

XXXI NOTES ON THE HABITS AND
DISTRIBUTION OF *LIMNOCNIDA*
INDICA, ANNANDALE

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(Plate xxxvi).

The medusa which forms the subject of the present paper was discovered in May, 1911, by Mr. Agharkar who sent the few specimens he was then in a position to collect to Dr. Annandale for examination. Dr. Annandale communicated the discovery to the Asiatic Society (see A.S.B. Proceedings for August, 1911) and to "Nature" (vol. lxxxvii, 1911, p. 144). As the specimens had reached him in a fragmentary condition Dr. Annandale was unable to describe them fully and further collecting was undertaken by the authors of this note in April, 1912, since when he has described the species under the name *Limnocyclus indica* (Rec. Ind. Mus. vii, pp. 253-256).

Our knowledge of the distribution of the genus *Limnocyclus* in India is probably still very incomplete. So far it has only been collected in Western India from the Yenna and Koyna, two tributaries of the Krishna, and we have been unable to add to these records by personal observation; but the Mamlatdar of Medha, after seeing the specimens we had collected near his village, told us that he had seen similar organisms at Dhôm in the Krishna itself in March, 1912, and we think his evidence may be accepted as trustworthy. These three rivers, together with two others which flow down on the western side of the Ghats, rise in a small temple near Mahabaleshwar at an altitude of 4385 ft. above sea level. All of them sooner or later fall precipitously over a band of hard rock from the plateau into wide valleys which at their commencement are probably not more than 3000 ft. above sea level. No medusae have been seen or heard of above these falls, although we searched the only place in which they were likely to occur—an artificial lake in the upper course of the Yenna Valley close to Mahabaleshwar. Nor did we hear of any place where they were known west of the Ghats, or find them ourselves in the Vashishti, the only river we were able to examine on that side.

In the Yenna *Limnocyclus* was found in May, 1911, and again in April, 1912, in a pool at Medha, about 2200 ft. above sea level and about 15 miles below the falls; and local information points to its occurrence in a pool at Kelghar at the head of the deep valley and in some pools considerably below Medha. In the Koyna

the medusae were equally abundant in the same months in a pool at Tambi, about 2100 ft. above sea level, and a single specimen was obtained by Mr. Agharkar in 1911 at approximately the same altitude at Vela, about 10 miles further down the valley; again local information points to the occurrence of the organism in places we were unable to visit, particularly at Bamnoli, 5 miles above Tambi, and at Patan, 27 miles lower down.

We have no evidence of the occurrence of *Limnognathia* in the Krishna below its junction with the Yenna and Koyna, where it flows throughout the year without becoming broken into a series of pools in the dry season; and at present we are unable to confirm Col. Alcock's record from the lake at Purulia ("Nature," vol. lxxxvii, p. 214). With regard to this record, however, it is noteworthy that the rivers near Purulia are of a very similar character to those in which *Limnognathia* lives in the Western Ghats; and there is no reason to suppose that at the right time of year a more careful enquiry than we have yet been able to institute in Chota Nagpur will not result in its discovery there in large numbers in widely separated pools just as in Western India.

The Yenna, so far as our observations went, resembles the rivers near Purulia and Chakardharpur—the only ones in Chota Nagpur known to either of us personally—more closely than does the Koyna. Near Medha it consists of a number of rather shallow mud-lined pools varying greatly in length and connected to one another by channels among rocks where the fall of the river is usually more rapid than elsewhere. In the midst of one of these rocky portions of its bed, just below the foot-bridge, there is a pool of exceptional depth with rocks rising vertically out of it on both sides, and it was in this pool only that we found *Limnognathia*, a pool in which it had been found in the previous year also. There seemed to be nothing unusual about this pool except its depth and vertical rocks; but there was no means at hand of making any attempt at a survey either of this or any other part of the river. The total depth cannot have been more than fifteen or twenty feet; and the bottom as far as we could discover consisted entirely of mud. Though of small size its character makes it a favourite bathing pool for the village, and every morning, while the water is free from the sediment brought down by the first rains, it is filled with bathers.

The medusa is most easily obtained at this time, as it frequents the deepest part of the pool, a few rising to the surface at frequent intervals, particularly after any great disturbance of the water. Though colourless and more or less translucent it is a conspicuous and beautiful object when at the surface and the natives of all places where it occurs seem to know it well. They have applied to it two most appropriate names—*chakra* meaning a wheel, and *phul*, a flower. The few who speak English talk simply of "flowers." When actively swimming to the surface the tentacles naturally trail out behind; but when at rest either on

the bottom of an aquarium or when sinking through the water they are carried somewhat as in Günther's figure of *L. tanganicæ* (P.Z.S. Lond., II, 1907, pl. xxxvii, fig. 1) except that the small tentacles, which are less adherent to the exumbrella than are the large ones, hang downwards when not carried upwards by the motion of sinking. Both the position of these tentacles in Günther's figure and the unnatural thinness and flatness of the bell there indicated are no doubt due to the imperfect preservation of the specimen from which it was drawn. For the preservation of our specimens we used a mixture of corrosive-sublimate solution and 5% formalin; when the specimens were carefully fixed and the corrosive solution used was saturated excellent results were obtained, the medusæ shrinking but little when transferred gradually to strong spirit; but when, on one occasion, the preservation of the specimens was hurried and the corrosive weak, by the time the specimens were in spirit they were found to have shrunk enormously and some of the best of them are very like the one shown in Günther's figure.

The mouth varies greatly in size from time to time in the same individual. It generally falls open when specimens are fixed, but it is usually we think, if not always, a sign of decrepitude for the wall of the stomach to be vertical and the mouth as widely open as in Günther's figure. In all our best preserved specimens it is more or less oblique, and in many it is very markedly so, the thin lip within the gonad ring being much deeper and the aperture much smaller than when the mouth is more widely open. In life, we saw the aperture abruptly contracted on many occasions; but we never remember to have seen it reduced to the "minute star-shaped aperture" found in the specimen figured by Dr. Annandale in his recent paper (*loc. cit.* fig. 1). This specimen is a very minute one and was not examined microscopically when alive. Small specimens in general seemed to close their mouths more than big ones; but we never saw the mouth other than circular in thoroughly healthy specimens. We failed to observe any of the specimens feeding; but the stomachs of some small specimens mounted in Canada balsam have been found to contain the skins of entomostraca from which all trace of the soft parts has disappeared, having presumably been absorbed by the medusa.

The medusæ in the pool at Medha, when we were there, included specimens of all sizes and both sexes; but no asexual generation was observed. In both sexes the gonad ring is white, but in the female it is marked by numerous equidistant vertical grooves, whereas in the male it is quite smooth. The number of very small medusæ in the pool made it evident that reproduction of some kind was actively going on; but whether this was direct from the sexual generation or from an asexual hydroid stock we were unable to determine. We attempted to obtain large numbers of all the earliest stages with the help of a townet; but the swimmer to whom the net was entrusted dropped it, and it was not recovered till too late to use it again that day. Next day all the medusæ

had disappeared before the thick brown sediment brought down by the first heavy rain of the season. That they had completely disappeared we established as far as was possible both by stirring the pool with our nets and by attaching a townet to a large fishing net on the end of a very long bamboo, which the village fishermen were passing backwards and forwards over the muddy bottom of the deep rocky channel with which the pool commences. The townet must have been fishing quite close to the bottom, for it several times came up filled with thick black mud. The fact of the complete disappearance of the medusae has since been further established by the Forest Ranger at Medha, who reported a month later that nothing more had been seen of them although the river became clear about a fortnight after the sediment first appeared.

From Medha we crossed over the hills into the valley of the Koyna. The pools of which this river is composed in April are much broader and often much longer than are those of the Yenna. As many of them are connected only by the percolation of water through gravel barriers, rain near the source of the river does not carry sediment very far down; and all the pools near Tambi, where we first halted, were still quite clear. Only one of them contained medusae, again a pool in which they had been found in the previous year, but we were told that they were sometimes found in others. The pool in which we found them was long and wide without rocky banks, differing completely from that in which they had been found at Medha so far as could be judged from the surface. One evening, when a strong wind had swept the pool from end to end for a few hours, the medusae were found in enormous numbers in the shallow water at the leeward end, many of them in very poor condition. This shoal had entirely disappeared next morning. Medusae were often found in quite shallow water at the other end (the one we could most easily get to), having come there without the assistance of any wind so far as we could see, but these too were often in bad condition. The best specimens were obtained by watching for them to come up out of deeper water,¹ but even these seemed to us scarcely as healthy as those we saw at Medha. Moreover not a single specimen of unusually small size could be found even with the help of townets dragged both along the bottom and nearer the surface. From this we think it follows either that all the medusae were being produced in some unknown rocky cavity out in the middle of the pool and that only the feebler adults ever wandered far enough to drift ashore, or else that the season of the medusae was drawing to a close and would not require any catastrophe to end it completely. In either case the existence of a hydroid generation seems to us to be clearly indicated, since even the dying medusae showed no signs

¹ While at Tambi we tried to ascertain whether they were more abundant at certain times of day than at others. Local testimony on this point was conflicting. We found medusae plentiful between daybreak and sunrise, as well as throughout the heat of the day. We seemed to see them best during brief times of sunshine, but this may have been due to the illumination of the water to a greater depth than when the sun was obscured by clouds.

of the production of special resting eggs. The completeness of the disappearance of all medusae from the pool at Medha when this became muddy, and the absence of medusae from all pools between May of one year and February of the next¹ also seem to point to the same conclusion. Moreover the occurrence of the medusa year after year in certain pools and its absence from others seems probable from what we saw, though by no means certain; and the organism must by now have had ample time to establish itself in every pool suited to its requirements. As far as one can see from above there is no difference between the various pools of the Koyna which can account for the occurrence of the medusa in one and not in all of them, so we are driven to suppose this difference to exist in the bottom—a point, unfortunately, which could only be settled by a survey such as our equipment did not permit us to carry out. The character of the pool at Medha seems to indicate that the hydroid must live on solid rock; and as the medusae always came up from deep water and no hydroid could be found near the edge it is probable that the hydroid lives only at a distance from the surface.

We therefore conclude that in the life-cycle of *Limnocoñida indica* there is probably an asexual hydroid stage which lives attached to rocks² at the bottom of deep pools, and that this hydroid produces medusae by budding from February till April or May, when it ceases to do so whether the pool in which it lives is flooded or not, and very possibly dies. It is perhaps noteworthy that the long duration of this supposed fixed asexual generation corresponds to that of the free asexual medusae found in Tanganyika, while the duration of the free medusoid generation of which only sexual individuals are yet known corresponds to that of the sexual generation of Tanganyika and occurs only a little earlier in the year, this difference of season being necessitated by the summer rains of India. It is still possible, however, that asexual medusae may be found in India earlier in the medusa season; and our knowledge of the times at which the Tanganyika form reproduces in different ways rests on very few observations³ and may prove to be misleading.

¹ All the inhabitants of the district seem to be agreed on this point.

² These pools contain no water-weeds.

³ For a summary of these see Günther, *P.Z.S.* II, 1907, p. 644.