

A CRITICAL REVIEW OF SOME RECENTLY CREATED NEW SPECIES OF INDIAN ZYGNEMALES

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Received January 29, 1943

THE members of the order Zygnemales have attracted a good deal of attention recently in U.S.A., Europe, China and India. A number of new species and two new genera have been described. Of the work done outside India, the investigations of Transeau and his colleagues Tiffany, Taft and Li deserve particular mention. Transeau has described a number of new forms and has also given a systematic account of the species belonging to different genera in a series of monographs, which have proved exceedingly useful to workers in this line. Recently he brought out a mimeographed key of all the known species, which is invaluable to all those who are interested in the systematic study of this group. Jao and Li have published valuable monographs on the hitherto little known members of this group from China.

In Europe valuable work has been done by Czurda and Skuja on members of this order. In spite of differences of opinion one may have regarding the delimitation of various genera, Czurda's keys given in Heft 9 of *Die Susswasserflora Mitteleuropas* are of considerable use to the workers. His recent monograph on the "Morphology of Conjugatae" is an excellent treatise on this group and is very well illustrated.

In India pioneer work on Zygnemales was done by Iyengar whose short note on "Studies on Zygnemales" with detailed observations on peculiarities in conjugation is valuable.

The present author published a series of papers on this group and recently described an interesting new genus, which he has named *Sirocladium*, from Kumaon Himalayas. Some work has also been recently published on this group by Rao, Dixit, Misra and Singh from the Benares Hindu University under the direction of Prof. Bharadwaja, describing a number of new species.

As a number of young workers have interested themselves in this group it seems desirable to review some of the species described as new by the various authors. In the systematic studies of this group, the sculpturing of the spore-wall is of fundamental importance particularly in species of *Zygnema*, *Spirogyra*

and *Sirogonium*. A difference of a few microns in the width of vegetative cells or in the dimensions of zygospores is quite immaterial in most cases as it may be due to physiological conditions. In fact even in the same species there may be a wide range in the size of vegetative cells or zygospores. Only when the alga shows some marked peculiarity in conjugation as in *Zygonium taluguppense* Iyengar and *Zygnema Czurdæ* Randhawa, that a valid species can be based even if the zygospores are immature, irrespective of the sculpturing of the spore-wall.

Some of the species described as having smooth spore-wall, have been later on found to possess minute punctation. The species which were described in earlier days when microscopic technique was not so well advanced are in need of revision and re-examination. Sculpturing of the mesospore can only be observed at a magnification of $\times 800$ or more and the use of an oil immersion lens is imperative. There is another important detail which a worker should always keep in view. When observing the sculpturing of the spore-wall, *open the diaphragm of the condenser shutter fully*. When the diaphragm is closed, in most instances only reticulations are seen in the spore-wall. The present author made a similar mistake when describing the sculpturing of the spore-wall of *Zygnemopsis lamellata* Randh. which was originally described as reticulate, and later on it was found to be punctate. Another helpful tip is the use of 30% chromic acid to dissolve the cell contents, or by lightly crushing the spores under the cover-slip. This is particularly helpful when the spore-wall is finely punctate.

There is another mistake which one is likely to make when describing species, in which the dimensions and the shape of the vegetative cells is so alike that differences are only seen when mature spores appear. In algæ it is so rare to find pure material, for species are so much mixed in nature, and this is likely to create confusion when the vegetative cells are more or less alike in dimensions. This type of mistake is more likely to arise in the case of the species of *Zygnemopsis* in which aplanosporic species and zygosporic species are usually mixed. In his original description of *Zygnemopsis lamellata* the present author described both zygospores and aplanospores, which are usually found together. Later on more minute examination of the spore-wall revealed that the aplanosporic form is a different species with a pitted spore-wall in the aplanospores, while the zygospores which belong to the species *Z. lamellata* are punctate.

Sculpturing and pigmentation develop in the mesospore of the spore on maturity. Immature spores have thin walls and chloroplasts are clearly visible. Such material is usually of no value for investigation purposes and

cannot safely form the basis of a new species unless there are some marked peculiarities in the mode of their reproduction. Mature spores are usually deep blue, orange, or chocolate coloured, are always opaque and never show chloroplasts. When material with ripe spores is collected, the sculpturing of the mesospore should be carefully observed. The spore-wall is very rarely smooth in the species of *Zygnema* though there are some species of *Spirogyra* and *Mougeotia* in which it is smooth. Usually the following types of sculpturing has been observed in species described from India, and in some cases there may be combination of two or more types :—(1) Punctate, (2) Scrobiculate or pitted, (3) Reticulate, (4) Denticulate, and (5) Verrucose.

When the spore-wall is pitted the size of pits, and their distance from each other should be carefully measured.

In the identification of species of *Spirogyra* the type of septa should be carefully observed, to find out whether it is plane, replicate, semi-replicate or colligate. In species of *Spirogyra* and *Sirogonium* where the number of chloroplasts exceeds three, it becomes very variable, and in itself is a very unsafe character to base a new species. In a sample of *Sirogonium ventersicum* Transeau, the present author found 6–9 chloroplasts. In a similar material which Dixit described as *S. inflata* sp. nov. (1937) he found 10 chloroplasts. Later on a similar material was described by Singh (1938) as *S. indicum* sp. nov. and the number of chloroplasts is given as 7. The present author has found that in *Sirogonium ventersicum*, the number of chloroplasts varies from 4–10 and to pick up any individual cell and to say that it contains 7 or 10 chloroplasts and then to base a new species on it is rather a risky venture. Similarly the number of turns of a chloroplast is also variable and is an unreliable guide in species of *Spirogyra*.

The shape of zygospores is also variable in species of *Spirogyra* and globose to ellipsoid zygospores may be found in the same species or in some cases in the same filament. Similarly when the fruiting cells are inflated, the extent of inflation is very variable and is not of much significance. The size of zygospores is also variable and by itself is not a safe criterion for making a new species.

The following is a critical account of some doubtful species which have been described as new and a re-investigation seems to be necessary to clear the doubts.

***Zygnema* Agardh**

1. *Zygnema gangeticum* Rao.—The author has described the mesospore as *thin, smooth* and yellowish-brown. This feature as well as his figures show that he did not come across mature zygospores. The so-called *thinness*

of the mesospore is due to its immaturity. A similar form was described by the present author as *Z. heydrichii* Schmidle var. *indicum*. The present author is of the opinion that *Z. gangeticum* Rao is not a valid species, and is merely a variety of *Z. heydrichii* Schmidle.

2-4. The three species: 2. *Z. indica* Misra: 3. *Z. sphaerica* Misra and 4. *Z. Kashmiriensis* Misra—were described by Misra as new and are based on studies of material collected by Bharadwaja from Srinagar, Kashmir. In the case of *Z. indica*, the mesospore is described as “slightly thick, smooth, and blue”. In the case of *Z. Kashmiriensis*, the mesospore is described as “thin, smooth and brown”. However, the figures of the author clearly show that he was sketching immature zygospores which show chloroplasts. In *Z. sphaerica* he described the mesospore as “thin, smooth and blue”. This description shows that he came across immature zygospores only. The present author is of the opinion that all the above-mentioned three species are invalid being based on the study of immature zygospores. Moreover, too much reliance was placed on the keys of Czurda, which have become out of date, as a number of new species have been described since then from U.S.A., China and India.

Spirogyra Link.

1. *S. Czurda* Misra.—According to Misra “the presence of a scrobiculated mesospore is a unique feature of this alga”. However, a scrobiculate mesospore is found in a few known species of *Spirogyra*, such as *S. luteospora* Czurda. Comparison of Misra’s description of *S. Czurda* with that of Transeau of *S. luteospora* Czurda given in his “mimeographed key” shows that both these algæ have a single chloroplast, vegetative cells are of the same size, dimensions of zygospores are similar and spore-wall is scrobiculate in both. This leads one to the conclusion that *S. Czurda* Misra is not a valid species and Misra has actually recorded *S. luteospora* Czurda.

2. *S. Skuja* Randhawa and 3. *S. reticuliana* Randhawa were described by the present author as new. Further observations on the material of these algæ shows that they differ from each other only in minor features. The dimensions of the vegetative cells and zygospores are more or less similar. The description of *S. reticuliana* covers that of *S. Skuja* and the latter does not deserve to be treated as a separate species.

4. *S. paradoxa* Rao.—According to Rao this alga differs from *S. setiformis* (Roth) Kutz. “in the possession of narrower cells, lesser number of chloroplasts, and the fructifying cells which are commonly swollen on the conjugating side”. Narrower cells may be due to poor nourishment, and the number of chloroplasts when it exceeds three is a very uncertain feature.

The swelling of fructifying cells towards inside is not an important feature specially when it is not constant. The present author is of the opinion that *S. paradoxa* Rao is merely an attenuated form of *S. setiformis* (Roth) Kutz.

5. *S. azygospora* Singh.—While Singh has described the mode of reproduction as by means of *azygospores*, he actually gives the length and breadth of *zygospores*. This is possibly a mistake. Formation of *azygospores* is, however, not a permanent feature in any member of the Zygnemales, as due to interruption of normal conjugation *azygospores* may be formed in any species which normally produces *zygospores*. The production of *azygospores* is only a physiological feature and is not of any morphological and systematic importance. In dimensions of cells and number of chloroplasts Singh's *S. azygospora* resembles *S. submaxima* Transeau. In the opinion of the present author *S. azygospora* Singh is merely the *azygosporic* form of *S. submaxima* Transeau and therefore need not be treated as a separate species.

***Sirogonium* Kutz.**

1. *S. inflata* Dixit (1937).
2. *S. indicum* Singh (1938)
3. *S. ventersicum* Transeau var. *melanosporum* var. nov. Randhawa.

In 1937 Dixit described a new species of *Sirogonium* which he called *S. inflata*, in the course of investigations conducted at the Benares Hindu University. In the following year Singh, from the same Institution, described a new species which he called *S. indicum*. The present author also collected a similar form but with black *zygospores* from Fyzabad in 1938.

The following comparative chart shows the size of vegetative cells, and the size, shape and sculpturing of *zygospores* as actually described by Transeau, Dixit, Singh and Randhawa.—

Sl. No.	Character	1	2	3	4
		<i>S. ventersicum</i> Transeau, 1937	<i>S. inflata</i> Dixit, 1937	<i>S. indicum</i> Singh, 1938	<i>S. ventersicum</i> T. var. <i>melanospora</i> Randhawa, 1938
1	Size of vegetative cells in microns	65-72 × 110-250	81-99 × 166-298	60-80 × 210-285	80-90 × 140-260
2	Number of chloroplasts	5-8	10	7	6-9
3	Shape of fructifying cells	Inflated	Inflated	Inflated	Inflated
4	Zygospore— Size in microns .. Shape .. Sculpturing ..	80-90 × 133-152 Ovoid	81-85 × 111-139 Ellipsoidal with rounded ends Irregularly verrucose	75-90 × 135-165 Ellipsoidal with rounded ends Irregularly scrobiculate	90-110 × 140-160 Ellipsoid Verrucose

A careful perusal of the above figures will clearly show that the so-called *S. inflata* Dixit and *S. indicum* Singh differ only in very minor details from *S. ventersicum* Transeau. Singh describes the spore-wall of *S. indicum* as *irregularly scrobiculate* which is obviously wrong since it cannot be scrobiculate when it is irregular. It is surprising to note how from the same laboratory two different species, which did not differ materially from an already known species, came to be described in two successive years as two new species.

The present author is of the opinion that *S. inflata* Dixit and *S. indicum* Singh are not valid species and the samples described are covered by the descriptions of the present author's description of *S. ventersicum* Tran. var. *melanosporum*. Black pigment of zygospores usually disappears in preserved material and perhaps due to this reason Dixit and Singh failed to observe it in their material.

A request was made to Dr. Bharadwaja to send some material of the new species of Zygnemales described from his laboratory for verification and comparison. In his letter dated the 3rd April 1942 he writes—"A similar work, as you have intimated to me, is being conducted here on a larger scale in my Department. It would not, therefore, be advisable to allow the same thing to be done at two places."

Consequently the present author could not check the findings of Dixit and Singh had to content himself with their published descriptions and sketches only. There are certain other species like the following which also need to be verified and compared with the already known species. On account of lack of material it is not possible to give any account here.

1. *Zygnema gorakhporeense* Singh.—In this case the spore-wall is described as *lamellated with broad scrobiculations* but in the figures the pits are not shown.

2. *Spirogyra crenulata* Singh.
3. *Spirogyra kundænsis* Singh.
4. *Spirogyra Ghoseli* Singh.
5. *Spirogyra anamola* Rao.
6. *Spirogyra bimorphis* Dixit.

Besides the above-mentioned species Rao and Singh have described a number of "formas" of *Sirogyra* and *Zygnema*. While some of these are merely described as "formas", there are others which are described as '*forma Nov*'. As their names, such as *megaspora*, *inflata*, *maxima*, *crassa* and *tenuis* show, these algæ differ from the type only in larger dimensions of zygospores and vegetative cells, or in having narrower cells and zygospores, or greater or

lesser inflation of fructifying cells, or slight differences in the shape of zygospores varying from ellipsoidal to subspherical. As has been already discussed these differences are of no great value or importance and in most cases are merely of physiological nature. In fact the dimensions of the vegetative cells and zygospores of the same species collected from two different ponds seldom agree. The present author is of opinion that these so-called 'formas' (which are merely ecological variants) are of little taxonomic value, and do not deserve any special names.

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