bluish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms medium-bluish-green penicillate colonies, 1-4 mm in size, growing in or at the surface of the medium. The culture also forms an incohesive mat with penicillate projections, adpressed at the bottom of the flask. The medium is not colored.

Microscopic observation (28-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. The width of the primary axes ranges from 6 to 8 microns. Secondary axes are uniseriate, wavy, and show slight tapering. No sheath is observed in both axes. The width of the secondary axes ranges from 6 to 7 microns. Vegetative cells are variable in shape and size. They are long barrel-shaped, 7-9 microns wide, and 11-13 microns long in primary branches; long angular in the middle portion of secondary branches; and short barrel-shaped, 5.5-6.5 microns wide, and 3.5-6 microns long at the apex of secondary branches. Most apical cells are rounded. Heterocysts are variable in shape and size; most are angular, 5-6 microns wide, and 9-16 microns long. Spores and hormogonia were not observed.

Notes:

This strain forms circular or elongated cells 4-8 times larger than most vegetative cells.

Strain Fi 09 XX

This strain, identified as *Fischerella* sp., was added to the collection in 1979. It originates from India.

Visual description:

- A 27-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 2-4 mm in size. The culture has dull luster, is opaque and dark yellowish green. The medium is yellowish.
- A 20-day-old culture in liquid medium forms dark-green penicillate colonies, 2-5 mm in size, growing adpressed at the bottom of the flask. The medium is yellowish.

Microscopic observation (27-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, becoming multiseriate in some places. They are wavy and show no tapering. Secondary axes are uniseriate, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is observed in both axes. Vegetative cells are vacuolated and variable in shape and size. They are rounded to barrel-shaped and 6-8 microns wide in primary branches. The multiseriate portions are 11-16.5 microns wide. In secondary branches, they are barrel-shaped to angular, 5-6 microns wide, and 5-12 microns long near the base, and 3 microns wide and 6-17 microns long near the apex. Most apical cells are rounded. Heterocysts are intercalary and single. They are mostly barrel-shaped, 5.5-7.5 microns wide, and 7.5-11 microns long in primary branches, and 5-7 microns wide and 10-12 microns long in secondary branches. Spores and heterocysts were not observed.

Strain Fi 10 Ph

This strain, identified as *Fischerella* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Palao, Kiangnan, Philippines, in 1982.

Soil properties: available (Kiangan, Palao 2).

Visual description:

- A 27-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 1-2 mm in size. The culture has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing in or at the surface of the medium. Numerous distinct, penicillate colonies, 2-3 mm in size, are attached to the mat. The culture is dark yellowish green. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. The width of the primary axes ranges from 6-7 microns. Secondary axes are uniseriate, wavy, and show slight tapering. The width of the secondary axes ranges from 5.5-7 microns at the base and 6 microns at the apex. A thin, hyaline homogeneous sheath is observed in both axes. Vegetative cells are variable in shape and size. They are barrel-shaped to angular in primary branches; 4-5 microns wide and 4-7 microns long when barrel-shaped, and 3.5-4 microns wide and 7-11 microns long when angular. In secondary branches, they are angular, 4-4.5 microns wide and 7.5-12 microns long. Most apical cells are rounded. Heterocysts are intercalary and single. They are variable in shape and size. They are mostly barrel-shaped to angular, 4-5.5 microns wide and 6-17 microns long in primary branches. In secondary branches, they are angular, 3.5-4.5 microns wide and 7-11 microns long. Spores and hormogonia were not observed.

Strain Fi 11 Th

This strain, identified as *Fischerella* sp., was added to the collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a soil collected from the Sampaton Experimental Station, Cheng Mai, Thailand, in 1985. The soil sample, which was provided by Dr. I. Watanabe, was taken from an INSFFER azolla trial plot with 0-36-24 NPK applied.

Visual description:

- A 29-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are 2-4 mm in size. The culture has dull luster, is opaque and dark green. The medium is not colored.
- A 20-day-old culture in liquid medium forms dark-green penicillate colonies, 2-5 mm in size, growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (29-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. No sheath is observed. The width of the primary axes ranges from 5 to 6 microns. Secondary axes are uniseriate, entangled, and show slight tapering. A thin, hyaline, homogeneous sheath is observed. The width of the secondary axes ranges from 3 to 3.5 microns. Vegetative cells are variable in shape and size. They are mostly barrel-shaped, 5-6 microns wide and 8-10 microns long in primary branches; in secondary branches, they are long angular, 2.5-3 microns wide, and 6-7 microns long. Most apical cells are rounded. Abnormal vegetative cells, deformed and inflated, are observed. Heterocysts are mostly intercalary and single. They are variable in shape and size; most are long rounded, 4-5 microns wide, and 10-12 microns long. Spores and hormogonia were observed.

Notes:

Old prostrate filaments are multiseriate.

Strain Fi 12 Sn

This strain, identified as *Fischerella* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil collected from Bambey, Senegal, in 1972.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 29-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 2 to 6 mm in size. The culture has dull luster, is opaque and light yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms penicillate colonies, 3-7 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. Mat-like, incohesive growth at the surface has darker color. The medium is not colored.

Microscopic observation (29-day-old culture on solid medium):

- True ramifications are present. Primary axes are both uniseriate and multiseriate, wavy, and show no tapering. No sheath was observed. The width of the primary axes ranges from 6 to 16 microns. Secondary axes are uniseriate, helical, and show slight tapering. A thin, hyaline, homogeneous sheath is observed. The width of the secondary axes ranges from 5 to 6.5 microns. Vegetative cells are variable in shape and size. They are mostly rounded, 5-6 microns wide, and 4.5-6 microns long in primary branches; in secondary branches, they are short angular, 5-6 microns wide, and 3-5 microns long, with septa that are hardly or not visible at all. Heterocysts are mostly intercalary and single. They are variable in shape and size; most are angular, 6-7 microns wide, and 8-23 microns long. Spores and hormogonia were not observed.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommergues Y (1978).

Strain Fi 13 Cn

This strain, identified as *Fischerella* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It originates from Canaria Islands. It was isolated by P.A. Roger (ORSTOM) from an upland soil.

Visual description:

- A 27-day-old culture on solid medium shows colonial growth. Colonies are filamentous, skewed viewed from the top and burrowing from the side. They are from 1-4 mm in size. The culture has dull luster, is opaque and medium bluish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms medium-bluish-green penicillate colonies, 2-7 mm in size, growing in or at the surface of the medium. The colonies tend to aggregate. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. Secondary axes are uniseriate, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is observed in both axes. Vegetative cells are vacuolated and variable in shape and size. They are barrel-shaped, 6-7 microns wide, and 6-15 microns long in primary branches; barrel-shaped, 3 microns wide, and 14-23.5 microns long near the base; and angular, 2.5-3 microns wide, and 3-5 microns long near the tip. Most apical cells are rounded. Heterocysts are intercalary and single. They are mostly barrel-shaped, 4.5-5.5 microns wide, and 13-15.5 microns long in primary branches, and 3.5-4 microns wide and 9.5-14 microns long in secondary branches. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show motility.

Strain Fi 14 In

This strain, identified as *Fischerella* sp., was added to the collection in 1989. It originates from India.

Visual description:

- A 29-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial-shaped viewed from the top and burrowing from the side. They are from 3 to 6 mm in size. The culture has dull luster, is opaque and medium green. The medium is not colored.
- A 20-day-old culture in liquid medium forms dark-bluish-green penicillate colonies, 2-7 mm in size, growing in or at the surface of the medium. The colonies tend to aggregate. The medium is not colored.

Microscopic observation (29-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate, wavy, and show no tapering. No sheath was observed. The width of the primary axes ranges from 6 to 7 microns. Secondary axes are uniseriate, helical, and show tapering. A thin, hyaline, homogeneous sheath is observed. The width of the secondary axes ranges from 4 to 4.5 microns. Vegetative cells are variable in shape and size. They are mostly rounded, 5-6 microns wide, and 8-11 microns long in primary branches, and very long angular in secondary branches. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are very long angular, 5-6 microns wide, and 12-16 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Strain Fi 15 As

This strain, identified as *Fischerella* sp., was added to the collection in 1989. It originates from Austria. It was isolated by P.A. Roger (ORSTOM) from a saline soil sample (IV) provided by S. Zechmeister-Boltenstern (Wien Univ.).

Soil properties: available

Visual description:

- A 27-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 1-5 mm in size. The culture has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 20-day-old culture in liquid medium forms dark-green penicillate colonies, 1-5 mm in size, growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- True ramifications are present. Primary axes are uniseriate becoming multiseriate in some places, wavy, and show no tapering. Secondary axes are uniseriate, wavy, and show slight tapering. A thin, hyaline, homogeneous sheath is observed in both axes. Vegetative cells are highly vacuolated and variable in shape and size. They are mostly barrel-shaped, 5.5-7 microns wide, and 4-12 microns long in primary branches. Multiseriate portions are 12-13 microns wide. In secondary branches, vegetative cells are barrel-shaped, 5-5.5 microns wide at the base and 2.5-4 microns wide at the apex. Division by septa is difficult to observe. Most apical cells are rounded. Heterocysts are intercalary and single. They are mostly barrel-shaped, 4.5-6 microns wide, and 9-11 microns long in primary branches, and 3.5-4 microns wide and 9-15 microns long in secondary branches. Spores and hormogonia were not observed.

Bibliographic reference on the strain or its environment: Wollenweber B. and Zechmeister-Boltenstern S. (1989).

GLOEOTRICHIA

Strain Gl 01 Ph

This strain, identified as *Gloeotrichia* sp., was added to the collection in 1983. It originates from the Philippines. It was isolated by M. Martinez (UPLB, Philippines).

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, burrowing into the agar. The culture has dull luster, is opaque and medium yellowish brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms an incohesive mat growing addressed at the bottom of the flask, and a cohesive mat growing at the surface of the medium. The culture is dark brown. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show polarity and marked tapering. A thin, hyaline, homogeneous sheath is observed. Motility of the trichomes is not observed. Most filaments are 100-800 microns long. The width of the filaments ranges from 7 to 10 microns at the apex, and from 4 to 6 microns at the middle. Vegetative cells are variable in shape and size. They are mostly barrel-shaped at the distal portions of the filaments. Division by septa is hardly or not visible at the apex and middle portions of the filaments. Most apical cells are rounded. Heterocysts are mostly terminal, either single or in chains. They are variable in shape and size; most are triangular, 7-9 microns wide and 6-8 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts and show no motility.

Strain Gl 02 Ph

This strain, identified as *Gloeotrichia* sp., was added to the collection in 1983. It originates from Philippines. It was isolated by M. Martinez (UPLB) from a ricefield soil.

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. The culture has dull luster, is opaque and dark brown. The medium is not colored.
- A 20-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask, and an incohesive mat growing at the surface of the medium. The culture is dark brown. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are single, wavy, and show polarity and slight tapering. A thin, hyaline, homogeneous sheath is observed. Motility of the trichomes is not observed. Most filaments are 50-550 microns long. The width of the filaments ranges from 5 to 6 microns at the apex, and from 4 to 5 microns at the middle. Vegetative cells are variable in shape and size. They are mostly angular, 3.5-4 microns wide, and 3.5-5.5 microns long at the apex and middle portions of the filament. At the distal portions, they are mostly barrel-shaped, 5-6 microns wide, and 5-10 microns. Most apical cells are pointed. Heterocysts are single and both intercalary and terminal. Intercalary heterocysts are variable in shape and size; most are barrel-shaped, 5 microns wide, and 7-9 microns long. Terminal heterocysts are truncated rounded, 5-7 microns wide, and 5-6 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have terminal heterocysts and show no motility.

Notes:

This strain looks like a *Calothrix*; however, because of the origin and the mucilaginous sheath observed under the microscope, it is still considered a *Gloeotrichia*.

LPP GROUP

Strain LP 01 Sn

This strain, identified as LPP Group, came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM) in 1977.

NODULARIA

Strain Nd 01 Ms

This strain, identified as *Nodularia* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Kuala Kurau, Perak, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 24-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and medium green. The medium is yellowish.
- A 21-day-old culture in liquid medium forms a medium-green cohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (21-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, straight, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are discoid rounded, 4-5 microns wide, and 2-3 microns long. Most

apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are isometric rounded, 6-7 microns wide, and 6-7 microns long. Spores are mostly intercalary, adjacent to heterocysts, and ornamented. They are long barrel-shaped, 9-10 microns wide, and 8-12 microns long. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

NOSTOC

Strain Ns 01 Ms

This strain, identified as *Nostoc* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Kuala Kurau, Perak, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 75-day-old culture on solid medium shows localized spreading growth, located on the agar surface. At the denser part of the algal streaks, growth is freckled, margins are spreading and ropey in aspect. The culture has intermediate luster, is opaque and dark greenish brown. The medium is not colored.
- An 85-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is dark greenish brown. The medium is not colored.

Microscopic observation (47-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long rounded, 3-4 microns wide, and 7-8.5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long rounded, 4-5 microns wide, and 6.5-7.5 microns long. Spores are mostly intercalary, in chains, and smooth. They are long ellipsoidal, 5-6 microns wide, and 6-7 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 02 SL

This strain, identified as *Nostoc* sp., was added to the collection in 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasoorya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 27-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has glossy luster, is opaque and light green. The medium is not colored.
- A 63-day-old culture in liquid medium shows light-green flocculent growth. The medium is not colored.

Microscopic observation (65-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 5.5-6.5 microns long when forming trichomes. Upon ageing, they become separated from each other and are isometric rounded, 6-7 microns wide, and 6-7.5 microns long. Most apical cells are rounded. A few terminal heterocysts, smaller than vegetative cells, were observed. Hormogonia smaller than vegetative cells were also observed.

Notes:

Two sizes of long filaments are observed in a young culture.

In older cultures, vegetative cells form some kind of shapeless aggregates.

The type of growth on solid medium is that of an *Anabaena*.

It produces abundant mucilage.

Strain Ns 03 Ms

This strain, identified as *Nostoc* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Simpai Lima, Perak, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- An 80-day-old culture on solid medium shows colonial growth. Colonies are 2-7 mm in size, rounded viewed from the top and high convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium yellowish brown. The medium is not colored.
- A 40-day-old culture in liquid medium shows medium-yellowish-brown flocculent growth. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 5-6 microns wide, and 5-8.5 microns long. Most apical cells are rounded. Heterocysts are intercalary and single. They are long rounded to ellipsoidal, 6-7.5 microns wide, and 7.5-11 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 04 Ms

This strain, identified as *Nostoc* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Bumbong Lima, Penang, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual description:

- A 75-day-old culture on solid medium shows light-reddish-brown colonial growth. Most colonies are smaller than 0.5 mm, irregular-shaped viewed from the top and flat from the side. The margin is smooth. The medium is not colored.
- A 40-day-old culture in liquid medium has an aggregative sedimentary type of growth, growing addressed at the bottom of the flask. It is medium brown. The medium is pinkish.

Microscopic observation (75-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 4.5-7 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are isometric rounded, 6-7 microns wide, and 6-7 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 05 SL

This strain, identified as *Nostoc* sp., was added to the collection in 1986.

It originates from Sri Lanka. It was isolated by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 47-day-old culture on solid medium shows generalized spreading growth, coiled in aspect, located at the agar surface. It has intermediate luster, is opaque and dark brownish green. The medium is not colored.
- A 63-day-old culture in liquid medium shows medium-brownish-green flocculent growth. The medium is not colored.

Microscopic observation (65-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric rounded and 4.5-5.5 microns in diameter. Most apical cells are rounded. Heterocysts are infrequent and observed only in hormogonia. They are terminal and smaller than vegetative cells. Spores were not observed. Hormogonia are thinner than the filaments. They show no motility.

Notes:

A 27-day-old culture has motile hormogonia.

Growth on solid medium is that of an *Anabaena*.

A 34-day-old liquid culture shows chains of somewhat separated spore-like cells.

Strain Ns 06 Ms

This strain, identified as *Nostoc* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Teroi, Kedah, Malaysia, in 1983. The soil sample was provided by W. Ventura.

Soil properties: available

Visual descriptions:

- A 27-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, rounded viewed from the top and high convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium to dark yellowish brown. The medium is not colored. Older colonies form gas bubbles.
- A 30-day-old culture in liquid medium shows medium-yellowish-brown flocculent growth. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Most filaments are 50-1000 microns long. Vegetative cells are from isometric to long barrel-shaped, 6-7 microns wide, and 5.5-10.5 microns long. They are highly vacuolated. Most apical cells are rounded. Only detached heterocysts are observed. They were long ellipsoidal, 5-6.5 microns wide, and 7-10 microns long. Free spores are observed. They are long ellipsoidal, 7-7.5 microns wide, and 12-13 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 07 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1983. It originates from the Philippines. It was isolated by M. Martinez (UPLB) from a ricefield located in Los Banos, Philippines.

Visual description:

- An 80-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has intermediate luster and is light yellowish green. The medium is not colored.
- A 17-day-old culture in liquid medium forms an incohesive mat growing in or at the surface of the medium. It is medium green. The medium is not colored.

Microscopic observation (80-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 4-6 microns long. Most apical cells are rounded. Only detached, mostly bipolar heterocysts are observed. They are long barrel-

shaped, 4-4.5 microns wide, and 5-6 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 08 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'oh, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Apalnga'oh 1).

Visual description:

- A 27-day-old culture on solid medium shows generalized spreading growth, coiled in aspect, located on the agar surface. It has intermediate luster, is opaque and medium green.
- A 21-day-old culture in liquid medium shows flocculent growth, some partly adpressed at the bottom of the flask. The culture is medium bluish green in color (not a healthy-looking strain). The medium is not colored.

Microscopic description (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Gliding of the trichomes was observed. Most filaments are 50-600 microns long. Vegetative cells are short barrel-shaped, 3-4 microns wide, and 2-3 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric rounded, 3.5-4 microns wide, and 4-5 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show motility.

Notes:

Filaments are very straight in liquid medium, but slightly contorted on solid medium. They are motile in liquid medium but not on solid medium.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ns 09 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1974.

Visual description:

- A 28-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is opaque and dark brownish green. The medium is not colored.
- A 21-day-old culture in liquid medium forms an incohesive mat growing in or at the surface of the medium. It is dark brownish green. The medium is not colored.

Microscopic observation (32-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric rounded, 3-4 microns wide, and 2.5-4 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 3-4 microns wide, and 3-4 microns long. No spores were observed. Hormogonia are angular and thinner than the filaments. They have no heterocysts and show motility.

Notes:

One characteristic of the strain is its high phycocyanin content.

Strain Ns 10 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'ho, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Apalnga'ho 3)

Visual description:

- A 23-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, rounded viewed from the top and low convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium green. The medium is not colored.
- A 21-day-old culture in liquid medium has an aggregative sedimentary type of growth. The culture is medium green. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show neither polarity nor tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3.5-4 microns wide, and 4-5 microns long. Most apical cells are rounded. Heterocysts are both intercalary and terminal, either single or in pairs. Intercalary heterocysts are isometric rounded, 5.5-6 microns wide, and 5.5-6 microns long. Terminal heterocysts are ellipsoidal, 4-5 microns wide, and 5-7 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ns 11 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitan 1)

Visual description:

- A 90-day-old culture on solid medium shows colonial growth. Colonies are 1-4 mm in size, irregular-shaped viewed from the top and low convex from the side. The margin is rough. The culture is dark yellowish brown. The medium is not colored.

- A 40-day-old culture in liquid medium shows medium-brown homogeneous growth. The medium is not colored.

Microscopic observation (90-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 5-10 microns.

Most apical cells are rounded. Distorted vegetative cells are observed. Only detached, mostly bipolar heterocysts are observed. They are long barrel-shaped, 4-5 microns wide, and 7-8 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ns 12 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1974.

Visual description:

- A 40-day-old culture on solid medium shows generalized spreading growth, diffuse in aspect, located on the agar surface. It has dull luster, is opaque and medium brownish green. The medium is reddish.

- A 65-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium green. The medium is not colored.

Microscopic observation (40-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, about 5 microns wide, and 3-7

microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 5-6 microns wide, and 6.5-7.5 microns long. No spores were observed. Hormogonia are narrower than the filaments. They have no heterocysts and show motility. Abnormal, contorted vegetative cells are observed.

Notes:

A 90-day-old slant culture shows very contorted filaments of dark spores.

Strain Ns 13 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitan 2).

Visual description:

- An 80-day-old culture on solid medium shows cohesive growth with rough margin. It has intermediate luster, is opaque and dark yellowish brown. The medium is not colored.

- A 34-day-old culture in liquid medium shows dark-brown flocculent growth. The medium is not colored.

Microscopic observation (34-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3.5-4.5 microns wide, and 4-7 microns

long. Most apical cells are rounded. Abnormal, elongated vegetative cells are observed. Heterocysts are mostly

intercalary and single. They are long ellipsoidal, 4.5-5.5 microns wide, and 6.5-8 microns long. Free, single, and smooth

spores are observed. They are long ellipsoidal, 5-6 microns wide, and 7.5-9 microns long. Hormogonia are thinner than

the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ns 14 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Roger (ORSTOM) in 1974.

Visual description:

- A 40-day-old culture on solid medium shows cohesive growth with rough margin. It has intermediate luster, is opaque and medium yellowish green. The medium is not colored.

- A 65-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Microscopic observation (46-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, aggregated, and show no tapering. No sheath is

observed. Motility of the trichomes is not observed. Vegetative cells are short rounded, 4-5 microns wide, and 2-4

microns long. In older, aggregated filaments, cells are isometric rounded, 6-7 microns. Most apical cells are rounded.

Heterocysts are mostly terminal and single. They are isometric and smaller than the vegetative cells (2-3 microns). No

spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 15 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'ho, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Apalnga'ho 2).

Visual description:

- A 23-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, rounded viewed from the top and high convex from the side. The margin is smooth. The culture has intermediate luster, is translucent and light yellowish green. The medium is not colored.

- A 21-day-old culture in liquid medium shows light-yellowish-green homogeneous growth. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show neither polarity nor tapering. No sheath is observed. Motility of the trichomes is not observed. Most filaments are 50-500 microns long. Vegetative cells are isometric barrel-shaped, 5-5.5 microns wide, and 4-5.5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. Intercalary heterocysts are isometric rounded, 5.5-6 microns wide, and 5-5.5 microns long. Terminal heterocysts are rounded, 5-5.5 microns wide, and 5 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ns 16 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Apalnga'ho, Banawe, Philippines, in 1982.

Soil properties: available (Apalnga'ho 1).

Visual description:

- A 75-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is opaque and medium green. The medium is not colored.

- A 21-day-old culture in liquid medium forms an incohesive mat growing in or at the surface of the medium. It is medium green. The medium is not colored.

Microscopic observation (75-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 2.5-4 microns wide, and 3-4.5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 3.5-4.5 microns wide, and 4.5-5.5 microns long. Spores are mostly intercalary, in chains, and smooth. They are isometric rounded, 5-6 microns wide, and 5-6 microns long. Hormogonia are thinner than the filaments. They either have terminal or no heterocysts at all, and show no motility.

Notes:

This strain is a good example that the type of growth is not representative of a given genus (colonial *Nostoc* or spreading *Anabaena*).

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ns 17 Mr

This strain, identified as *Nostoc* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Belanitra Experimental Station in 1986. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Soil properties: available

Visual description:

- A 30-day-old culture on solid medium shows microcolonial growth. Colonies are rounded viewed from the top and high convex from the side. The margin is smooth. The culture has intermediate luster, is translucent and light green. The medium is not colored.

- A 21-day-old culture in liquid medium forms irregular colonies, 1-5 mm in size, growing in or at the surface of the medium. It is medium yellowish green. The medium is not colored.

Microscopic observation (46-day-old culture on solid medium):

- The culture exhibits very poor growth. Most of the cells are isolated. A few, short trichomes without ramifications were observed. They are uniseriate, single, wavy, and show neither polarity nor tapering. Vegetative cells are from isometric to long barrel-shaped, 2.5-5 microns wide, and 2.5-7 microns long. Abnormal vegetative cells, distorted and dissymmetrical, were observed. Most apical cells are rounded. Spores and hormogonia were not observed.

Notes:

Definitely a *Nostoc*; however, this strain is a freak.

Strain Ns 18 Mr

This strain, identified as *Nostoc* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Belanitra Experimental Station in 1986. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Soil properties: available

Visual description:

- A 23-day-old culture on solid medium shows colonial growth. Colonies are 1-3 mm in size, elongated viewed from the top and high convex from the side. The margin is smooth. The culture has intermediate luster, is opaque and medium yellowish brown. The medium is not colored.

- A 21-day-old culture in liquid medium shows light-yellowish-brown flocculent growth. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, helical, and show neither polarity nor tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3-4 microns wide, and 4.5-6 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. Intercalary heterocysts are long ellipsoidal, 4-5 microns wide, and 5-6 microns long. Terminal heterocysts are ellipsoidal, 2.5-4 microns wide, and 3-5.5 microns long. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show no motility.

Strain Ns 19 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 21-day-old culture on solid medium shows colonial growth. Colonies are 2-4 mm in size, irregular-shaped viewed from the top and flat from the side. The margin is rough. The culture has intermediate luster, is opaque and dark brownish green. The medium is not colored.

- A 28-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium brownish green. The medium is yellowish.

Microscopic observation (42-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 2.5-3.5 microns wide, and 3-6.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 4-5 microns wide, and 5.5-8 microns long. Spores in chains are observed. They are long ellipsoidal, 4.5-5 microns wide, and 8-8.5 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Notes:

This strain might have the ability to produce spores or resting cells from all vegetative cells.

Strain Ns 20 Mr

This strain, identified as *Nostoc* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Belanitra, Madagascar, in 1986. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Soil properties: available

Visual description:

- A 23-day-old culture on solid medium shows colonial growth, irregular-shaped viewed from the top and warty from the side. The margin is rough. The culture has intermediate luster, is opaque and medium yellowish brown. The medium is not colored.

- A 21-day-old culture in liquid medium shows light-yellowish-brown flocculent growth. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show neither polarity nor tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric angular, 2-3 microns wide, and 2-4 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 3.5-4 microns wide, and 4-5 microns long. Spores and hormogonia were not observed.

Notes:

Despite the absence of hormogonia in the culture, this strain was still classified as *Nostoc* because of the contorted shape of the filaments and the chains of round spores.

Strain Ns 21 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from an algal material collected from Mangatarem, Pangasinan, Philippines, in 1986. The algal material was provided by G. Romero.

Visual description:

- A 24-day-old culture on solid medium shows colonial growth. Most colonies are smaller than 0.5 mm (microcolonial type), irregular-shaped viewed from the top and warty from the side. The margin is rough. The culture has intermediate luster, is opaque and light green. The medium is not colored.

- A 21-day-old culture in liquid medium forms round colonies, 2-3 mm in size, growing in or at the surface of the medium. The culture is medium green. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, coiled, aggregated, and show neither polarity nor tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 4-5 microns wide, and 4-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 4.5-5 microns wide, and 5.5-6 microns long. Spores and hormogonia were not observed.

Notes:

Analyses of the BGA sample: 2.27% N, 0.056% P, 0.16% K, 3.31% Ca, 4.65%Mg, 0.15% Na, including ash (44.8% ash). The presence of contorted filaments indicates that this is truly a Nostoc.

Strain Ns 22 Eg

This strain, identified as Nostoc sp., was added to the collection in 1987. It was isolated by F. Ghazal (Agric. Res. Cent., Egypt) from a ricefield located in Sakha, Egypt, in 1987.

Visual description:

- A 24-day-old culture on solid medium shows colonial growth. Colonies are 1-1.5 mm in size and low convex viewed from the side. The margin is rough. The culture has dull luster, is opaque and dark green. The medium is not colored.
- A 21-day-old culture in liquid medium has an aggregative sedimentary type of growth, and an incohesive patchy growth at the bottom of the flask. The culture is medium green; the patchy growth is medium yellowish green. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, aggregated, and show neither polarity nor tapering. No sheath is observed. Motility of the trichomes is not observed. There are three sizes and shapes of cells: a) barrel-shaped cells (5-6 microns wide and 5.5-7 microns long); b) granular, ellipsoidal cells (5 microns wide and 5.5-7.5 microns long); and c) yellowish-brown round cells (8-9 microns in diameter). Very few heterocysts are observed.

Strain Ns 23 Mr

This strain, identified as Nostoc sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Belanitra Experimental Station, Madagascar, in 1986. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Soil properties: available

Visual description:

- A 25-day-old culture on solid medium shows colonial growth. Colonies are 2-5 mm in size, rounded viewed from the top view and high convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium yellowish green. The medium is not colored.
- A 41-day-old culture in liquid medium shows flocculent growth growing in or at the surface of the medium. It is medium yellowish green. The medium is not colored.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 6-7 microns wide, and 6-8 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 8-9 microns wide, and 7-12 microns long. Ornamented spores, either single or in chains, are observed. They are long ellipsoidal, 2 microns wide, and 4 microns long. No hormogonia were observed.

Notes:

No hormogonia were observed, but this strain is still classified as Nostoc on the basis of the type of colonial growth on solid medium and the contorted shape of the filaments.

Strain Ns 24 Th

This strain, identified as Nostoc sp., was added to the collection in 1985. It originates from Thailand. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil in 1985. The soil sample was taken by Dr. I. Watanabe from an INSFFER azolla trial plot with 0-36-24 NPK applied.

Visual description:

- A 25-day-old culture on solid medium shows colonial growth. Colonies are 1-5 mm in size, irregular-shaped viewed from the top and high convex, as well as warty, from the side. The margin is smooth. The culture has intermediate luster, is opaque and dark brown. The medium is not colored.
- A 41-day-old culture in liquid medium shows medium-brown homogeneous growth. The medium is not colored.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 4-5 microns wide, and 4-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 6-8 microns wide, and 7-11 microns long. Free, ornamented spores in chains are observed. They are long ellipsoidal, 6-7 microns wide, and 8-11 microns long. Hormogonia are thinner than the filaments.

Strain Ns 25 In

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It originates from India. The culture was provided by P.K. Singh of India.

Visual description:

- A 24-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has glossy luster, is opaque and medium yellowish brown. The medium is not colored.
- A 21-day-old culture in liquid medium shows an aggregative sedimentary type of growth, partly addressed at the bottom of the flask. It is medium yellowish brown. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show neither polarity nor tapering. No sheath is observed. Motility of the trichomes is not observed. Most filaments are 50-200 microns long. Vegetative cells are long barrel-shaped, 1.5-2.5 microns wide, and 3-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 3-4 microns wide, and 4-6 microns long. No spores were observed. Hormogonia are vacuolated and have the same width as the trichomes. They have no heterocysts and show no motility.

Strain Ns 26 Ir

This strain, identified as *Nostoc* sp., was added to the collection in 1985. It originates from Iran. It was isolated by P.A. Roger (ORSTOM) from an algal crust in 1985.

Visual description:

- A 24-day-old culture on solid medium shows cohesive growth with finger-like expansions at the margin. It has glossy luster, is opaque and medium green. The medium is not colored.
- A 22-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, coiled, and show neither polarity nor tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 3-3.5 microns wide, and 3-4 microns long. Round, slightly granulated vegetative cells, 6-7 microns wide and 6-7 microns long, are also observed. Most apical cells are rounded. Heterocysts are mostly intercalary and in pairs. They are long ellipsoidal, 4.5-5.5 microns wide, and 4.5-6 microns long. No hormogonia were observed.

Notes:

Filaments are highly vacuolated; clearly a *Nostoc*.

Strain Ns 27 Th

This strain, identified as *Nostoc* sp., was added to the collection in 1985. It originates from Thailand. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil sample provided by Dr. I. Watanabe in 1985.

Visual description:

- A 25-day-old culture on solid medium shows colonial growth. Colonies are 1-6 mm in size, rounded viewed from the top and high convex, as well as warty, from the side. The margin is smooth. The culture has intermediate luster, is opaque and medium brown. The medium is not colored. Young colonies are rounded, translucent, and light brown. Older colonies are rugged or warty and dark brown.
- A 41-day-old culture in liquid medium forms irregular, mucilaginous colonies, 2-10 mm in size, growing in or at the surface of the medium. It is medium yellowish brown. The medium is yellowish.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4.5-5.5 microns wide, and 6-8 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 7-9 microns wide, and 9-14 microns long. Spores are in chains and ornamented. They are long ellipsoidal, 6 microns wide, and 9-11 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 28 Ir

This strain, identified as *Nostoc* sp., was added to the collection in 1985. It originates from Iran. It was isolated by P.A. Roger (ORSTOM) from an algal crust sample in 1985.

Visual description:

- A 22-day-old culture on solid medium shows cohesive growth with smooth margin. It has glossy luster, is opaque and medium green. The medium is not colored.
- A 22-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium green. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are from isometric to long barrel-shaped, 4-5 microns wide, and 4-7.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are mostly long ellipsoidal, 5-6.5 microns wide, and 6-7.5 microns long. Free spores are observed. They are long rounded, 8-9 microns wide, and 10-10.5 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show motility.

Notes:

Filaments are highly vacuolated.

Strain Ns 29 As

This strain, identified as *Nostoc* sp., was added to the collection in 1988. It was isolated by P.A. Roger (ORSTOM) from a saline gley collected from Neusiedlersee, Austria, in 1988. The soil sample (I) was provided by S. Zechmeister-Boltenstern (Wien Univ.).

Soil properties: Saline gley soil containing carbonate and having high molder humus.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, irregular-shaped viewed from the top and low convex from the side. The margin is smooth. The culture has intermediate luster, is opaque and dark brown. The medium is not colored.

- A 22-day-old culture in liquid medium shows medium-reddish-brown homogeneous growth. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric rounded to long barrel-shaped, 3-6 microns wide, and 3-7 microns long. Most apical cells are rounded. Detached heterocysts are observed. They are long ellipsoidal, 3-4 microns wide, and 4-5 microns long. No spores were observed. Hormogonia are angular with pointed apical cells and thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Wollenweber B. and Zechmeister-Boltenstern S. (1989).

Strain Ns 30 As

This strain, identified as *Nostoc* sp., was added to the collection in 1988. It was isolated by P.A. Roger (ORSTOM) from a saline gley collected from Neusiedlersee, Austria, in 1988. The soil sample (I) was provided by S. Zechmeister-Boltenstern (Wien Univ.).

Soil properties: Saline gley soil containing carbonate and having high molder humus.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are 1-4 mm in size, rounded viewed from the top and high convex the from side. The margin is smooth. The culture has glossy luster, is translucent and light yellowish green. The medium is not colored.

- A 22-day-old culture in liquid medium forms irregular colonies, 1-3 mm in size, growing in or at the surface of the medium. It is medium green. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, helical, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are from isometric to long barrel-shaped, 4.5-5.5 microns wide, and 5-7 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are rounded to ellipsoidal, 5-7 microns wide, and 6-8 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Wollenweber B. and Zechmeister-Boltenstern S. (1989).

Strain Ns 31 As

This strain, identified as *Nostoc* sp., was added to the collection in 1988. It was isolated by P.A. Roger (ORSTOM) from a solonchak collected from Neusiedlersee, Austria, in 1988. The soil sample (III) was provided by S. Zechmeister-Boltenstern (Wien Univ.).

Soil properties: Solonchak with a high fraction of coarse sand and low humus content.

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, ropey and aura-like in aspect, located on the agar surface. It has intermediate luster, is opaque and medium green. The medium is not colored.

- A 22-day-old culture in liquid medium forms a cohesive patchy mat growing addressed at the bottom of the flask. It is medium yellowish green. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy to aggregated, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are from short to isometric barrel-shaped, 3-4 microns wide, and 2.5-4 microns long. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are truncated ellipsoidal, 2.5-3 microns wide, and 3.5-4 microns long. Spores and hormogonia were not observed.

Notes:

Filaments become contorted with age.

Bibliographic reference on the strain or its environment: Wollenweber B. and Zechmeister-Boltenstern S. (1989).

Strain Ns 32 As

This strain, identified as *Nostoc* sp., was added to the collection in 1988. It was isolated by P.A. Roger (ORSTOM) from a solonetz collected from Neusiedlersee, Austria, in 1988. The soil sample (IV) was provided by S. Zechmeister-Boltenstern (Wien Univ.).

Soil properties: Solonetz. The surface soil is sandy loam with medium humus content.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, rounded viewed from the top and flat from the side. The margin is smooth. The culture has glossy luster, is opaque and medium yellowish green. The medium is not colored.

- A 22-day-old culture in liquid medium shows light-yellowish-green flocculent growth. The medium is yellowish.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, helical, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 3.5-4 microns wide, and 3-4.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric rounded, 5-6 microns wide, and 5-6 microns long. Spores and hormogonia were not observed.

Notes:

Filaments tend to be contorted as they age; clearly a *Nostoc*.

Bibliographic reference on the strain or its environment: Wollenweber B. and Zechmeister-Boltenstern S. (1989).

Strain Ns 33 SL

This strain, identified as *Nostoc* sp., was added to the collection in 1986. It originates from Sri Lanka. The culture was provided by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka, in 1986.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are 1-5 mm in size, rounded viewed from the top and flat from the side. The margin of the colonies is aura-like. The culture has glossy luster, is opaque and dark brown. The medium is not colored.

- A 22-day-old culture in liquid medium has an aggregative sedimentary type of growth, partly addressed at the bottom of the flask. It is dark yellowish brown. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 2.5-3 microns wide, and 4-6.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 4-4.5 microns wide, and 5-7 microns long. Spores and hormogonia were not observed.

Strain Ns 34 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRR collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a saline sandy soil collected from Retba, Senegal, in 1976.

- A 25-day-old culture on solid medium shows generalized spreading growth located on the agar surface. It has glossy luster, is opaque and medium green. The medium is not colored.

- A 41-day-old culture in liquid medium shows medium-brownish-green homogeneous growth. The medium is not colored.

Microscopic observation (30-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are from short to isometric barrel-shaped, 3.5 microns wide, and 2-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 3.5 microns wide, and 5 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Reynaud PA, Roger PA (1981) and Reynaud PA, Roger PA (1981).

Strain Ns 35 Sn

This strain, identified as *Nostoc* sp, came from the ORSTOM collection and was added to the IRR collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture on solid medium shows cohesive growth with rough margin. It has dull luster, is opaque and medium green. The medium is not colored.

- A 38-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium brownish green. The medium is yellowish.

Microscopic observation (38-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed.

Motility of the trichomes is not observed. Vegetative cells are isometric rounded, 4.5-5.5 microns wide, and 4-5.5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are isometric rounded, 5-6 microns in diameter. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 36 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Palao, Kiangan, Philippines, in 1982.

Soil properties: available (Palao 2).

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. It has intermediate luster, is opaque and dark green. The medium is not colored.
- A 38-day-old culture in liquid medium forms a dark-green incohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (38-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3-3.5 microns wide, and 4.5-5.5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long barrel-shaped, 4-4.5 microns wide, and 5-6 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 37 Ir

This strain, identified as *Nostoc* sp., was added to the collection in 1985. It originates from Iran. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil in 1985.

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. It also forms colonies about 1 mm in size, rounded viewed from the top and flat from the side. The margin is rough. The culture has intermediate luster, is opaque and dark green. The medium is not colored.
- A 22-day-old culture in liquid medium forms a medium-green incohesive mat growing addressed at the bottom of the flask. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped to ellipsoidal, 2.5-3 microns wide, and 3-5.5 microns long. Most apical cells are rounded. Detached heterocysts are observed. They are long ellipsoidal, 4-4.5 microns wide, and 5-5.5 microns long. Hormogonia are angular and thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 38 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Reynaud (ORSTOM) from a ricefield soil collected from Richard Toll, Senegal, in 1975.

Soil properties: available

Visual description:

- A 22-day-old culture on solid medium shows cohesive growth with smooth margin. It has glossy luster, is opaque and medium yellowish brown. The medium is yellowish.
- A 38-day-old culture in liquid medium shows medium-yellowish-brown homogeneous growth. The medium is not colored.

Microscopic observation (38-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, straight, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 4.5-5 microns wide, and 6 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are isometric rounded, 7-8.5 microns in diameter. Spores and hormogonia were not observed.

Bibliographic reference on the strain or its environment: Roger PA, Reynaud PA (1976).

Strain Ns 39 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 32-day-old culture on solid medium shows colonial growth. Colonies are 3-7 mm in size, rounded and elongated viewed from the top and high convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium yellowish brown. The medium is not colored.
- A 48-day-old culture in liquid medium forms irregular, mucilaginous colonies, 3-15 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is yellowish.

Microscopic observation (30-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, coiled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long ellipsoidal, 6 microns wide, and 8-9 microns long. Most apical cells are rounded. The heterocysts are long ellipsoidal, 8-9 microns wide, and 10.5-12 microns long. Spores are in chains and adjacent to heterocysts. They are long ellipsoidal, 6 microns wide, and 10.5 microns long. No hormogonia were observed.

Strain Ns 40 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P. Roger and P. Reynaud (ORSTOM) around 1975.

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, coiled in aspect, located on the agar surface. It has glossy luster, is opaque and medium brownish green. The medium is not colored.
- A 13-day-old culture in liquid medium forms an incohesive mat growing in or at the surface of the medium. It is dark brownish green. The medium is not colored.

Microscopic observation (13-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 5-6 microns wide, and 4-7 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long barrel-shaped, 5-6 microns wide, and 6.5-7.5 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show motility. Some of the hormogonia are extremely long.

Strain Ns 41 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 29-day-old culture on solid medium shows cohesive growth. It has intermediate luster, is opaque and medium brownish green. The medium is yellowish.
- A 48-day-old liquid culture has an aggregative sedimentary type of growth. It is medium brownish green. The medium is yellowish.

Microscopic observation (30-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, aggregated, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 6-7 microns wide, and 5-7 microns long. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are long ellipsoidal, 6 microns wide, and 7 microns long. Free spores are observed. They are long ellipsoidal, 4-5 microns wide, and 6 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 42 Au

This strain, identified as *Nostoc* sp., came from the Pasteur Institute and was added to the IRRRI collection in 1983. It originates from Australia. It was isolated by R. Rippka (Pasteur Institute, France).

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are 1-2 mm in size, rounded viewed from the top and low convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium brownish green. The medium is not colored.
- A 22-day-old culture in liquid medium forms a cohesive mat growing addressed at the bottom of the flask. It is medium yellowish green. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, aggregated, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 3.5-4 microns wide, and 3-4 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 4-5 microns wide, and 5-7 microns long. Free spores are observed. They are long ellipsoidal, 6 microns wide, and 8 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility. Bibliographic reference on the strain or its environment: Rippka et al. 1979.

Strain Ns 43 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture on solid medium shows generalized spreading growth, fibrous in aspect, located on the agar surface. It has intermediate luster, is opaque and medium yellowish green. The medium is not colored.
- A 22-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium green. The medium is yellowish.

Microscopic observation (23-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, aggregated, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped to ellipsoidal, 1.5-2 microns wide, and 2-2.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric rounded, 1.5 microns wide, and 1-2 microns long. Free spores are observed. They are rounded, 2 microns wide, and 2 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 44 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. It has intermediate luster, is opaque and light brown. The medium is not colored.
- A 38-day-old culture in liquid medium forms an incohesive mat growing adpressed on the bottom of the flask. It is medium yellowish brown. The medium is yellowish.

Microscopic observation (38-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, straight, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3-3.5 microns wide and 3.5-4.5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are isometric barrel-shaped, 4.5 microns wide, and 5-6 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 45 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 24-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 38-day-old culture in liquid medium shows homogeneous growth. It is dark yellowish green. The medium is not colored.

Microscopic observation (38-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, straight, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 5-6 microns wide, and 4.5-6.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric rounded, 4.5-5.5 microns wide, and 4.5-6 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show motility.

Strain Ns 46 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are composite. Aggregates are from 5 to 10 mm in size. Individual colonies are rounded viewed from the top and flat from the side. The colonies have finger-like expansions. The culture has dull luster, is opaque and dark brown. The medium is not colored.
- A 22-day-old culture in liquid medium forms an incohesive mat, growing both at the surface of the medium and adpressed at the bottom of the flask. The culture is dark brown. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are usually long barrel-shaped, 3-3.5 microns wide, and 3-5.5 microns long. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are rounded to ellipsoidal, 3-4 microns wide, and 3-5 microns long. Intercalary heterocysts are rounded, 3.5-4 microns wide, and 4-6 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Strain Ns 47 Sn

This strain, identified as *Nostoc*, sp. came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1975.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Most colonies are smaller than 0.5 mm (microcolonial type), rounded viewed from the top and flat from the side. The margin of the colonies is aura-like. The culture has dull luster, is opaque and medium green. The medium is not colored.
- A 38-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Microscopic observation (38-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, straight, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 5-5.5 microns wide, and 5-6 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 6-7 microns wide, and 7-8.5 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Notes: Free spores, long ellipsoidal and 5-5.5 x 7 microns, are observed in a 30-day-old culture.

Strain Ns 48 Sn

This strain, identified as *Nostoc sphaerica*, came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Most colonies are smaller than 0.5 mm (microcolonial type), elongated viewed from the top and flat from the side. The margin is rough. The culture has dull luster, is opaque and medium green. The medium is not colored.
- A 38-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is dark green. The medium is yellowish.

Microscopic observation (38-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, straight, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 5-5.5 microns wide, and 4.5-6 microns long. Most apical cells are rounded. Abnormal vegetative cells, elongated and irregular, are observed. Heterocysts are mostly intercalary and single. They are isometric barrel-shaped, 5-6 microns wide, and 5-6 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 49 Ms

This strain, identified as *Nostoc* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Simpai Lima, Perak, Malaysia, in 1983. The soil sample was provided by W. Ventura (IRRI).

Soil properties: available

Visual description:

- A 21-day-old culture on solid medium shows colonial growth. Colonies are 2-5 mm in size, rounded viewed from the top and high convex from the side. The margin is smooth, becoming aura-like in older colonies. The culture has glossy luster, is opaque and medium yellowish brown. The medium is not colored.
- A 30-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish brown. The medium is not colored.

Microscopic observation (42-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are from long to very long barrel-shaped, 5-5.5 microns wide, and 5-20 microns long. Most apical cells are rounded. Detached, bipolar heterocysts, either single or in pairs, are observed. The single heterocysts are ellipsoidal, 7-7.5 microns wide, and 10-13 microns long; those in pairs are rounded to ellipsoidal, 5-6 microns wide, and 6-9 microns long. Spores were not observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Notes:

Vegetative cells are highly vacuolated; some become distended.

Strain Ns 50 Sn

This strain, identified as *Nostoc microscopicum*, came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture on solid medium shows generalized spreading growth, diffuse in aspect, located on the agar surface. It has dull luster, is opaque and medium yellowish green. The medium is not colored.
- A 22-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium green. The medium is yellowish.

Microscopic observation (46-day-old culture on solid medium):

- Aggregates of rounded cells, 2.5-8 microns in diameter, are observed. Heterocysts and spores were not observed. Hormogonia are thinner than the filaments. They have truncated rounded, terminal heterocysts and show no motility.

Strain Ns 51 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Roger (ORSTOM) in 1985.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are 1-1.5 mm in size, rounded viewed from the top and flat from the side. The margin is rough. The culture has intermediate luster, is opaque and dark green. The medium is not colored.
- A 39-day-old culture in liquid medium forms irregular, mucilaginous colonies, 10-20 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (39-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are short barrel-shaped, 4-5 microns wide, and 3-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric barrel-shaped, 5.5-6.5 microns wide, and 5.5-6.5 microns long. Spores and hormogonia were not observed.

Notes:

No hormogonia clearly thinner than the filaments were observed. This strain was classified as *Nostoc* because of the kind of colony formation in liquid medium and the observation of aggregated filaments.

Strain Ns 52 Eg

This strain, identified as *Nostoc* sp., was added to the collection in 1990. It originates from Egypt. It was isolated by F. Ghazal from a ricefield located in the Nile delta in 1988.

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. Also observed are colonies 0.5-2 mm in size, irregular-shaped viewed from the top and flat from the side. The margin of the colonies is aura-like. The culture has intermediate luster, is opaque and dark brown. The medium is not colored.
- A 39-day-old culture in liquid medium forms an incohesive mat, growing both addressed at the bottom of the flask and in or at the surface of the medium. It is medium brown. The medium is not colored.

Microscopic observation (39-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long ellipsoidal, 2-2.5 microns wide, and 2.5-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are isometric rounded, 3.5-4.5 microns wide, and 3.5-4.5 microns long. Spores were observed, 4 microns wide and 6 microns long. No hormogonia were observed.

Strain Ns 53 Eg

This strain, identified as *Nostoc* sp., was added to the collection in 1990. It was isolated by F. Ghazal (Egypt) from a ricefield located in the Nile delta, Egypt, in 1988.

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is opaque and medium green. The medium is not colored.
- A 39-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Microscopic observation (39-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 2.5-3 microns wide, and 3-5.5 microns long. Most apical cells are rounded. Heterocysts are mostly terminal, 2.5-3 microns wide, and 2.5-3 microns long. Spores are mostly intercalary, in chains, and smooth. They are isometric rounded, 6-8 microns wide, and 6-8 microns long. No hormogonia were observed.

Strain Ns 54 Eg

This strain, identified as *Nostoc* sp., was added to the collection in 1990. It was isolated by F. Ghazal (Egypt) from a ricefield located in the Nile delta, Egypt, in 1988.

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has central colonies, 1-2 mm in size, irregular-shaped viewed from the top and flat from the side. The margin of the colonies is aura-like. The culture has intermediate luster, is opaque and medium brown. The medium is not colored.
- A 39-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium brown. The medium is not colored.

Microscopic observation (39-day-old culture in liquid medium):

- Trichomes have no ramifications. They form cells of different sizes and look almost multiseriate (aggregated filaments characteristic of *Nostoc*). Heterocysts are very small and extremely numerous. A few short filaments (not hormogonia) are 2-3 microns wide.

Strain Ns 55 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1974.

Visual description:

- A 28-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has glossy luster, is opaque and medium brownish green. The medium is not colored.
- A 63-day-old culture in liquid medium shows dark-brownish-green flocculent growth.

Microscopic observation (32-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric rounded, 3-4 microns wide, and 3-5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 3-4 microns wide, and 3-4 microns long. Spores and hormogonia were not observed.

Notes:

An older culture had more contorted filaments.

Strain Ns 56 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitan 1).

Visual description:

- A 22-day-old culture on solid medium shows cohesive growth with finger-like expansions at the margin. It has intermediate luster, is opaque and medium green. The medium is not colored.
- A 22-day-old culture in liquid medium shows medium-green homogeneous growth. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, straight, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Most filaments are 50-150 microns long. Vegetative cells are long barrel-shaped, 4-4.5 microns wide, and 4-6 microns long. Most apical cells are rounded. Heterocysts are terminal and found at both ends of filaments. They are truncated ellipsoidal, 4-5 microns wide, and 4-5.5 microns long. Spores and hormogonia were not observed.

Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ns 57 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Pitan, Banawe, Philippines, in 1982.

Soil properties: available (Banawe, Pitan 2).

Visual description:

- A 25-day-old culture on solid medium shows generalized spreading growth, coiled in aspect, located on the agar surface. It is medium yellowish green. The medium is not colored.
- A 61-day-old culture in liquid medium shows a cohesive mat growing in or at the surface of the medium. It is medium brownish green. Small, finger-like projections at the edge of the mat are observed.

Microscopic observation (40-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are long angular, 3.5-4.5 microns wide, and 3-6 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long barrel-shaped, 4-5 microns wide, and 4-6 microns long. Spores and hormogonia were not observed. Bibliographic reference on the strain or its environment: Roger PA, Voggesberger M, Margraf J (1986).

Strain Ns 58 Ms

This strain, identified as *Nostoc* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Serbarang Perai, Penang, Malaysia, in 1983. The soil sample was provided by W. Ventura (IRRI).

Soil properties: available

Visual description:

- A 26-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. It has intermediate luster and is light green.
- A 62-day-old culture in liquid medium forms a mucilaginous mass growing in or at the surface of the medium, with small, finger-like projections darker at the tip than at the base. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (26-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, in bundles, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric angular, 4-5 microns wide, and 4-5 microns long. Most apical cells are pointed. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 6-7 microns wide, and 7-8 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 59 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Richard Toll, Senegal, in 1970.

Soil properties: available

Visual description:

- A 26-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It is medium brownish green. The medium is not colored.
- A 62-day-old culture in liquid medium shows an incohesive mat growing in or at the surface of the medium, with small, finger-like projections darker at the tip than at the base. The culture is medium brownish green. The medium is not colored.

Microscopic observation (26-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Gliding of the trichomes is observed. Vegetative cells are long angular, 2.5-3.5 microns wide, and 3.5-6 microns long.

Most apical cells are pointed. Heterocysts are single and both intercalary and terminal. They are long rounded, 4.5-5.5 microns wide, and 7.5-8.5 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show motility.

Bibliographic reference on the strain or its environment: Roger PA, Reynaud PA (1976).

Strain Ns 60 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IIRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil collected from Bambey, Senegal, in 1973.

Soil properties: upland sandy soil (Dior)

Visual description:

- A 47-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, located on the agar surface. It has intermediate luster, is opaque and medium yellowish brown. The medium is not colored.

- A 28-day-old culture in liquid medium forms irregular, fluffy colonies, 5-20 mm in size, growing in or at the surface of the medium. The culture is medium yellowish brown. The medium is not colored.

Microscopic observation (27-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 3.5-4.5 microns wide, and 4-7 microns long. Most apical cells are pointed. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 7-8 microns wide, and 7-10 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

- Microscopic observation of a 13-day-old culture in liquid medium shows similar features except for the following: trichomes are wavy; vegetative cells are long barrel-shaped and 4.5-5.5 microns wide; most apical cells are rounded; abnormal vegetative cells, elongated and swollen, are observed; heterocysts are long barrel-shaped, either single or in pairs, 6.5-7.5 microns wide, and 10-12 microns long; hormogonia are slightly thinner than the filaments and vacuolated.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommergues Y (1978).

Strain Ns 61 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IIRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Djibelor, Senegal, in 1974.

Soil properties: available

Visual description:

- A 52-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. The strain also shows colonial growth. Most colonies are smaller than 0.5 mm, irregular-shaped viewed from the top and low convex from the side. The margin is rough. The culture has intermediate luster, is opaque and medium brownish green. The medium is not colored.

- A 63-day-old culture in liquid medium forms mucilaginous colonies (> 20 mm in size) with small, finger-like projections growing in or at the surface of the medium. The culture is medium yellowish brown. The medium is reddish.

Microscopic observation (32-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, entangled, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-4.5 microns wide, and 4-6 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric rounded, 4-5.5 microns wide, and 4-6.5 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show motility.

Bibliographic reference on the strain or its environment: Garcia J, Raimbault M, Jacq V, Rinaudo G, Roger PA (1974).

Strain Ns 62 Ms

This strain, identified as *Nostoc* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Teroi, Kedah, Malaysia, in 1983. The soil sample was provided by W. Ventura (IIRRI).

Soil properties: available

Visual description:

- A 75-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has dull luster, is opaque and dark brownish green. The medium is not colored.

- A 40-day-old culture in liquid medium forms an incohesive mat, growing in or at the surface of the medium and partly attached at the bottom of the flask. The mat has small, finger-like projections. The culture is dark brownish green. A 55-day-old culture shows similar features; when shaken, the culture becomes aggregative sedimentary.

Microscopic observation (75-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate and show no tapering. They are both single, contorted and straight in bundles. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3.5-4.5 microns wide, and 5-6 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 4-5 microns wide, and 5-7 microns long. Free, smooth spores are observed. They are long rounded, 5.5-6.5 microns wide, and 7-8 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 63 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Richard Toll, Senegal, in 1974.

Soil properties: available

Visual description:

- A 25-day-old culture on solid medium shows generalized spreading growth, coiled in aspect, located on the agar surface. It has glossy luster, is opaque and medium brownish green. The medium is not colored.
- A 41-day-old culture in liquid medium forms an incohesive mat with small, finger-like projections, growing in or at the surface of the medium. The culture is dark brownish green. The medium is not colored.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 6 microns wide, and 6-8 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal, 5-6 microns wide, and 6-7 microns long. Free spores in chains are observed. They are long ellipsoidal, 5 microns wide, and 8-12 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Roger PA, Reynaud PA (1976).

Strain Ns 64 SL

This strain, identified as *Nostoc* sp., was added to the collection in 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 55-day-old culture in liquid medium forms a cohesive mat with few small, finger-like projections, growing in or at the surface of the medium. The culture is dark brownish green. The medium is not colored.
- A 22-day-old culture on solid medium shows generalized spreading growth, coiled in aspect, located on the agar surface. It has intermediate luster, is opaque and medium brownish green. The medium is not colored.

Microscopic observation of a 29-day-old culture grown in liquid medium:

- Trichomes have no ramifications. They are uniseriate, single, contorted, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are short barrel-shaped, 1.5-2 microns wide, and 2-4 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are from isometric to long ellipsoidal, 2 microns wide, and 2-3.5 microns long. Spores are mostly intercalary, in chains, and ornamented. They are long ellipsoidal, 2 microns wide, and 3.5 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show motility.

Strain Ns 65 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is opaque and medium brownish green. The medium is not colored.
- A 22-day-old culture in liquid medium forms an incohesive mat with small, finger-like projections, growing in or at the surface of the medium. The culture is dark brownish green. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, helical, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Most filaments are 50-300 microns long. Vegetative cells are from isometric to long barrel-shaped, 4 microns wide, and 3-6 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. Intercalary heterocysts are rounded to barrel-shaped, 4-5 microns wide, and 4-6.5 microns long. Terminal heterocysts are long ellipsoidal, 4-5 microns wide, and 4.5-7 microns long. No spores were observed. Hormogonia are angular and thinner than the filaments. They have no heterocysts and show motility.

Strain Ns 66 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 29-day-old culture on solid medium shows generalized spreading growth coiled in aspect. It has glossy luster, is opaque and medium brownish green. The medium is not colored.
- A 48-day-old culture in liquid medium forms a cohesive mat growing in or at the surface of the medium. It is dark brownish green. The medium is not colored. Surface growth is darker than below-surface growth. Small, finger-like projections are observed at the lower part of the mat.

Microscopic observation (29-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 3.5 microns wide, and 3.5-5 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. They are long ellipsoidal,

5 microns wide, and 7 microns long. Spores, free and in chains, are observed. They are isometric rounded, 2 microns wide, and 2-3 microns long. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Strain Ns 67 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Fanaye, Senegal, in 1975.

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, located on the agar surface. It has glossy luster, is opaque and medium yellowish green. The medium is not colored.
- A 48-day-old culture in liquid medium forms a medium-yellowish-green cohesive mat growing addressed at the bottom of the flask. The culture has finger-like projections. The medium is not colored.

Microscopic observation (34-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, entangled, and show no tapering. No sheath is observed. Motility (oscillation) of the trichomes is observed. Vegetative cells are isometric barrel-shaped, 3.5 microns wide, and 3.5-4 microns long. Most apical cells are pointed. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 3.5 microns wide, and 5 microns long. Free spores in chains are observed. They are isometric rounded, 3.5-6 microns wide, and 5-6 microns long. Hormogonia are angular with pointed apical cells and thinner than the filaments. They have no heterocysts and show motility.

Strain Ns 68 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, coiled in aspect, located on the agar surface. It has glossy luster, is opaque and dark brownish green. The medium is not colored.
- A 22-day-old culture in liquid medium forms a cohesive mat with small, finger-like projections, growing in or at the surface of the medium. The culture is dark brownish green. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are from isometric to long barrel-shaped, 2.5-3.5 microns wide, and 3.5-7 microns long. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are long ellipsoidal, 3.5-4 microns wide, and 6-7.5 microns long. Intercalary heterocysts are rounded to ellipsoidal, 4.5-5 microns wide, and 5-7 microns long. No spores were observed. Hormogonia are angular with pointed apical cells and thinner than the filaments. They have no heterocysts and show no motility.

Notes:

Becomes contorted with age.

Strain Ns 69 Sn

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Reynaud (ORSTOM) from a saline sandy soil collected from Retba, Senegal.

Visual description:

- A 21-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has intermediate luster, is opaque and dark brownish green. The medium is not colored.
- A 55-day-old culture in liquid medium forms an incohesive mat with small, finger-like projections, growing in or at the surface of the medium. The culture is dark brownish green. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, helical, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Most filaments are 50-300 microns long. Vegetative cells are long barrel-shaped, 4.5-5 microns wide, and 4-6 microns long. Most apical cells are rounded. Heterocysts are single and both intercalary and terminal. Intercalary heterocysts are rounded to ellipsoidal, 4.5-5 microns wide, and 5-6 microns long. Terminal heterocysts are truncated ellipsoidal, 3.5-4 microns wide, and 4.5-8 microns long. No spores were observed. Hormogonia are angular with pointed apical cells and thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Reynaud and Roger (1981) , Reynaud and Roger (1981).

Strain Ns 70 MI

This strain, identified as *Nostoc* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from ENS, Bamako, Mali, in 1976.

Soil properties: available

Visual description:

- A 27-day-old culture in liquid medium shows medium-yellowish-green homogeneous growth. The medium is not colored.
- A 21-day-old culture on solid medium shows cohesive growth with rough margin. It has dull luster, is opaque and dark yellowish green. The medium is yellowish.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are isometric barrel-shaped, 6-6.5 microns wide, and 6-6.5 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric rounded, 8-8.5 microns wide, and 8-8.5 microns long. No spores were observed. Two hormogonia-like chains of cells are thinner than the filaments. They have no heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Traore TM, Roger PA, Reynaud PA, Sasson A (1978).

Strain Ns 71 Ph

This strain, identified as *Nostoc* sp., was added to the collection in 1980. It originates from Philippines. It was isolated by M. Martinez (UPLB, Philippines).

Visual description:

- A 34-day-old culture in liquid medium shows medium-green flocculent growth. The medium is not colored.
- A 21-day-old culture on solid medium shows colonial growth. Most colonies are smaller than 0.5 mm, rounded viewed from the top and high convex from the side. The margin is smooth. The culture has glossy luster, is opaque and medium green. The medium is not colored.

Microscopic observation (21-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped, 4-5 microns wide, and 4-6 microns long. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are long ellipsoidal, 5-6 microns wide, and 7-8 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Notes:

Hormogonia which are angular and thinner than the filaments are observed in a 36-day-old culture in liquid medium. This strain, given to IRRI as *Anabaena variabilis* var. *sphaerica*, was reclassified as *Nostoc*.

OSCILLATORIA

Strain Os 01 Sn

This strain, identified as *Oscillatoria* sp. PCC 7515, came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from an upland sandy soil collected from Bambey, Senegal, in 1972.

Soil properties: upland sandy soil (Dior).

Visual description:

- A 22-day-old culture in liquid medium forms an incohesive mat growing in or at the surface of the medium. The culture is dark green. The medium is not colored.

Bibliographic reference on the strain or its environment: Ganry F, Roger PA, Dommergues Y (1978).

Strain Os 02 Sn

This strain, identified as *Oscillatoria* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Reynaud (ORSTOM) from a ricefield soil collected from Riniao, Senegal, in 1985.

Visual description:

- A 22-day-old culture in liquid medium forms a cohesive mat, which looks like a deflated balloon, growing in and at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

Strain Os 03 Sw

This strain, identified as *Oscillatoria* sp. PCC 7515, was added to the collection in 1983. It originates from Sweden. It was isolated by R. Rippka of the Pasteur Institute, France.

Visual description:

- A 22-day-old culture in liquid medium forms an incohesive hairy mat, with visible thread-like structures, growing both at the surface of the medium and adpressed at the bottom of the flask. When shaken, the filaments aggregate and become ball-like. The culture is medium yellowish brown. The medium is not colored.

Bibliographic reference on the strain or its environment: Rippka et al. 1979.

Strain Os 04 Sn

This strain, identified as *Oscillatoria* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture in liquid medium forms a cohesive mat with thread-like structures, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

PSEUDOANABAENA

Strain Ps 01 Sn

This strain, identified as *Pseudanabaena* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 33-day-old culture in liquid medium shows dark-brownish-green homogeneous growth. The medium is bluish.

Microscopic observation (33-day-old culture in liquid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show no tapering. No sheath is observed. Motility of the trichomes is not observed. Vegetative cells are long angular, 1.5-2 microns wide, and 1.5-3 microns long. Most apical cells are rounded. Spores and hormogonia were not observed.

SCYTONEMA

Strain Sc 01 SL

This strain, identified as *Scytonema* sp., was added to the collection in 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasoorya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are filamentous, radial viewed from the top and burrowing from the side. They are from 4 to 6 mm in size. The culture has intermediate luster, is opaque and dark green. The medium is not colored.

- A 22-day-old culture in liquid medium forms penicillate colonies, 2-3 mm in size, growing both at the surface of the medium and addressed at the bottom of the flask. The culture is medium green. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, wavy, and show no tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. The width of the trichomes ranges from 5 to 6 microns. Vegetative cells are vacuolated, isometric to long angular, 4.5-5.5 microns wide, and 4-6 microns long. Division by septa is difficult to observe. Most apical cells are rounded. The sheath extends beyond the apical cell. Heterocysts are mostly intercalary and single. They are from isometric to long angular, 5.5-6 microns wide, and 5.5-7 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have no heterocysts and show no motility.

Strain Sc 02 SL

This strain, identified as *Scytonema* sp., was added to the collection in 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasoorya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are filamentous, skewed viewed from the top and burrowing from the side. They are from 2 to 4 mm in size. The culture has intermediate luster, is opaque and light green. The medium is not colored.

- A 22-day-old culture in liquid medium forms penicillate colonies, 2-4 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, wavy, and show no tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Vegetative cells are vacuolated, short angular, 10-11 microns wide, and 5-7.5 microns long. Division by septa is difficult to observe. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are isometric to long barrel-shaped, 5.5-6 microns wide, and 5.5-7 microns long. Spores and hormogonia were not observed.

Strain Sc 03 Eg

This strain, identified as *Scytonema* sp., was added to the collection in 1987. It was isolated by P.A. Roger (ORSTOM) from a ricefield located in the Nile delta, Egypt, in 1987.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are filamentous, skewed viewed from the top and burrowing from the side. They are from 2 to 4 mm in size. The culture has intermediate luster, is opaque and medium brownish green. The medium is not colored.

- A 22-day-old culture in liquid medium forms a light-green cohesive mat growing in or at the surface of the medium. The medium is not colored.

Microscopic observation (23-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, wavy, and show no tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. The width of the trichomes ranges from 6.5 to 7.5 microns. Vegetative cells are isometric to long angular, 5.5-7 microns wide, and 6-10 microns long. Division by septa is difficult to observe. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are very long barrel-shaped, 8.5-9.5 microns wide, and 12-23.5 microns long. Spores and hormogonia were not observed.

Notes: Vegetative cells become contorted, even coiled, in some places.

Strain Sc 04 Sn

This strain, identified as *Scytonema* sp., came from the ORSTOM collection and was added to the IRRI collection in 1985. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Riniao, Senegal, in 1975.

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are filamentous, skewed viewed from the top and burrowing from the side. They are from 1 to 2 mm in size. The culture has dull luster, is opaque and medium green. The medium is yellowish.
- A 22-day-old culture in liquid medium forms penicillate colonies, 0.5-1 mm in size, growing both at the surface of the medium and adpressed at the bottom of the flask. The culture is medium yellowish green. The medium is yellowish.

Microscopic observation (23-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, wavy, and show no tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. The width of the trichomes ranges from 9 to 11 microns. Vegetative cells are short angular, 8.5-10.5 microns wide, and 5-7 microns long. Division by septa is difficult to observe or absent. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are from long to very long barrel-shaped, 9.5-12 microns wide and 7-32 microns long. Spores and hormogonia were not observed.

Strain Sc 05 Ph

This strain, identified as *Scytonema* sp., was added to the collection in 1982. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from IRRI, Philippines, in 1982.

Soil properties: available (IRRI farm, upper MN).

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are filamentous, skewed viewed from the top and burrowing from the side. They are from 2 to 5 mm in size. The culture has intermediate luster, is opaque and medium yellowish green. The medium is not colored.
- A 22-day-old culture in liquid medium forms penicillate colonies, 1-10 mm in size, growing in or at the surface of the medium. The culture is medium yellowish green. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, entangled, highly vacuolated, and show no tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. The width of the trichomes is about 5.5 microns. Vegetative cells are from long to very long angular, 4.5-5 microns wide, and 5.5-15 microns long. Division by septa is difficult to observe or absent. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are barrel-shaped to angular, 5-5.5 microns wide, and 5-20.5 microns long. Spores and hormogonia were not observed.

Strain Sc 06 Th

This strain, identified as *Scytonema* sp., was added to the collection in 1989. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from the Sampatong Research Station, Thailand, in 1989.

Soil properties: available (Sapatong res. station).

Visual description:

- A 22-day-old culture on solid medium shows colonial growth. Colonies are filamentous, skewed viewed from the top and burrowing from the side. They are from 2 to 5 mm in size. The culture has intermediate luster, is opaque and dark bluish green. The medium is not colored.
- A 22-day-old culture in liquid medium forms an incohesive fluffy mat growing in or at the surface of the medium. It is dark yellowish green. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, entangled, and show no tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. The width of the trichomes ranges from 6.5 to 7.5 microns. Vegetative cells are isometric to very long angular, 6-7 microns wide, and 6.5-18 microns long. Division by septa is difficult to observe. Most apical cells are rounded. Heterocysts are mostly intercalary and single. They are from long to very long barrel-shaped, 7.5-11.5 microns wide, and 11.5-30 microns long. Spores and hormogonia were not observed.

Strain Sc 07 SL

This strain, identified as *Scytonema* sp., was added to the collection in 1986. It originates from Sri Lanka. It was isolated by S.A. Kulasooriya of the University of Peradeniya, Sri Lanka.

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, skewed, fibrous in aspect, and burrowing into the agar. It has intermediate luster, is translucent and light green. The medium is not colored.
- A 22-day-old culture in liquid medium shows medium-yellowish-green flocculent growth. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, wavy, and show no tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. The width of the trichomes ranges from 7 to 9 microns. Vegetative cells are short angular, 6.5-7.5 microns wide, and 4.5-9 microns long. Division by septa is difficult to observe in most trichomes. Most apical cells are rounded. Heterocysts are intercalary

and single. They are from short ellipsoidal to very long barrel-shaped, 3.5-7 microns wide, and 7-28 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility. Notes: Upon ageing, some filaments become helical and contorted. Highly vacuolated filaments were observed.

Strain Sc 08 Mr

This strain, identified as *Scytonema* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Manjakandriana, Madagascar, in 1986. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Soil properties: available

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, fibrous in aspect, burrowing into the agar. It has dull luster, is opaque and light green. The medium is not colored.
- A 22-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Microscopic observation (24-day-old culture on solid medium):

- False, Y-shaped, and geminate ramifications are present. Trichomes are uniseriate, single, entangled, and show slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. The width of the trichomes ranges from 8 to 10 microns. Vegetative cells are angular, 7-9.5 microns wide, and have variable length. Division by septa is difficult to observe. Most apical cells are rounded. Heterocysts are intercalary and single. They are variable in shape and size. No spores were observed. Hormogonia are thinner than the filaments. They have no heterocysts and show no motility.

Notes: Vegetative cells become vacuolated and are not divided by septa as they mature.

Strain Sc 09 Mr

This strain, identified as *Scytonema* sp., was added to the collection in 1986. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Manjakandriana, Madagascar, in 1986. The soil sample was provided by R. Rabeson (FOFIFA, Madagascar).

Soil properties: available

Visual description:

- A 22-day-old culture on solid medium shows generalized spreading growth, ropey in aspect, located on the agar surface. It has dull luster, is opaque and medium green. The medium is not colored.
- A 34-day-old culture in liquid medium forms a cohesive mat growing adpressed at the bottom of the flask. It is medium yellowish green. The medium is not colored.

Microscopic observation (22-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, has slight tapering, and show no polarity. No sheath was observed. Motility of the trichomes is not observed. Vegetative cells are long barrel-shaped. Most apical cells are rounded. Abnormal, bottle-shaped heterocysts were observed. Heterocysts are single and both intercalary and terminal. Intercalary heterocysts are variable in shape and size. They are mostly rounded and can be very long. Terminal heterocysts are rounded. No spores were observed. Hormogonia are thinner than the trichomes. They have no heterocysts and show motility.

Notes:

False, geminate ramifications are observed in a 34-day-old liquid culture.

SYNECHOCOCCUS

Strain Sy 01 Sn

This strain, identified as *Synechococcus aquatilis*, came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture in liquid medium has an aggregative sedimentary type of growth. It is medium yellowish green. The medium is not colored.

Strain Sy 02 Sn

This strain, identified as *Synechococcus* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description:

- A 22-day-old culture in liquid medium shows granular growth at the bottom of the flask. It is dark green. The medium is not colored.

Strain Sy 03 Sn

This strain, identified as *Synechococcus* sp., came from the ORSTOM collection and was added to the IRRRI collection in 1985. It originates from Senegal. It was isolated by P.A. Reynaud (ORSTOM).

Visual description: A 22-day-old culture in liquid medium has an aggregative sedimentary type of growth partly adpressed at the bottom of the flask. The culture is dark green. The medium is not colored.

TOLYPOTHRIX

Strain Tx 01 As

This strain, identified as *Tolypothrix* sp., was added to the collection in 1988. It was isolated by P.A. Roger (ORSTOM) from a solonetz collected from Neusiedlersee, Austria, in 1988. The soil sample (IV) was provided by S. Zechmeister-Boltenstern (Wien Univ.).

Soil properties: Solonetz. The surface soil is sandy loam with medium humus content.

Visual description:

- A 21-day-old culture on solid medium shows localized spreading growth, diffuse in aspect, burrowing into the agar. It has dull luster, is opaque and medium green. The medium is not colored.
- A 22-day-old culture in liquid medium forms both penicillate colonies growing in the medium and a thin patchy mat growing addressed at the bottom of the flask. The culture is medium green. The medium is not colored.

Microscopic observation (28-day-old culture on solid medium):

- False, Y-shaped ramifications are present. Trichomes are uniseriate, single, wavy, and show polarity and marked tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are from 50-150 microns long. The width of the trichomes is 9.5 microns at the apex, 6-6.5 microns at the middle, and 5-6 microns at the distal portions. Abnormal, distended cells are observed at the apex. Vegetative cells are vacuolated and variable in shape and size. Division by septa is difficult to observe. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are variable in shape and size - rounded to ellipsoidal. No spores were observed. Hormogonia are thinner than the filaments. They have intercalary heterocysts and show no motility.

Bibliographic reference on the strain or its environment: Wollenweber B. and Zechmeister-Boltenstern S. (1989).

Strain Tx 02 Jp

This strain, identified as *Tolypothrix tenuis*, was added to the collection in 1978. It originates from Japan. It was isolated by A. Watanabe.

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, ropey in aspect, burrowing into the agar. It has dull luster, is opaque, and dark brown. The medium is not colored.
- A 22-day-old culture in liquid medium forms an incohesive mat growing in or at the surface of the medium, and a cohesive mat growing addressed at the bottom of the flask. The culture is dark yellowish brown. The medium is not colored.

Microscopic observation (26-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are from 50-850 microns long. The width of the trichomes ranges from 7-7.5 microns at the apex, 6.5 microns at the middle, and 6 microns at the distal portions. Vegetative cells are angular with variable sizes. Most apical cells are pointed. Heterocysts are mostly terminal and single. They are usually rounded, 5-8 microns wide, and 5-7.5 microns long. No spores were observed. Hormogonia are thinner than the filaments. They have terminal heterocysts and show no motility.

Strain Tx 03 Ms

This strain, identified as *Tolypothrix* sp., was added to the collection in 1983. It was isolated by P.A. Roger (ORSTOM) from a ricefield soil collected from Serbarang Perai, Penang, Malaysia, in 1983. Soil sample was provided by W. Ventura (IRRI).

Soil properties: available

Visual description:

- A 22-day-old culture on solid medium shows localized spreading growth, ropey in aspect, located on the agar surface. It has dull luster, is opaque and dark brown. The medium is not colored.
- A 22-day-old culture in liquid medium forms a cohesive mat, growing both at the surface of the medium and addressed at the bottom of the flask. The culture is medium yellowish brown. The medium is not colored.

Microscopic observation (26-day-old culture on solid medium):

- Trichomes have no ramifications. They are uniseriate, single, wavy, and show polarity and slight tapering. A thin, hyaline, homogeneous sheath is present. Motility of the trichomes is not observed. Most trichomes are from 50-350 microns long. The width of the trichomes is 6.5 microns at the apex, 6 microns at the middle, and 5 microns at the distal portions. Vegetative cells are variable in shape and size. Their shape ranges from isometric to short angular near the apex, becoming barrel-shaped towards the distal portions. Most apical cells are rounded. Heterocysts are mostly terminal and single. They are rounded, 5.5-6 microns wide, and 4-5.5 microns long. No spores were observed. Hormogonia have the same width as the filaments. They have terminal heterocysts and show no motility.

7. METHODS FOR SENDING THE STRAINS AND REVIVING THEM

For mailing we use material dried on small paper strips. This method is valid only for short time conservation (maximum of one year) but very convenient for mailing. For special requests, we can send agar slants.

To preserve the strains on paper, 1-month-old cultures produced in 125-ml erlenmeyer flasks are decanted and deposited on 1 x 5 cm strips of sterile Whatman chromatography paper n°3. Paper strips with the BGA culture are dried in a sterile hood at room temperature and then placed in envelopes to avoid contamination. To regrow the strains, about 1 cm of the paper is placed in a 50 ml erlenmeyer with 1 cm of BG-11₀ medium. After one day in the laboratory without direct illumination, the flask is placed under continuous fluorescent light (about 600 lux). As soon as algal growth is visible, the paper material should be removed.

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9. APPENDICES

9.1. Culture media

- Stock solutions for medium BG -11 and BG-11₀ for BGA (Stanier et al. 1971)

Stock solutions (g l ⁻¹) (concentrated 200 times)		Solution of oligoelements (g l ⁻¹) (concentrated 1000 times)	
1. NaNO ₃	300.0	H ₃ Bo ₃	2.86
2. K ₂ HPO ₄	8.0	MnCl ₂ .4H ₂ O	1.81
3. MgSO ₄ .7H ₂ O	15.0	NaMoO ₄ .2H ₂ O	0.39
4. CaCl ₂ .2H ₂ O	7.2	CuSO ₄ .5H ₂ O	0.079
5. NH ₄ citrate Fe(III)	1.2	Co(NO ₃) ₂ .6H ₂ O	0.0494
+ citric acid	1.2		
6. Na ₂ EDTA.2H ₂ O	0.2		
7. Na ₂ CO ₃	4.0		

- BG-11 medium for non-N₂-fixing BGA (non-selective)

Liquid medium: 5 ml of solutions 1-7 and 1 ml of oligoelements solution are diluted to 1 liter. The medium is autoclaved for 15 min at 120 °C.

Solid medium for Petri plates and agar slants
1% Bacto agar is added.

Liquid medium for mass culture of BGA (Na₂CO₃ x 5) :

The medium is prepared by using 5 ml/l of solutions 1-6, 25 ml/l of solution 7 and 1 ml/l of the oligoelements solution. The medium is prepared in 4-liter flasks and transferred after sterilization into 20-l reagent bottles. The reagent bottles are sterilized in a hot-air oven at 160 °C for 2 hours. The medium is bubbled with CO₂ enriched air until clear (pH 7-7.4), before inoculating BGA.

- BG-11₀ media for N₂-fixing BGA : Solution 1 is omitted.

9.2. Mass culture for inoculum production

We have designed a simplified and low-cost set-up for scaling up unialgal cultures (Fig.4). Strains are grown in 12-liter flasks in BG-11 or BG-11₀ medium with Na₂CO₃ concentration increased five-fold and continuous bubbling with air enriched with CO₂ through a glass tube connected to a cotton wool air filter (1 in Fig. 1). The pH of the medium in equilibrium with air is about 9. By bubbling air enriched with 0.5% CO₂, pH is buffered at about 7. Air is provided by a membrane pump (2). In order to avoid the pump to work at a high pressure, air flow is regulated by opening an adjustable clamp or a tap (3) attached to a flask filled with cotton wool (4) inserted after the air pump to filter air and to reduce vibrations in the air, which would render readings on the flowmeter (5) imprecise. CO₂ (industrial grade) is provided from a cylinder (6) with a conventional regulator (7). Bubbling rate of air enriched with CO₂ in the culture flasks is usually less than 1 liter min⁻¹, which corresponds to a CO₂ flow rate less than 30 ml min⁻¹ for a set up of six flasks. As valves permitting such a very low flow rate are expensive, we found more convenient to use a capillary tube (8) to regulate CO₂ flow from the regulator. The capillary tube is obtained by melting the extremity of a glass tube in a bunsen burner (8 bis). To obtain adequate capillaries we prepare a large number of them and sort and calibrate them under a constant pressure of CO₂. Then, it is easy to adjust CO₂ flow rate by adjusting the pressure of the second stage of the regulator(7). CO₂ flow rate is monitored by a double bubbler (9) and/or a flowmeter (10)(optional). The use of a double bubbler after the capillary tube is needed to avoid water to enter the regulator in case of malfunction. A constant gas pressure is maintained in the whole set up by a water regulator (11) in which water height is about 10 cm higher than the level of medium in the culture flasks. The rate of air in individual flasks can be adjusted with a tap of the distribution ramp (12). Constant agitation of the medium is ensured by magnetic stirrers (13). Light is provided by four 30 w fluorescent tubes per flask (14).

The pH of the medium (15) is monitored from a cell (16) filled with culture medium in which air enriched with CO₂ is bubbled. At the beginning of the operation, in order to permit faster adjustment of relative air and CO₂ flows, the pH meter is connected to one of the outlets of the distribution ramp. When cultures are grown, the pH meter is then connected to the gas exit of one of the flask cultures which allows to verify if gas flow rate is sufficient. Deficiency in CO₂ is corrected by increasing total air-CO₂ flow using the taps of the distribution ramp and not by increasing CO₂ rate in air. The main advantage of this design is that no electrode is inserted into the culture flasks. Once the right adjustment of air flow rate and the adequate CO₂ manometer pressure and capillary tube have been found, it is advisable not to change it anymore. If further adjustments are needed during the culture, they should be made by small changes of air flow while waiting for at least one hour between each adjustment. It is also important to realize that for the purpose of scaling up unialgal cultures, pH of the culture may vary by a few tenths of units without any detrimental effects.

When starting a new culture, after the medium has been sterilized, flocculation is observed. The medium is then bubbled overnight to equilibrate the pH. At equilibrium, the medium becomes clear and free of any flocculence. As pointed out by Rippka et al., it is a safe rule that the volume of a liquid culture be augmented by 10- to 40-fold at each successive transfer. Therefore, a 12-liter flask should be inoculated with 250-1000 ml of dense culture. To avoid bleaching of the inoculum by photooxidation, fluorescent lights are only turned on the second day after inoculation and its intensity gradually increased during BGA growth by increasing the number of fluorescent tubes turned on. One day before harvest, magnetic stirrers are turned off to allow decantation of the culture and facilitate collection.

Productivity of BGA in this set up is about 30 g fresh weight l⁻¹ within 3-4 weeks.

Figure 4. Set up for mass culture of unialgal strains of BGA

9.3. Information on sites of origin of the strains

AUSTRIA SAMPLES

	Soil I	Soil II	Soil III	Soil IV
Sand (%)	5	36	82	55
Silt (%)	79	41	12	34
loam (%)	16	23	6	11
sorption capacity	medium	medium	medium	low
pH in CaCl ₂	8.0	9.3	7.8	8.1
Carbonate content (%)	44	27	6.7	1.4
total C (%)	9.7	4.9	3.3	1.9
total N (%)	0.5	0.1	0.0	0.1
C/N	20	76	96	16
P ₂ O ₅ (mg/100g)	5	4	5	2
K ₂ O (mg/100g)	65	45	12	5
Exchangeable Ca (mmol/100g)	6.18	13.50	3.33	3.83
Exchangeable Mg (mmol/100g)	6.10	3.72	2.02	1.13
Exchangeable K (mmol/100g)	3.00	2.00	0.33	0.12
Exchangeable Na (mmol/100g)	23.00	28.00	0.57	5.10

BAMAKO, MALI

Bamako soil (experimental plot at ENS)

Texture:

clay, 22.5%; fine silt, 17.6%; coarse silt, 8.2%; fine sand, 17.4%; coarse sand, 23.6%.

pH: (water/soil w/w =1.5) 6.8 after submersion; 8.0 at the end of the crop cycle.

Organic C 4.7%, Organic N 0.23%, C/N 20.5.

Organic matter 0.8%

Available P

Exchangeable bases (meq/100g): Ca 13.6, Mg 4.2, K 1.0, Na 0.7.

BAMBEY, SENEGAL

IRAT experimental station

Upland sandy soil (Dior) extremely poor in organic matter.

Usually planted to millet or groundnut

pH water (1/2.5): 5.5;

Granulometry: coarse sand 20%, fine sand 75%, silt and clay 4.5%;

Total C 0.28%; Total N 0.019%; C/N 14.7,

Ca⁺⁺ (meq/100g): 0.7

Mg⁺⁺ (meq/100g): 0.2

Na⁺⁺ (meq/100g): 0.04

K⁺⁺ (meq/100g): 0.05

Sum exchangeable bases (meq/100g): 0.99

T: 1.8

BANAWE (SITES DESCRIPTION)

Samples were taken from three fields in each of four localities :

1 : **Lawig** (municipality of Lamut) is located in the foothills of the Cordillera at about 300 m elevation. Two rice crops are grown per year, using 60 kg N/ha. Lamut does not belong to the rice terraces, and was selected for comparison with other localities where no chemical fertilizer is used and only one rice crop is grown per year.

2 : **Palao** (municipality of Kiangan) is on the top of a terraced, southeast oriented slope, at about 800 m elevation. Straw and weeds are composted and incorporated into the soil.

3: **Pitan** (municipality of Banawe) is southwest oriented, at about 1100 m elevation. No compost is applied. The aquatic biomass growing during the fallow period is incorporated before transplanting.

4: **Apalnga'oh** (municipality of Banawe) is on the eastern slope of a narrow valley. It is the upper limit of the wetland growing area. One crop is grown per year. Fertilization is the same as in Pitan.

BANAWE ,SOIL PROPERTIES

Location	Elevation (m)	pH	C (%)	N (%)	C/N	P ppm	CEC meq/100 g
Apainga'oh 1	1500	5.0	1.68	0.14	12.0	4.8	30
Apainga'oh 2	1500	4.9	1.26	0.15	8.4	5.7	27
Apainga'oh 3	1500	5.1	1.70	0.16	10.6	5.4	28
average	1500	5.0	1.55	0.15	10.3	5.3	28
Pitan 1	1100	5.3	2.19	0.23	9.6	8.4	34
Pitan 2	1100	5.3	1.78	0.17	10.1	5.7	36
Pitan 3	1100	5.0	2.02	0.20	9.9	8.8	34
average	1100	5.2	2.00	0.20	9.9	7.6	35
Palao 1	800	6.5	1.88	0.19	9.7	12.5	51
Palao 2	800	6.6	1.86	0.21	9.0	10.5	53
Palao 3	800	6.2	1.82	0.19	9.8	16.5	50
average	800	6.4	1.85	0.20	9.5	13.2	51
Lawig 1	300	6.4	1.52	0.16	9.7	18.5	53
Lawig 2	300	6.8	1.44	0.15	9.5	13.5	54
Lawig 3	300	6.5	1.55	0.17	9.1	15.0	56
average	300	6.5	1.51	0.16	9.4	17.5	55

CALAUAN, PHILIPPINES

Soil properties:

pH (H₂O): 5.3, organic C: 19.2%, total N: 2.60%, CEC (meq/100 g): 71.7, available P (Olsen): 4.6 ppm.

DJIBELOR (12), SENEGAL

Soil properties:

13% clay, 25% silt, 56% sand, 1.18% C, 0.08%N, C/N 14, pH 4.8 after rehumectation, 6.3 after 4 weeks of submersion.

EGYPT

Range of soil properties in soils studied in the Nile delta (F.M.A. Ghazal, Ph.D. 1987): pH 7.6-8.1, C 1.04-2.60%, N 0.09-0.23%, C/N 10-13, CEC (meq/100 g) 35-49, Olsen P 5-51 ppm.

IRRI FARM, UPPER MN

Soil properties: pH (H₂O): 6.8, organic C: 1.26%, total N: 0.13%, CEC (meq/100 g): 34.7, available P(Olsen): 12.0 ppm.

LOUISIANA, PHILIPPINES: Chemical and algological characteristics

<u>Chemical properties</u>		<u>Algal flora (0-1cm soil layer)</u>	
pH (water)	5.7	Total (CFU/cm ²)	1.3 x 10 ⁵
Organic C (%)	1.42	BGA (CFU/cm ²)	2.2 x 10 ⁴
Total N (%)	0.156	N ² -fixing BGA (CFU/cm ²)	1.6 x 10 ⁴
CEC (meq/100g)	27.70	<i>Nostoc</i> spp.	94 %
Na	2.47	<i>Calothrix</i> spp.	5 %
K	0.75	Others	< 1 %
Mg	6.36		
Ca	11.60		
Avail. P (ppm)	5.8		

MADAGASCAR SAMPLES

Pedological information provided by R. Rabeson pedologie, FOFIFA BP 1444 Antananarivo 101, Madagascar. Analysis, performed by IRRRI's ASL are for the 0-20 cm horizon).

RLM : Mahitsi experimental station. Humic gleyic soil developed on alluvial soil. International long-term fertility on rice. pH: 5.6; C: 3.18 %; N: 0.364 %; CEC meq/100g: 11.3; Olsen P: 10 ppm; Bray P: 56 ppm.

RLB : Betafo. Farmer field. International long-term fertility on rice. Hydromorphic gley on an old volcanic soil. pH: 5.7 ; C: 2.46 %; N: 0.254 %; CEC: 18.6 meq/100g; Olsen P: 8.3 ppm. Bray P: 10 ppm.

BLN : Belanitra experimental station. Mineral hydromorphic gley soil developed on alluvial soil. pH: 5.4; C: 1.85 %; N: 0.177 %; CEC: 9.86 meq/100g; Olsen P: 3.1 ppm. Bray P: 9.3 ppm.

MJD : Manjakandriana. Humic gleyic soil with peat in the subsoil. pH: 4.9 ; C: 3.31 %; N: 0.395 %; CEC: 10.2 meq/100g; Olsen P: 5.3 ppm; Bray P: 6.4 ppm.

MALAYSIA SAMPLES

Simpai Lima : Acidic problem soil. Rice at tillering. pH: 4.3; C: 5.86 %; N: 0.461 %; CEC 29.8 meq/100g; Olsen P: 18 ppm.

Tikang Bato : Newly plowed field. Snails were abundant. pH: 4.3; C: 3.46 %; N: 0.337 %; CEC 23.1 meq/100g; Olsen P: 18 ppm.

Bumbong Lima : Flooded field just before transplanting, largely covered with Azolla. pH: 5.5; C: 2.24 %; N: 0.223 %; CEC 6.0 meq/100g; Olsen P: 7.9 ppm.

Kuala Kurau : Experimental field. Rice at heading stage. Composite sample from plots with various N fertilizer levels. pH: 5.1; C: 2.66 %; N: 0.274 %; CEC 28.1 meq/100g; Olsen P: 4 ppm.

Teroi : flooded soil with rice at maximum tillering. pH: 4.6; C: 2.32 %; N: 0.200 %; CEC 21.4 meq/100g; Olsen P: 8.6 ppm.

Serberang Perai : Flooded ricefield, just after harvest. pH: 4.6; C: 2.45 %; N: 0.240 %; CEC 18.6 meq/100g; Olsen P: 12 ppm.

RICHARD TOLL, SENEGAL

Soil properties: 54% clay, 27% silt, 19% sand, pH: 4.9 at rewetting and 6.6 after 4 weeks of submersion, C: 0.94% , N: 0.077% , C/N: 12.2 , avail P: 0.025% P₂O₅

SAMPATONG RESEARCH STATION, THAILAND

Analysis of Ap horizon (0-12 cm): 43% sand, 27% silt, 30% clay, pH (H₂O): 6.1, C: 1.31%, N: 0.11%, C/N: 12, exchangeable cation (meq/100 g): Ca 10.6, Mg 1.6, K 0.1, Na 0.4, CEC 14, avail P (Bray): 8.5 ppm.

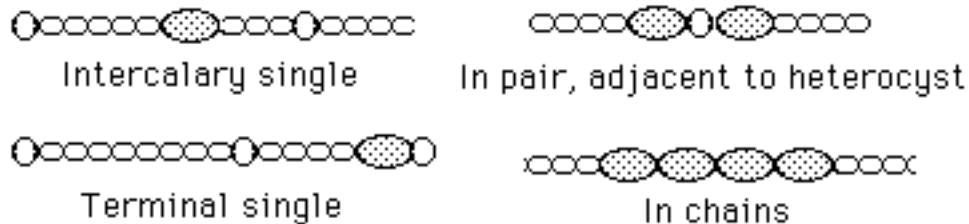
9.4. GLOSSARY

AGGREGATION (types of and description):

- Diffuse: absence of discernable structures in the mat. Growth spreads out as a delicate cottony patch on and/or under agar surface; e.g. some LPP strains with thin trichomes.
- Fibrous: felt-like mat; e.g. *Calothrix* and some LPP with thick trichomes.
- Ropy: having clearly discernable wavy structures resulting from the formation of bundles; e.g. many *Anabaena*
- Coiled: having circular bundles; e.g. some *Anabaena*

AKINETE:

A thick-walled, nonmotile, reproductive spore derived from a vegetative cell in which food has been concentrated.

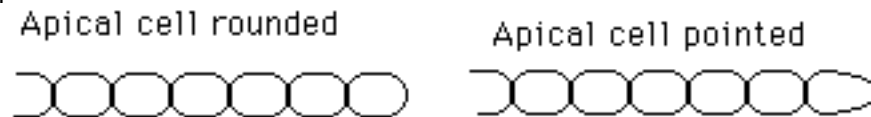


APICAL:

At the anterior end (apex); apical growth is growth at the apex of a trichome.

Growth of the trichome can be either intercalary or apical, depending on the genus.

The shape of the apical cell is sometimes used as a taxonomic character for BGA.



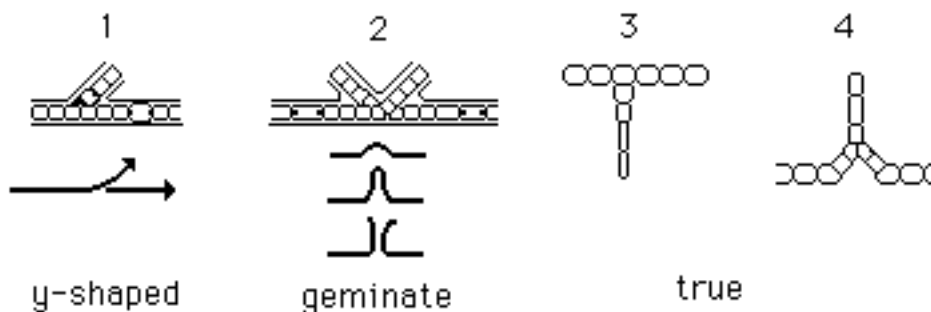
AXENIC:

A population of individuals or one strain free from other strains; synonym = pure culture. Obtaining axenic cultures of BGA is frequently difficult and tedious. However such cultures are absolutely necessary for conducting physiological experiments. In particular the demonstration of the ability of a strain to fix nitrogen has to be done imperatively with an axenic culture.

BRANCHING:

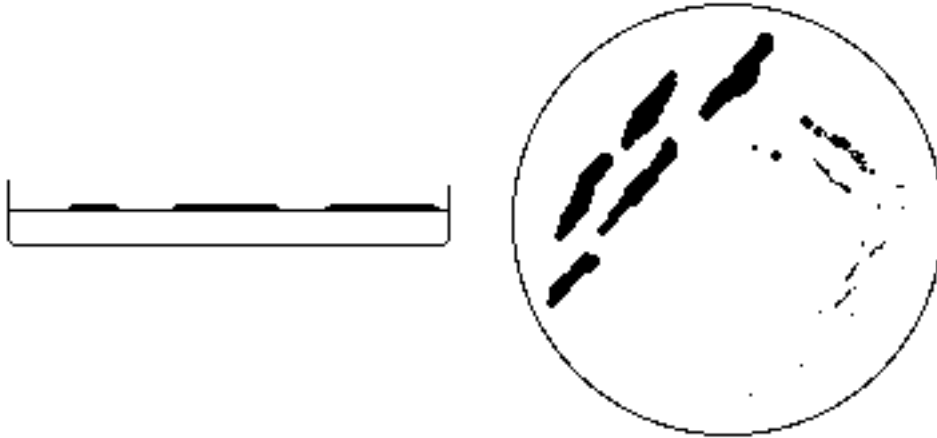
BGA can develop two kinds of branching.

- False branching is the result of the extrusion of the filament throughout the sheath which may produce either a Y false branching (1) as in *Tolypothrix* or a geminate false branching (2) as in *Scytonema*.
- True branching is produced by the vertical division of cells in a main axis as in *Fischerella* (3). Division can take place at right angle by involving a single parent cell (T-branching) or involve two cells of the main filament (inverted V-branching)(4).



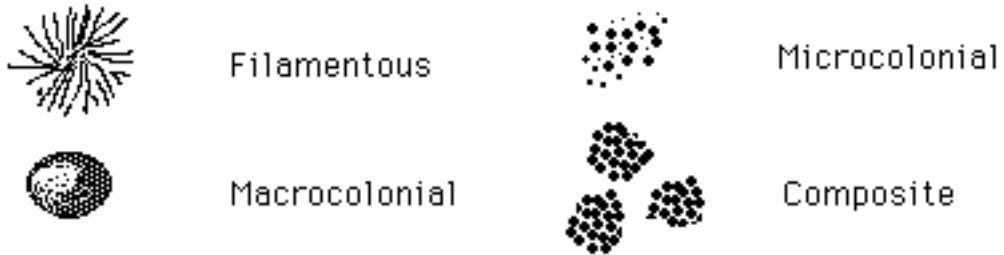
COHESIVE GROWTH:

continuous, thick, flat growth, nonspreading, with occasional discrete patches having no definite shape. The absence of definite shape and flat growth are main criteria in differentiating cohesive growth from microcolonial growth.



COLONIAL GROWTH TYPES:

- Filamentous: colonies are composed of filaments exhibiting a preferential orientation and having a hairy margin.
- Macrocolonial: colonies are generally mucilaginous and larger than 0.5 mm.
- Microcolonial: colonies are generally mucilaginous and smaller than 0.5 mm; may look almost like even spreading growth due to the small size of colonies.
- Composite colonies: macrocolonies composed of microcolonies.

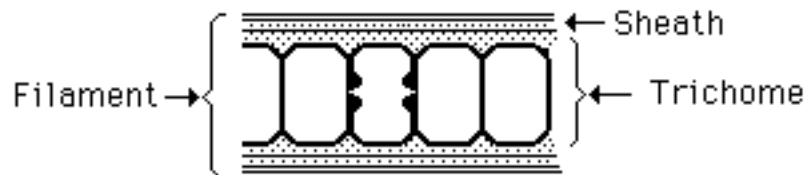


COLOR:

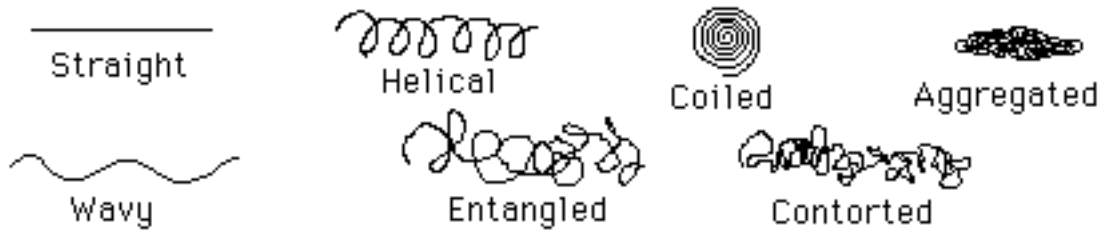
- Color of the alga: Is defined by the combination of three descriptors including intensity, modifier, and base color.
- Color of the medium: Results from the diffusion of water soluble pigments (e.g., phycocyanins, phycoerythrins) or other substances.

FILAMENT (definition):

For BGA, comprises the trichome (row of closely adjoining cells) and the sheath, when there is one.



FILAMENT (shape description):



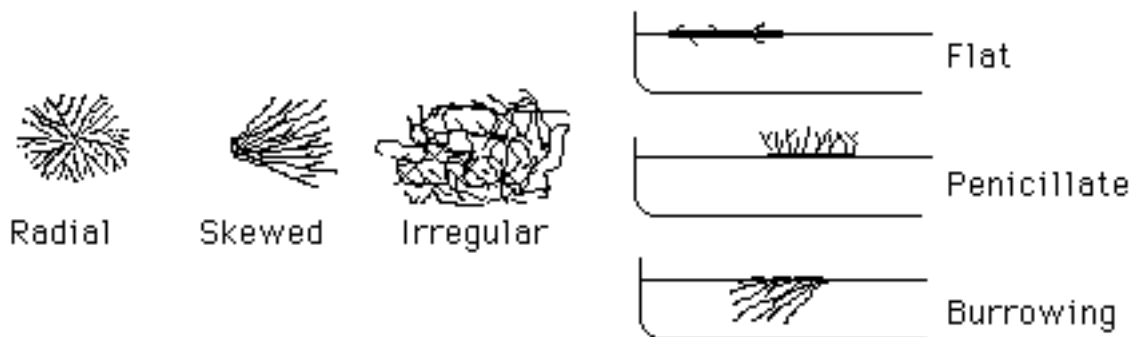
FILAMENTOUS COLONIES, MORPHOLOGY:

Top view

- Radial: trichomes generally diverging from the center.
- Skewed: trichomes generally growing in one direction
- Irregular: trichomes growing randomly

Side view:

- Flat: planar growth along the agar surface.
- Penicillate: brush-like growth away from the agar.
- Burrowing: growth into the agar.



GLIDING MOVEMENT:

Movement of organism without flagella or pseudopodia when in contact with a substrate. Gliding movement is characteristic of some Oscillatoriales and Nostocales.

HETEROCYST:

A thick-walled, usually translucent cell of heterocystous BGA, known to be the site of nitrogen fixation. Heterocysts are either terminal or intercalary.

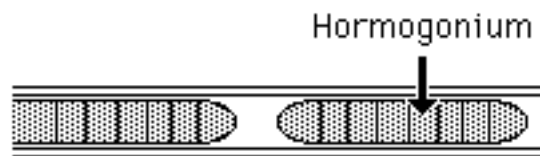
The criterion for differentiating intercalary heterocysts from terminal heterocysts is the number of polar granules (or nodules). A polar granule is a thickening in the heterocyst wall at the front of the attachment of the heterocyst to the adjacent cell.

Intercalary heterocysts are characterized by the presence of two polar nodules, while terminal heterocysts have only one polar nodule.



HORMOGONIUM:

A usually motile segment of a BGA capable of growing into another filament or a short section of a BGA filament.



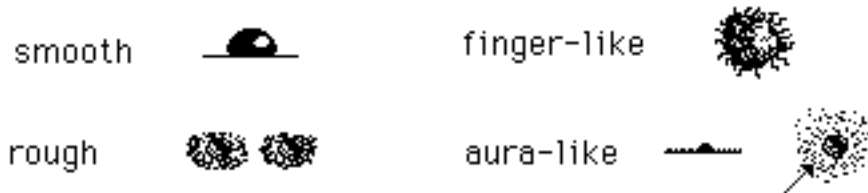
LUSTER:

The following is the scale used to describe the brilliance of colonies of BGA growing on agar plates:

- Dull: Lacking brilliance or luster. Usually observed with non mucilaginous, mat-forming strains (i.e. Calothrix), or strains forming filamentous colonies (i.e. Fischerella)
- Intermediate luster : usually observed with mucilaginous strains of the spreading and aggregative types.
- Glossy: Glistening, shiny. Usually observed with mucilaginous strains that form colonies

MARGIN:

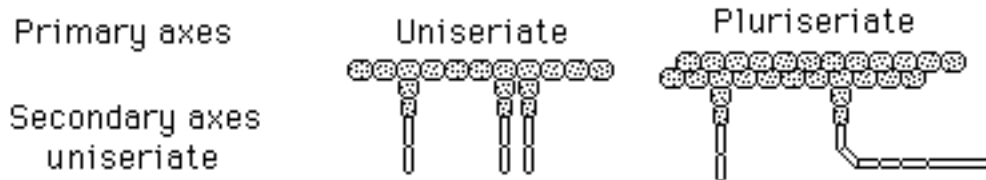
- Smooth: continuously even, without roughness.
- Rough: uneven margin without marked projections.
- Fingerlike: uneven margin with long projections.
- Aura-like: having a roundish diffuse growth zone spreading around a denser central colony. Frequently results from the migration of akinetes and their growth into filaments.



MULTISERIATE:

Thallus or filament composed of several series of cells.

Example: Fischerella



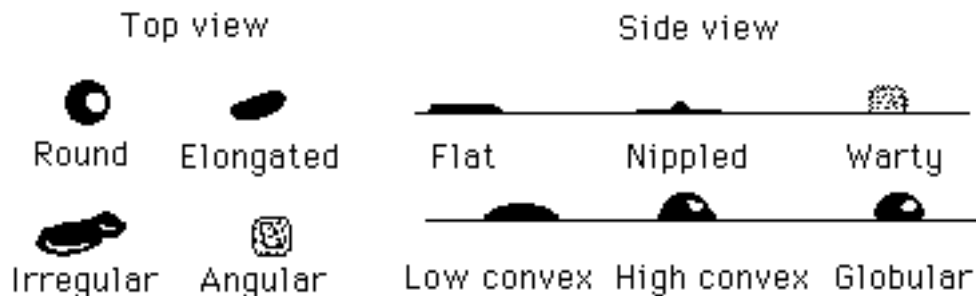
NON-FILAMENTOUS COLONIES (morphological description):

Top view

- Round: circular
- Elongated: colonies with unequal axes.
- Irregular: having no definable shape.
- Angular: colonies with relatively straight margins and corners.

Side view:

- Flat: planar growth along the agar surface.
- Nippled: planar growth with a central protuberance.
- Low convex: section of a sphere with height smaller than 1/4 of diameter.
- High convex: section of a sphere with height between 1/4 and 1/2 of diameter.
- Globular: section of a sphere with height larger than 1/2 diameter.
- Warty: having irregular protuberances resembling warts.



OPACITY:

- Opaque: Not permitting the passage of light.
- Translucent: Permitting the passage of light.

- Transparent: Can be seen through, e.g. mucilaginous colonies of some unicellular strains.

PENICILLATE:

Brush-like.

SEPTA:

Cross partition or walls usually complete, sometimes interrupted.

SHEATH:

An (often pectinaceous) investment outside the wall of certain algal cells.

SPORE:

A cellular agent of asexual reproduction (in BGA synonym: akinete)

SPREADING GROWTH:

Growth that indicates movements of trichomes or hormogonia away from streaks.

- Generalized spreading: Growth covers entire plate.
- Localized spreading: Spreading in the vicinity of streaks only.

TAPERING:

Becoming gradually smaller towards one end.

TRICHOME (SHAPE):

A hair of gelatinous bristle, or an extension of the cell wall; name applied to the thread of cells in filamentous BGA, minus the sheath.

UNIALGAL:

A culture containing only one strain or species of alga - does not imply that it is a pure culture.

UNISERIATE:

A filament in which there is a single series of cells, as opposed to a filament with more than one series.

9.5. Procedure for strain and information request

Strains of BGA are provided free of charge on simple request as dried material on paper strips, together with a printout of the information on the strain and a description of method for revival.

Our only requirement is to acknowledge the origin of the strains in papers reporting experiments in which they have been utilized.

The 6 Hypercard stacks describing the collection are provided free on the receipt of 2 4 1/2 inches double sided diskettes. The stacks are not protected and can be modified. Their utilization requires a MacIntosh +, SE, or II with a hard disk and the Hypercard 2 program.

ACKNOWLEDGEMENTS

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