TAXONOMIC STUDY OF THE GENUS SPIRULINA (NOSTOCOPHYCEAE, CYANOPHYTA) FROM NORTHERN AREAS OF PAKISTAN

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ABSTRACT

Specimens of the blue-green alga, Spirulina Turpin have been collected from various freshwater habitats in the districts of Jhang, Lahore, Sheikhupura and Sialkot in the Punjab Province of Pakistan as well as from different water bodies in Muzaffarabad, Chenari and Neelum Valley of Azad Kashmir during June 1996 – April 2000. They were taxonomically investigated and found to belong to 7 species.

Key Words: Blue-green algae, taxonomy, morphology, distribution, ecology.

INTRODUCTION

Spirulina Turpin is a commonly occurring blue-green alga (Phormidiaceae, Nostocales, Nostocophyceae; fide Shameel, 2001) in the marine as well as freshwater habitats. It has been recorded from Indian Ocean but not reported from the coast of Pakistan (Silva et al., 1996). There are a few reports of the occurrence of this genus from freshwater habitats of Pakistan (Jahangir et al., 2000; Leghari et al., 2000; Mahar et al., 2000) but no detailed taxonomic investigation was made so far. A huge collection of blue-green algae was made from various districts of the Punjab, certain areas of NWFP and Azad Kashmir (Naz et al., 2003) and detailed taxonomic study was carried out (Naz et al., 2004a, b). The present work is a continuation of that study, which describes the taxonomy of Spirulina growing in the northern areas of Pakistan.

MATERIALS AND METHODS

Collections were made from various freshwater habitats of the districts of Jhang, Lahore, Sheikhupura and Sialkot in the Punjab Province of Pakistan and from different water bodies in Muzaffarabad, Chenari and Neelum Valley of Azad Kashmir during June 1996 – April 2000. The methods used for the collection and studies of the materials were the same as described previously (Naz et al., 2004a). The specimens were taxonomically determined with the help of standard literature (Gomont, 1892; Forti, 1907; Tilden, 1910; Frémy, 1929, 1933; Geitler, 1932; Desikachary, 1959; Starmach, 1966; Gupta, 1972).

RESULTS AND DISCUSSION

On the basis of their morphological and cytological characteristics the following 7 species of Spirulina have been identified and taxonomically described, which were found to grow in the northern regions of Pakistan.

Spirulina Turpin emend. Gardner

Trichomes unicellular or multicellular, cylindrical, sheath absent; loosely or tightly coiled into a more or less regular spiral; apex of trichome usually not attenuated; cross-walls if present obscured; terminal cell rounded, without calyptra. Under this genus following species could be collected from northern areas of Pakistan and Azad Kashmir, they may be distinguished as follows:

1. Spirals close to one another ------------------------------- 2
   Spirals distant from each other --------------------------- 3
2. Spirals less than 3 µm broad ------------------------------ S. labyrinthiformis (2)
   Spirals more than 3 µm broad ----------------------------- S. subsalsa (6)
3. Trichomes more than 2 µm broad -------------------------- 4
   Trichomes less than 2 µm broad --------------------------- 5
4. Trichomes more than 4 µm broad -------------------------- S. princeps (5)
Trichomes less than 4 µm broad .......................... S. gigantea (1)
5. Spirals loosely arranged ................................ S. laxissima (3)
    Spirals closely arranged ................................ 6
6. Trichomes more than 1 µm broad ........................ S. major (4)
    Trichomes less than 1 µm broad ........................ S. subtilissima (7)

1. S. gigantea Schmidle
   (Forti, 1907: 210; Frémy, 1929: 236; Geitler, 1932: 930; Desikachary, 1959: 197; Masud-ul-Hasan and Zeb-un-Nisa, 1986: 231)

General characters: Trichomes deep blue-green; regularly spirally coiled, 2.5-4.0 µm broad, at the end conically attenuated; spirals 11-20 µm broad, 3-12 µm distance between two spirals (Fig. 1).

Geographical distribution: Myanmar: Rangoon (Ghose, 1926); Kamayat and Rangoon (Skuja, 1949); Pakistan.


Remarks: The specimens have been collected from stagnant pools, riverside ponds and fountain water during February and December 1999. In spring season it occurred in large quantity and free floating state as compared to winter season, mixed with other algae. Due to changes in locality and temperature some morphological differences were found within this species. During winter season its cells were smaller in size as those in summer.

2. S. labyrinthiformis (Linnaeus) Gomont
   (Gomont, 1892: 255; Forti, 1907: 215; West and West, 1907: 38; Frémy, 1929: 207, 1933: 134; Geitler, 1932: 928;

General characters: Trichomes 3.5-5.0 µm broad, blue-green, very regularly spirally coiled; spirals very close to each other, 0.8-2.8 µm broad (Fig. 2).

Geographical distribution: Myanmar, India, Pakistan.

Locality: Lahore: near tube-well house, Ravi Park.

Remarks: The collections have been made from different places such as stagnant water pools, rice fields and soil surface during January and May 1997. During summer season it occurred in massive amount especially in rice field locality and also in free floating state. In winter season it was found in soil binding habitat. It was observed that it may survive in winter season but cold climate is not suitable for its growth.

3. S. laxissima G.S. West
   (West and West, 1907: 38; Frémy, 1929: 207; Geitler, 1932: 929; Desikachary, 1959: 196; Starmach, 1966: 374; Gupta, 1972: 484)

General characters: Trichomes 1.3-1.5 µm broad, blue-green; spirals loose, but regular, 6.5-7.0 µm broad, 11.0-11.5 µm distant from each other; end cells rounded, obtuse (Fig. 3).

Geographical distribution: India: Madras (Ganapathi, 1940); Pakistan.

Localities: Lahore: Thokar Niaz Baig; Sialkot: Jamakey Village.

Remarks: It has been reported for the first time from Pakistan. The collection work was done at rice fields and temporary puddles during June 1996. It was found in free floating state. In rice field areas it was found in different reproductive stages. It appears that it prefers intense sunlight and high temperatures for its optimum growth, as both these factors were available in the rice field.
4. *S. major* Kützing ex Gomont

**General characters:** Trichomes blue-green, 0.9-2.0 µm broad, regularly, spirally coiled; spirals 2.5-5.0 µm broad, 2.5-5.5 µm distant (Fig. 4).

**Geographical distribution:** Myanmar: Rangoon (Ghose, 1926); India: Calcutta (Biswas, 1926, 1942, Banerji, 1938), Hyderabad; Pakistan.

**Localities:** Lahore: Muridkey, Narang Mandi, Mahmood Booti, Nasir Bagh; Sheikhupura District: Aliwala; Sialkot: Mudair Sharif Village, Punnwal Village; Azad Kashmir: Chenari, Neelum Valley.

**Remarks:** The collections have been made from different localities such as stagnant water pools, rice fields and soil surface during January and June 1997. During summer season it occurred in massive amount especially in rice field locality, in free floating state. It was also found as soil binding alga during winter season. Although, it may survive in winter season but the cold climate is not suitable for its growth.

5. *S. princeps* W. et G.S. West
(West and West, 1902: 205; Forti, 1907: 211; Frémy, 1929: 236; Geitler, 1932: 931; Desikachary, 1959: 197; Starmach, 1966: 375; Masud-ul-Hasan and Yunus, 1989: 101)

**General characters:** Trichomes 3.0-4.5 µm broad, short, blue-green; regularly spirally coiled, spirals at 10-12 µm distance (Fig. 5).

**Geographical distribution:** India: Travancore (Parukutty, 1940), Madras; Sri Lanka: Kosgoda, Urahaignesmahendai (West and West, 1902), Haberane (Crow, 1923); Pakistan.

**Locality:** Lahore: between Muridkey and Narang Mandi.

**Remarks:** The collections were made from the area along both sides of the road, where it occurred during July 1998 in free floating state.

Usually, rice is cultivated in the month of July and harvested in September. In the early stage of rice cultivation, a large amount of water is supplied for irrigation, and this water remains in the field for considerable time. During these months intensity of sunlight is very high, so a large amount of blue-green algae grow in massive quantity and develop dominant associations.

6. *S. subsalsa* Oersted ex Gomont
(Gomont, 1892: 253; Forti, 1907: 214; Frémy, 1929: 211, 1933: 133, Geitler, 1932: 927; Feldmann, 1937: 165; Desikachary, 1959: 193)

**General characters:** Tricomes 3.5-4.0 µm broad, blue-green; spirals regularly coiled; sometimes loosely entangled in a thallus or occurring singly among other algae; spirals very close to each other, 2.2-3.2 µm broad (Fig. 6).

**Geographical distribution:** Myanmar, Sri Lanka, India, Pakistan.

**Locality:** Lahore: Ravi Park.

**Remarks:** Collections were made during extreme summer season i.e. June 1997. It occurred in large quantity and in epizoikotic condition. The pH and temperature of water were favourable for its growth.

7. *S. subtilissima* Kützing ex Gomont
(Gomont, 1892: 252; Forti, 1907: 212; Frémy, 1929: 233; Geitler, 1932: 929; Desikachary, 1959: 196; Starmach, 1966: 374)
**General characters:** Trichomes 0.9 μm broad, bright blue-green; regularly spirally coiled; spirals 1.5-25 μm, distance between spirals 1.25-2.0 μm (Fig. 7).

**Geographical distribution:** India: Calcutta (Banerji, 1938), Shembaganur, near Madurai (Frémy, 1942), Mumbai (Gonzalves and Joshi, 1946); Pakistan.

**Locality:** Lahore: Jinnah Garden.

**Remarks:** It has been reported for the first time from Pakistan. Specimens were collected from fountain during April 2000. Temperature was about 35.4°C and pH 7.5. It occurred in the free floating and vegetative state in stagnant water of fountain area.

**REFERENCES**


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