

SPONGILLA CARTERI AND ITS VARIETIES.

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Annandale (2) writing in 1911, stated that "the range of the species (*S. carteri*) extends westwards to Hungary, southwards to the Island of Mauritius and eastwards to the Island of Madura in the Malay Archipelago; a specimen from Lake Victoria Nyanza in Central Africa has been referred to it by Kirkpatrick (15) but I doubt whether the identification is correct. In India, *Spongilla carteri* is by far the most universally distributed and usually much the commonest fresh-water sponge; it is one of the only two species as yet found in Ceylon." Following this general statement, he gives in detail the various localities in India, Burma and Ceylon where this sponge has been found.

In 1923, Arndt (5) reported a variety of this sponge, *S. carteri* var. *melli*, from Canton, China, and in the same paper gave a new sub-specific name, *S. carteri* subsp. *balatonensis*, to the form of this species which had previously been reported from Hungary.

In 1923, Resvoj (17) described as *S. rotundacuta*, a sponge from the delta of the Volga River but later (18) considered it as a variety of *S. carteri*.

In 1926, the writer (7) reported Arndt's variety *melli* from Amoy, China, and since that time has had the opportunity to examine a large number of specimens of this sponge from both Canton and Amoy. This variety has not been found in China north of Amoy, Fukien Province.

In 1926, Resvoj reported *S. carteri* from Bayram Ali and the variety *mollis* from Bukhara in Turkestan. He also recorded (20) in the same year the occurrence of *S. carteri* and his variety *rotundacuta* from Astrakhan on the lower Volga River.¹

In 1928, Resvoj (21) recorded *S. carteri* from the neighbourhood of Rostov on the Don River and added the following comments concerning its distribution in Russia: "The discovery of *S. carteri* in the lower courses of the Don reveals quite clearly the area which is covered by this species in Russia. It is known from the Volga Delta and from Turkestan (Bukhara and Bayram Ali), where it is probably the predominant form. After the discovery of this species in the Volga Delta and in the lower courses of the Don, we can expect its occurrence in the other South Russian Rivers—the Dniepre, the Bug and the Dniester. In this way the colonies of *S. carteri* in the Platten Lake (Hungary) would not prove to be quite so isolated as it has appeared up to this time. One can suppose that a narrow belt stretched across South

¹ Dr. Resvoj has kindly read the manuscript of this article and sends me the following supplementary note. "I had only very little specimens of *S. carteri* var. *rotundacuta*, described by me as a new species (1923). In 1926 I have published specimens from Astrakhan, which I consider as belonging to the typical form of *S. carteri*. The spicules of these are short-pointed, but the gemmules form only a pavement layer. Now (1930) I possess specimens from different localities of the Volga delta (yet unpublished), they have gemmules partly lying of the substratum, partly dispersed in the lower part of the sponge."

Russia along which this species spreads onwards toward the West to Hungary. Arndt, conjecturingly, sets up another connection between the principal locality of this species and its occurrence in Hungary, namely through West Persia, Kurdistan and Asia Minor." *S. carteri* has also been recorded (4) from Seistan (E. Persia and S. W Afghanistan).

Through the kindness of Dr. W Arndt, of the Berlin Zoological Museum, who has also courteously read this article in manuscript, my attention has been called to the additional records by Miss Grimailowskaja (13) of *S. carteri* in Russia. She found this species in the materials collected by Beling during his hydrobiological investigations of the southern Bug River in the territory between Golta and Nikolajew, near the town of Golta, in 1925. She writes as follows concerning this species : " The occurrence of *S. carteri* near the town, Golta, is of great interest since it is only the third place in which it hitherto has been found in Europe. Until now *S. carteri* has been considered as being a representative of tropical and subtropical sponge fauna. By the new findings of P. Resvoj and also myself the area in which *S. carteri* occurs is much extended. It is notable that *S. carteri* of the southern regions is distinguished from the one from the northern regions by the location of the gemmules ; while those of the typical southern forms are profusely distributed in the tissue of the sponge, they are (in the Russian forms) accumulated in the base of the sponge, forming a thin layer. This difference from the typical form has been also described in case of the Volga findings by P. Resvoj. It is furthermore noteworthy that *S. carteri* of the southern regions is more similar to the typical form than those of the Volga ; the spicules of the southern type are distinctly pointed (the needles of the typical form have long thin tips) while the spicules of the sponges from the Volga River near Astrakhan show a tendency to have rather rounded tips." Miss Grimailowskaja (14) also recorded for the first time *S. carteri* from the collections made in July and August, 1927, by the Hydrobiological Expedition working on the Dneipre River.

In 1928, Vorstmann (22) also recorded *S. carteri* as occurring in both eastern and western Java.

Through the kindness of H. M. Smith, some specimens of fresh-water sponge were sent to me from the large swamp, Nong Han, in East Siam (10). These were collected on March 11, 1929, and are to be referred to the typical form of *S. carteri*. This is one step further east on the mainland than Annandale had recorded this sponge and forms a connecting link between the Indian and the Chinese representatives of this species. Nothing is known of the fresh-water sponges of the region between Siam and Canton, but it is very likely that this sponge will be found to occur in the intervening territory of about the same latitudes when the sponge-fauna of that region is explored.

I do not take into account the sponge supposed to be of this species mentioned by Kirkpatrick (15) as having been found in Lake Victoria Nyanza in Africa, since this record seems doubtful.

From the records given above it will be seen that this sponge has a very wide, and probably continuous range, from Amoy and Canton, China, on the East to the Platten Lake (Balaton Lake) in Hungary, on

the West ; from the rivers of southern Russia on the North to Mauritius Island on the South. The occurrence of this sponge outside of the above range would be very interesting, while there is little doubt that it will be found to be a common species inside of it when the entire region has been carefully explored for its sponge fauna.

Annandale (1) gives the following definitions as a basis for his classification in his study of fresh-water sponges :—

“ *Species*.—A group of individuals differing in constant characters of a definite nature and of systematic importance from all others in the same genus.

Subspecies.—An isolated or local race, the individuals of which differ from others included in the same species in characters that are constant but either somewhat indefinite or else of little systematic importance.

Variety.—A group of individuals not isolated geographically from others of the same species but nevertheless exhibiting slight, not altogether constant, or indefinite differences from the typical form of the species (*i.e.*, the form first described).

Phase.—A peculiar form assumed by individuals of a species which are exposed to peculiarities in environment and differ from normal individuals as a direct result.

“ There are cases in which imperfection of information renders it difficult or impossible to distinguish between a variety and a subspecies. In such cases it is best to call the form a variety, for this term does not imply any special knowledge as regards its distribution or the conditions in which it is found.”

On the basis of his definitions quoted above Annandale (2) described varieties of *S. carteri*. It is worth while to repeat here the statement of his reasons for giving definite names to these varieties.

S. carteri var. *mollis*.

“ This variety is characterized by a paucity of skeleton spicules. The sponge is therefore soft and so fragile that it usually breaks in pieces if lifted from the water by means of its support. Owing to the paucity of skeleton spicules, which resemble those of the typical form individually, the radiating and transverse fibers are extremely delicate.”

The skeleton spicules in a cotype (54386) of this variety measured 306—340 μ in length and 14—16 μ in thickness. The specimen contained no gemmules.

“ Var. *mollis*, again, may be a phase directly due to environment. It is the common form in the ponds of certain parts (*e.g.* in the neighbourhood of the maidan and at Alipore) of the Calcutta Municipal area, but in ponds in other parts (*e.g.* about Belgatchia) of the same area, only the typical form is found. It is possible that the water in the former ponds may be deficient in silica or may possess some other peculiarity that renders the production of spicules difficult for *S. carteri*; but this seems hardly probable, for *S. crassissima*, a species with a rather dense siliceous skeleton, flourishes in the same ponds. I have noticed that in ponds in which the aquatic vegetation is luxuriant and such genera of plants as *Pistia* and *Limnanthemum* flourish, there is always a tendency for *S. carteri* to be softer than in ponds in which the vegetation is

mostly cryptogamic, and in Calcutta those parts of the town in which sponges of this species produce most spicules are those in which a slight infiltration of brackish water into the ponds may be suspected; but in the interior of India, in places where the water is absolutely fresh, hard specimens seem to be the rule rather than the exception.

The typical form and var. *mollis* grow to a larger size than is recorded for any other species of the family."

Resvoj (19) referred some of the specimens of *S. carteri* collected at Bukhara, Turkestan, to the var. *mollis* on account of the "feebly developed skeleton and the soft consistence of the sponges." The others he considers as belonging to the typical form. His measurements of this variety are as follows:—

Skeleton spicules	250 μ \times 9–16 μ .
Gemmule ,,	95–190 μ \times 3–4 μ .
Diameter of gemmules	396–455 μ .

My measurements of a bit of material (54323) from the Indian Museum collection of this variety from Turkestan are:—

Skeleton spicules	255–340 μ \times 14–20 μ .
Gemmule ,,	170–206 μ \times 5–7 μ .
Diameter of gemmules	527–680 μ .

S. carteri var. *cava*.

"This variety is characterized by the fact that the oscula open into broad horizontal canals, the roof of which is formed by a thin layer of parenchyma and skeleton or, in places, of the external membrane only. The skeleton is loose and fragile, and the living sponge has a peculiar glassy appearance. In spirit the colour is yellowish, during life it is greenish or white. Taken at Bombay, November, 1907."

"Var. *cava* appears to be a variety in the strict sense of the word, for it was found on the island of Bombay, the original locality of the species, growing side by side with the typical form."

I have measured the spicules and gemmules of a cotype of this sponge (54538) and get the following dimensions:—

Skeleton spicules	340–375 μ \times 17–24 μ .
Gemmule ,,	255–271 μ \times 9–14 μ .
Diameter of gemmules	408–552 μ .

S. carteri var. *lobosa*.

"The greater part of the sponge in this variety consists of a number of compressed but pointed vertical lobes, which arise from a relatively shallow, rounded base, in which the oscula occur. The dried sponge has a yellowish colour. Apparently common in Travancore."

"Var. *lobosa*, however, should perhaps be regarded as a subspecies rather than a variety, for I have received specimens from two localities in the extreme south-west of India and have no evidence that the typical form occurs in that part of the country. Evidence, however, is rather scanty as regards the occurrence of fresh-water sponges in South India."

S. carteri generally has "large, deep, round oscula" but in var. *lobosa* this feature which is so characteristic of this sponge, is not so marked as in other forms.

The skeleton spicules of a cotype of this variety (54360) measure from 280–340 μ in length and from 14 to 20 μ in thickness. The gemmule spicules are from 154–216 μ in length and from 6–10 μ in thickness. The gemmules are from 510–638 μ in diameter.

Arndt (5) after restudying the available specimens of *S. carteri*, has felt justified in creating a new subspecies. The following is a free translation of his description :—

S. carteri subsp. *balatonensis*.

“ This sponge differs in shape from the Indian type-form and varieties and is typical for its locality. It is a flat disk, from which short, round tower-like branches rise. The colonies appear extended, brownish yellow crusts, from which numerous flattened cylindrical projections grow to a height of 2.5 cm. with a diameter of 1 cm. On the distal end of this projection there is a single osculum with a round deep opening so characteristic of the *S. carteri*. The skeleton is slightly developed as contrasted with the Indian form, which differs very conspicuously from the form now described in its unbranched and massive form and differs from the form described by Annandale (1911) which externally very closely resembles fragments of the Hungarian specimen-variety *lobosa* in which the oscula do not open at the ends of the branches but at the basal crusts.

The specimens from Platten Lake are very fragile and soft. They agree in this respect with Annandale's variety *mollis* from Calcutta.

In respect to the spicules and the gemmules these forms do not differ from the original type.

Skeleton spicules	242 \times 10 μ to 320 \times 16 μ .
Gemmule ,,	139 \times 3 μ to 180 \times 6 μ .

On account of the absence of the type-form *S. carteri* in the Platten (Balaton) Lake, I named this well differentiated form as subsp. *balatonensis*.”

Annandale (2) states, concerning this sponge, that “ the only complete European specimen of this species I have seen differs considerably in outward form from any Indian variety, consisting of a flat basal area from which short, cylindrical, turret-like branches arise.”

I have measured the spicules of a small piece of this sponge and find that our results correspond very closely to those of Arndt's given above.

In the same paper, Arndt (5) created another variety based on two specimens from Canton. He gives the following description of this variety.

S. carteri var. *melli*.

“ In contrast to the Indian examples of the type-form specimens which had been identified by Carter himself, are the Chinese examples, the entire surface of the massive half spherical colony was covered with similar ball-shaped projections about 4 mm. long and 2–3 mm. in diameter. The large oscula opened on the tops of long projections whose diameter reached 8–10 mm. For the type-form Annandale states that the oscula do not tower above the sponge. The colour of the dried

specimen is light brown, the radial fibers of the strongly developed skeleton show 5 to 8 spicules, the transverse fibers 1—3 spicules. ..

Length of Skeleton spicules	231–320 μ .
Thickness of Skeleton spicules	12– 16 μ .

Gemmules fill the entire sponge and are very abundant. The Canton specimens show no peculiarities.

Since it is unknown in that locality up to this time, whether it is exactly like the type form or not, I place it a variety in the sense of Annandale and name it in honor of Mr. Mell as var. *melli*."

I have measured a large series of the spicules from the sponges from Amoy and Canton representing this species and while there is a certain amount of variation in their length and thickness, yet I do not believe that these differences are constant enough to deserve a varietal name. I give a few typical measurements in microns.

	Skeleton spicules.		Gemmule spicules.		Diameter of Gemmules.
	Length.	Thickness.	Length.	Thickness.	
China—					
Specimen No. 53008	272–340 μ	16–19 μ	150–184 μ	7–9 μ	..
" " 53008	255–325 μ	11–16 μ	161–180 μ	7–9 μ	459–507 μ
" " 54638	281–313 μ	14–19 μ	176–216 μ	6–9 μ	..
" " 54653	270–316 μ	16–22 μ	164–210 μ	6–8 μ	..
" " 54656	248–289 μ	8–12 μ	164–202 μ	4–7 μ	..
Amoy—					
Specimen No. 54677	273–307 μ	16–24 μ	158–180 μ	8–10 μ	..
Java—					
Specimen No. 53684	322–366 μ	16–20 μ	176–218 μ	10–12 μ	..
" " 53824	325–374 μ	22–26 μ	176–200 μ	8–11 μ	..
" " 53819	281–366 μ	18–26 μ	190–204 μ	5–8 μ	459–655 μ
" " 52915	297–349 μ	16–30 μ	170–220 μ	8–12 μ	..
" " 53861	349–392 μ	16–22 μ	178–229 μ	10–13 μ	..
" " 53701	301–344 μ	16–22 μ	196–238 μ	8–12 μ	..
" " 53831	298–357 μ	14–20 μ	153–221 μ	6–10 μ	..
Postov on Don River—					
Resvoj	290–330 μ	11–14 μ	155–190 μ	5–8 μ	365–415 μ
Mauritius Island—					
Specimen No. 54187	281–357 μ	15–18 μ	194–200 μ	8–10 μ	..
Siam—					
Specimen No. 53735	289–357 μ	14–20 μ	170–182 μ	4–10 μ	..
India—					
Specimen No. 54272	315–360 μ	16–20 μ	166–201 μ	7–8 μ	..

While there is rather a wide variation in the dimensions of the spicule, of some of the specimens as given in my records above, yet these, in some cases, vary so much within any one specimen, that I am not inclined to attach any great significance to this variation. So far in my studies I have not been able to associate any of these variations with any special external form of growth.

In his original record of *S. rotundacuta*, now considered a variety of *S. carteri*, Resvoj (17) gives in substance the following items in his description of this sponge: "The specimen was collected from Nikita, opposite Krasnolovny Fisheries on the Volga River. It consisted of a thin crust 4 mm. thick on inside and outside of a broken *Unio* shell; on its substratum was formed a continuous layer of yellow coloured gemmules; its surface was a continuous membrane perforated by the

vertical ends of bunches of skeleton spicules. The skeletal arrangement is very similar to that of *S. carteri*.

The skeleton spicules are smooth, cylindrical, regularly and slightly curved, with their ends rounded into a parabolic form; at times they appear slightly sharp-pointed or they may bear small rounded cylindrical projections at their tips. A few spicules show distinct, short, sharp points."

Resvoj contends that there are a few true flesh spicules scattered through the parenchyma and believes that he finds transitional forms connecting these with the smooth, spindle-shaped, sharp-pointed gemmule spicules which are present in large numbers around the gemmules. The smaller spicules are very similar to those *S. carteri*.

Resvoj gives the following measurements for *S. carteri* var. *rotundacuta* :—

	Skeleton spicules.		Gemmule spicules.		Diameter of Gemmules.
	Length.	Thickness.	Length.	Thickness.	
Volga River— Resvoj	220-265 μ	13-17 μ	148-205 μ 117-144 μ	6-11 μ 4-7 μ	275-428 μ
Astrakhan— Resvoj	215-305 μ	12-13 μ	145-196 μ	4 μ	300-445 μ

The writer is of the opinion that the flesh spicules described by Resvoj in his var. *rotundacuta* are either the immature skeleton spicules or the gemmule spicules which have been scattered through the sponge due to the handling of it. I have not been able to secure specimens of this sponge, but have had privilege to examine prepared slides.

Resvoj states that the skeleton spicules of *S. carteri* from Bayram Ali, Turkestan "mostly have sharp points, though sometimes the tips are almost rounded." The spicules are thicker than those collected at Bukhara.

In 1926, Resvoj (20) wrote concerning the sponges found at Astrakhan as follows :

"All seven specimens of this species present thin crusts with a pavement layer of gemmules. Our specimens differ in some respects from the typical form. In typical cases the gemmules are dispersed in the parenchyma and do not present a compact pavement layer. Yet more important is the construction of the macroscleres. Our specimens bear very short points, sometimes the spicules are almost rounded; you seldom encounter points of middle length. In typical cases the points are long.

I have already recorded (19) the occurrence of *S. carteri* in Turkestan, at Bukhara and Bayram Ali. Specimens from the latter place have the same tendency, only more feebly expressed, to shorten the length of the spicules' points and to round them. Out of the Volga delta, I have already described a form, *Spongilla rotundacuta*, which I have considered a separate species closely related to *S. carteri*. Its macroscleres, with rounded points, are cylindrical. After the findings at Bayram Ali and especially at Astrakhan, which connect this form with typical *S. carteri*, it will be more correct to consider it not as a separate species but as a variety of *S. carteri* var. *rotundacuta*."

This gives, so far as I have access to recent records, a summary of the present status of the study of *S. carteri* and its varieties.

Annandale (3) in 1918, places his varieties *mollis* and *cava* in the synonymy of *S. carteri* and in a personal letter to me Dr. Arndt now agrees with my opinion that his variety *melli* should also be probably placed as a synonym of the type species. All three of these varieties of *S. carteri* were distinguished from the type by characteristics of form, which are not stable enough to warrant a varietal name. This leaves the following varieties: *lobosa*, *balatonensis* and *rotundacuta*. We must confess to a doubt as to the validity of varieties *lobosa* and *balatonensis*¹ since these also are based on external form or skeletal structure, while the spicules and gemmules do not differ materially from the typical form of *S. carteri*. The variety *rotundacuta*, however, seems to be better substantiated because it has skeleton spicules with rounded ends and because it seems to have a very different arrangement of the gemmules they consistently form a "Pavement layer" at the base of the sponge instead of being scattered all through the sponge as is characteristic of the type form.

In my study (12) of the Java sponges of this species, *S. carteri*, I found three distinct types of growth which I have described as follows in an article in "*Treubia*" (1): "Rather compact sponges of a dirty, light brown colour with comparatively smooth surfaces and only a few conspicuous oscula; (2) Light, fluffy sponges of light straw color with their entire surfaces covered with branched growths, somewhat resembling cocks' combs, about one centimeter long. These growths are of an almost uniform length. This type also has a few oscula with low, crater-like elevations." These sponges were very fragile and most of them have crumbled into small bits during transportation. (3) "There is one Java specimen about two centimeters thick which evidently formed a crust on some flat surface; this specimen has a number of fresh-water shells embedded in it." All of the other Java specimens had grown around some plant support. There were no gemmules present in the sponges of the second type described above as they were evidently collected in a favourable growing season. In spite of the fact that the external appearance of these sponges varied so much, yet I found a remarkable constancy in the spicules and the gemmules, when present, and did not feel justified in creating varieties on such variable types of external form or habit of growth.

¹ It is also interesting in this connection to note the following conclusion by Moser (16):—"Also where local forms have found themselves in complete isolation, especially in Porifera, it must be treated as a change in growth on biophysical ground. Thus for instance, the local form '*balatonensis*' of *Spongilla carteri*, from the Plattensee (Plate on p. 8) described by Arndt (*Zoologischer Anzeiger* LVI, p. 78) in 1923, in the nature of its spicules and gemmules differs in nothing from the type-species according to Arndt, but is only a variation produced by outside influence (not due to flowing water, but due to the irregular movements of the waves of stirred up waters). This influence in the external habitat produces the only deviations from the type-form. A study of the fragments reveals a far-reaching agreement of both forms, making the distinction impossible. Such isolated local forms, which have no more connection with the type-form, are not called geographical races. (In the sense of Kleinschmidt: *Die Formenkreislehre und das Weltwerden des Lebens*, Halle 1925, or of B. Rensch, *Das Prinzip geographischer Rassenkreise und das Problem der Artbildung*, Berlin 1929)."

I recently brought back from Canton and Amoy, China, through the kindness of the Biology Departments of the Universities in those places, a large number of specimens of *S. carteri*. I find in the external appearance of these a very wide range of difference, but the spicules and gemmules in structure, size and arrangement are remarkable constant. For this reason I prefer to consider all of these sponges as *S. carteri*.

The Canton sponges may according to their habit of growth also be divided into three groups: (1) There are several specimens more or less cone-shaped with the top cut off and on this top is a very large osculum into the base of which open a number of canals. The outer surfaces of this group are devoid of prominent growths of any kind and are nearly always quite smooth. These sponges were taken from lumps of mud in the paddy fields and bits of the clay are still mixed with the sponges. The largest of these has a diameter of 10 cm. at the base and is almost equally as high. (2) Another lot of the specimens consists of crusts covering small sticks or grass stems. They vary in thickness from a few millimeters to two or three centimeters or more. These have irregular surfaces composed of elevations and depressions, the small oscula usually occurring in the depressions. Both of these groups contain very large numbers of gemmules which are scattered all through the structure of the sponges. (3) Some consist of a basal mat out of which very large numbers of cocks'-like growths arise, at times they are single and rod-like, and again these may become flattened out and joined together at the tops forming ridges. In the specimen in hand (54675) these growths seem to represent a new growth upon the older basal layer. The newer growth is lighter brown in colour and contains fewer gemmules than the lower portion. In other specimens where the outgrowths represent the same growth period as the base, they are also filled with gemmules. In none of these do I find the oscula on the outgrowths; they are at their bases sometimes very small and inconspicuous and at other times very large. One very large osculum in group (1) is over 2 cm. in diameter. I, however, consider all three of these groups as belonging to the type-form.

For the reason enumerated above, I am inclined to place all the varieties, *mollis*, *cava*, *lobosa*, *melli* and *balatonensis* in the synonymy of the type-form of this species. I have not seen a specimen of the variety *rotundacuta*, but from the descriptions and the illustrations which have been published and which I have seen, this form seems to possess characters of gemmule location and skeleton spicule structure, which entitle it to varietal distinction.

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