NOTES ON *NEVADNE GLAUCA* (ANNANDALE).

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INTRODUCTION.

In 1915, Annandale (1) described a rare anemone from the Chilka Lake as a new species of the genus *Gyrostoma* belonging to the family Actiniidae. The numerous differences between this species, *Gyrostoma glaucum*, and the other members of the Actiniidae were pointed out by Stephenson (6) who in his papers on Actinian classification assigned Annandale's species to a new genus *Nevadne*, and placed it in the Endomyarian family Myonanthidae, constituted of the genera *Myonanthus*, *Macrodactyla*, *Boloceroides* and *Nevadne*. Later investigations by Carlgren (2) showed that this family could be dispensed with since *Myonanthus* and probably *Macrocactyla* were really Actiniid genera, while *Boloceroides* was in many respects a primitive form requiring a separate place in classification. A new sub-tribe, Boloceroidaria, was constituted by him for *Boloceroides* and *Bunodeopsis* since these genera included forms without basilar muscles but at the same time having a well developed longitudinal ectodermal musculature on the wall of the column and feebly developed retractor muscles on the mesenteries. On re-examination of Annandale's type specimen of *Gyrostoma glaucum*, Carlgren (3) discovered some of the Boloceroidarian features in the anemone, like, for example, the ectodermal longitudinal musculature of the body wall. On the basis of this, he provisionally referred the genus to the Boloceroidaria, under an independent family, the Nevadneidae. A very peculiar arrangement of tentacles that involves an atypical mode of development of the later sets of micromesenteries and tentacles was also reported by Carlgren as a result of his detailed examination of a sextant of the oral disc. In view of the peculiarities in the tentacular arrangement and of the many gaps in our knowledge of *Nevadne glauca*, a thorough re-investigation of the species is highly desirable ; but this would be possible only if the anemone is rediscovered. The following observations are based on a single specimen (one of the type series) from the Indian Museum, kindly lent me from the collections of the late Dr. Annandale. I wish to thank Dr. Baini Prashad for the loan of this interesting and rare material and Prof. Gopala Aiyar for valuable help and suggestions.

I have examined one of the specimens labelled ZEV 6825/7. After carefully noting the external characters, the anemone was cleared in Turpineol, and the arrangement of mesenteries and their relationship with the different cycles of tentacles were followed as far as possible under the binocular. The anatomy was studied from serial transverse sections of the same anemone, stained in Heidenhain's Haematoxylin and Orange G. The preservation of the material being indifferent, the histological details could not be followed in detail.

EXTERNAL CHARACTERS.

The specimen is vase-shaped and evidently in a state of contraction. The measurements are as follows :—

Total length of the column	9 mm.
Diameter of the basal disc	3 mm.
Maximum width of the column	5 mm.
Diameter of the oral disc	4 mm.
Average length of tentacles—	
(*a*) Outer	14 mm.
(*b*) Inner	6 mm.

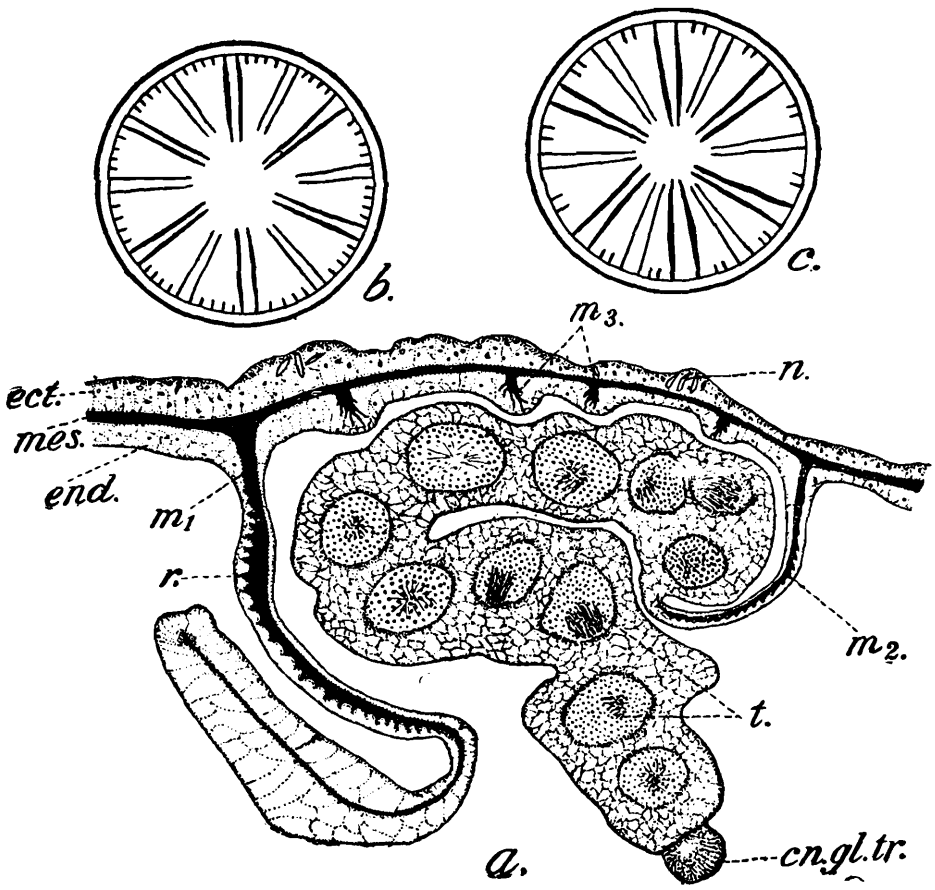
The basal disc is distinct and is provided with a distinct minute aperture in the centre. Annandale has described this as a distinct aboral pore characteristic of the species, but I doubt if this is a constant feature. As is frequently the case with young Actiniaria and certain Ceriantharia, these openings are not permanent structures, but are only punctures caused by sudden contractions. Basilar muscles are definitely absent. Insertions of the first and second cycles of mesenteries are clearly visible on the basal disc.

The column is broader at the distal part than at the proximal, and is narrowest just below the oral disc. The microscopic prominences described by Annandale are indistinguishable in the specimen, but the nematocysts on the column are arranged in groups as also noticed by Carlgren (**3**). The wall of the column is thin, and insertions of the mesenteries and their relationship with the tentacles are easily made out through the column of the cleared specimen. Columnar sphincter appears to be absent, but I have not been able to verify this from longitudinal sections of the anemone. Carlgren has already noted the presence of ectodermal longitudinal musculature on the column. In the specimen investigated by me, this muscle layer is absent from the column except in the upper region near the oral disc where it is quite distinct; but even here the musculature is rather feeble in comparison with that of other Boloceroidaria. However, these muscle fibres are quite clear at the portion of the column adjacent to the outermost row of tentacles; and it must have been this feature that led Carlgren to remark that they are rather well developed at the distal part of the column.

The Oral Disc is narrow and crowded with tentacles, there being no distinct margin. The throat is not open and has three or four faint throat ridges discernible on either side of the mouth.

The tentacles of the specimen examined number 78, which is considerably lower than the full quota of 144, described by Annandale and Carlgren. Among the 78, six are rather very small and obviously belong to cycles that have just begun to appear. Among the remaining 72, a set of 24 outermost tentacles can easily be distinguished as they are the largest in the anemone. The next in size is a set of six tentacles situated just adjacent to the mouth and evidently belonging to the primary cycle. Another set of six smaller tentacles is observed outside them, these being the tentacles of the second cycle. The remaining cycles are arranged between the latter and the last cycle of outermost tentacles. Based upon Annandale's remarks and his own examination

of the type specimen, Carlgren has found that the tentacular formula for the species is 6+6+12+48+48+24. This fact goes to prove that the specimen examined by me is one that has not attained the final stage in tentacular arrangement.



Anatomy of *Nevadne glauca* (Annandale).

a. Part of a transverse section passing through the column of *Nevadne glauca*, showing one primary mesentery, one secondary mesentery bearing gonad, and four tertiary mesenteries (× 300); *b.* Scheme of arrangement of the mesenteries at the distal-most part of the column, showing the 24 pairs of tertiary mesenteries; *c.* Scheme of arrangement of mesenteries on the column, somewhat below the oral disc, where only twelve pairs of tertiary mesenteries are visible. The primary mesenteries are shaded a little darker than the secondaries, while the tertiaries are represented as very small septa.

cn. gl. tr. cnidoglandular tract; *ect.* ectoderm of the column; *end.* endoderm of the column; *mes.* mesoglea; *m1.* primary mesentery; *m2.* fertile secondary mesentery; *m3.* tertiary mesenteries, four of them occurring between adjacent pairs of primary and secondary mesenteries; *n.* nematocysts; *r.* retractor; and *t.* testes.

The tentacles are without basal sphincters of the type noted for the Boloceroididae. The longitudinal musculature of the tentacles and the radial musculature of the oral disc are ectodermal, and are well developed.

ANATOMY.

The actinopharynx extends to about half the length of the column. There are two siphonoglyphs with aboral prolongations which are associated with two pairs of directive mesenteries. The musculature of the stomodaeum is weak.

The arrangement of the mesenteries is indicated in text figures *a*, *b* and *c*. There is no sharp distinction into macrocnemes and microcnemes. In all there are three cycles of mesenteries, consisting of a primary and a secondary cycle each with six pairs of septa, and a tertiary group of twenty-four mesenteries. Only the first and second cycles extend to the aboral extremity of the column, the last cycle of mesenteries being seen only near the oral disc. In each exocoel between one primary and secondary pair of septa, four mesenteries belonging to the last set are seen in sections of the upper-most part of the column. As pointed out by Carlgren, there is thus a doubling of the youngest cycle of mesenteries in this specimen also ; but there is this important difference that the doubling of mesenteries occurs in the fourth cycle in his specimen, while in the present individual, the doubling is in the third cycle. This fact is of considerable importance as it would mean that the deviation in the development of micro-mesenteries and tentacles commences even with the appearance of the third cycle of mesenteries. The relationships of the different cycles of mesenteries with the tentacles are as follows : The endocoels of the primary mesenteries are in communication with the innermost cycle of tentacles. The second cycle of tentacles belongs to the endocoels of the secondary mesenteries. The two pairs of mesenteries that lie in each exocoel between the pairs of primary and secondary septa are in communication with two endocoelic tentacles which are situated between the outermost group of large tentacles and those belonging to the inner group of endocoelic tentacles composed of the first and second cycles. Between each pair of endocoelic tentacles belonging to the third cycle, a single small exocoelic tentacle is seen in most sextants ; in others they are not observed, probably not being developed. The largest outermost set of twenty-four tentacles is also exocoelic.

Of the two pairs of mesenteries found in each exocoel between the first and second cycles of mesenteries, one pair is always found to be younger than the other as could be judged from the degree of development of the mesenteries and the extent to which they traverse the length of the column. Hence, in sections taken a little below the disc where the mesenteries of the first, second, and third cycles are found, only two mesenteries are seen between any two pairs of primary and secondary mesenteries (text figure *c*.). As we proceed higher up, the two other mesenteries make their appearance, thus making the full complement of four (*cf*. text figures *b* and *c*.). Hence, the mesentrial arrangement throughout the anemone, except where the last-mentioned younger mesenteries are found, is such as to suggest a normal condition, involving the six primary, six secondary, and twelve tertiaries. A parallel condition is also found in *Phytocoeteopsis ramunnii* described by me in a previous paper (**4**), where the doubling of later sets of micromesenteries and the attendant irregularities in arrangement could be noticed only near the oral disc of the anemone, the other regions of the column presenting the normal condition.

The primary mesenteries are provided with feeble retractors which have only a few muscle folds. Parietal muscles are absent. The secondary mesenteries attain almost the same amount of development as

the primaries, but the tertiaries are very weak. Mesenterial filaments are found on the mesenteries of the first and second cycles, and are absent from those of the third. The ciliated tracts of the filaments appear to be very short as only the cnidoglandular tract traverses the major portion of the mesenteries.

Annandale has observed the reproductive organs borne by the mesenteries of the second order as shown clearly by his figure of a section passing through an anemone (Figure 1, p. 71). The specimen studied by me is a male having well developed testes on some of the mesenteries, and containing spermatozoa in numerous chambers (text figure *a.*). The mesenteries belonging to the second cycle are provided with gonads, while the last cycle is completely sterile. The same is true of all the mesenteries of the first cycle except one which shows traces of gonads.

So far as could be ascertained from sections, spirocysts appear to be absent from the column, while a large number of nematocysts are arranged in groups. The capsules are of the usual type and are slightly curved. The spirocysts and nematocysts occur in great abundance on the tentacles. I am unable to make out the different types of capsules, but their measurements taken from sections are given below.

	L. B. (In Microns).
Nematoysts of the column (Majority Capsules).	12-18×2·5-3·0
Nematocysts of the tentacles—	
(1)	22-26×3·0
(2)	14-18×2·0
Spirocysts of the tentacles	25-28×3·0
Nematocysts of the throat	16-18×2·0
Nematocysts of the filament	20-22×3·0

REMARKS.

This re-investigation is in some respects incomplete in as much as certain points of structure are left unsettled owing to lack of sufficient material. Definite data have, however, been brought forward relating to the absence of basilar muscles on the pedal disc, and the structure of the column, actinopharynx, and the mesenteries. Of these the first feature definitely settles the unmistakable Athenarian character of the anemone, which along with the presence of longitudinal ectodermal muscles on the body-wall confirms its position in the Boloceroidaria. The distribution of the gonads and the presence of siphonoglyphs are in comformity with the views expressed in my paper on *Boloceractis* (**5**), where I have endeavoured to link up *Nevadne* to the Boloceroididæ, through an intervening *Boloceractis*-stage. The cardinal feature of the genus *Nevadne* is the doubling of the last set of micromesenteries and tentacles, involving an atypical mode of development of later orders which, as Carlgren has pointed out, is a marked deviation from what is found in all other Actiniaria. A similar peculiarity has also been noticed in *Phytocoeteopsis* (**4**); in both cases, there is reason to believe that there is a regular zone of growth where new tentacles appear and remain as interpolated structures, disturbing the original arrangement which otherwise would be quite normal. A detailed comparison of

the conditions in *Nevadne* and *Phytocoeteopsis* is being made in another study dealing with the development of the later sets of micromesenteries and tentacles in *Phytocoeteopsis ramunnii.*

The structural differences between the specimen described by Annandale and by Carlgren, and that which I have examined, are worthy of note since they seem to point to a reasonable doubt as to whether the present individual is conspecific with *Nevadne glauca*, in spite of its being labelled by Annandale as *Gyrostoma glaucum*. There is agreement between the two in all the main features excepting the absence of the 4th cycle of mesenteries and the presence of gonad in one of the primary mesenteries in my example. The cycle of mesenteries that has undergone doubling in this instance is the 3rd, while in the type specimen this occurs in the 4th cycle consisting of 48 septa. Do these characters necessitate the formation of a separate species for this anemone ? The last mentioned character is of much significance and would easily have marked off the anemone as belonging to a different species but for the fact the specimen does not seem to have reached its final stage of growth as judged by the nature of the mesenteries and tentacles. Further, the sizes of cnidae from different regions of this specimen are found to be in close agreement with those given by Carlgren. In view of these facts, I have described it as *Nevadne glauca.* The anemone is certainly a member of the genus *Nevadne*, but whether it is merely a developmental stage of *Nevadne glauca* or an almost adult stage of another closely related species cannot finally be settled until other specimens are investigated and the problem of the order of succession of later septa in the genus is subjected to a closer scrutiny.

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