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THE SETAE OF THE SUBTERRANEAN ISOPOD *NICHOLLSIA MENONI* TIWARI 1955, (CRUSTACEA, ISOPODA, PHREATOICOIDEA, NICHOLLSIDAE).

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ABSTRACT

24 types of setae are found on the body of *Nichollsia menoni*. These have been grouped into two major divisions i. e. macrotrichs and microtrichs. Their distribution and correlation with the possible function and subterranean mode of life is given.

INTRODUCTION

There are a number of references dealing with the setae in Isopods (Sars, 1899 ; Racovitza, 1912, 1925 ; Nordenstam, 1933 ; Needham, 1942 ; Nicholls, 1943 ; Chopra & & Tiwari, 1950 ; Menzies, 1956 ; Jones, 1968 ; John, 1968 ; Fish, 1972 ; Schmalfus, 1977 ; Gupta, 1980). In many cases the variation in the form and number of setae has been utilised for separation of species and subspecies ; e. g. in *Jaera albifrons* (Harvey & Naylor, 1968). The form and structure of setae have been correlated with the mode of life of the animal. Considering the subterranean mode of life in *Nichollsia menoni* it was thought desirable to investigate its setal armature. and to find the extent to which cavernicolous life has modified it.

The following account is the result of a more or less complete study to determine the variety and distribution of all setal types in *N. menoni* and to understand their functional morphology.

MATERIAL AND METHOD

The moulted skin as well as the animal's appendages were studied in glycerine preparations and also in lactophenol preparations. Addition of methylene blue to the medium gave better picture of the appendicular setae. All the studies were made under light microscope.

Classification :

Classification of setae has mostly been followed from those of Fish (1972).

The whole chaetotaxy of *Nichollsia menoni* has been divided into two major divisions : 1. Macrotrichs and 2. Microtrichs.

Macrotrichs :

The structure is basically similar in having a shaft wall enclosing a lumen which contains cytoplasm. On the basis of structural variations of the basic type, the setae can be classified into 4 major groups.

Group 1. *Simple macrotrichs* :

(a) Simple setae (b) Hamate seta (c) Rod setae (d) Aesthetascs (e) Acuminate seta.

Group 2. *Setulose macrotrichs* :

(a) Serrate Setae (b) Whip seta (c) Pap-

pose seta (d) Plumose setae. (e) Plumo-serrate seta (f) Brush seta (g) Brush spine.

Group 3. *Denticulate macrotrichs* :

(a) Dentate setae (b) Denticulate seta (c) Comb seta (d) Digitate setae.

Group 4. *Non-denticulate and non-setulose macrotrichs* :

(a) Cuspidate setae (b) Conate setae (c) Claw seta.

Microtrichs :

(a) Pegs (b) Triangular microtrichs (c) Multidentate hooks or spinnules (d) Setose bristles (e) Simple microtrichs.

Observations :

The terms seta, bristle and spines or cones used within each group indicate the degree of chitinization and thickening of the shaft wall. Setae are the least and spines are the most chitinized forms. The number of setae occuring within a group increases with the size of the animal, but the number of groups remains more or less constant. These groups exist as fringes, and closeset bundles. A seta has minute apical pore, which is not always terminal in position. This pore leads into a lumen which varies in prominence depending on the degree of cuticularization of the setal wall. Most of the setae have distinct lumen and an annulation dividing the seta in two equal or unequal proximal and distal halves. All the seta are built on a handle-blade pattern, the division being marked by a slight constriction or by a peculiarity in the structure at this point. This has been termed as "annulation" (Thomas, 1970). As already mentioned above, the position of annulation is variable among different setal types, but constant for a given variety.

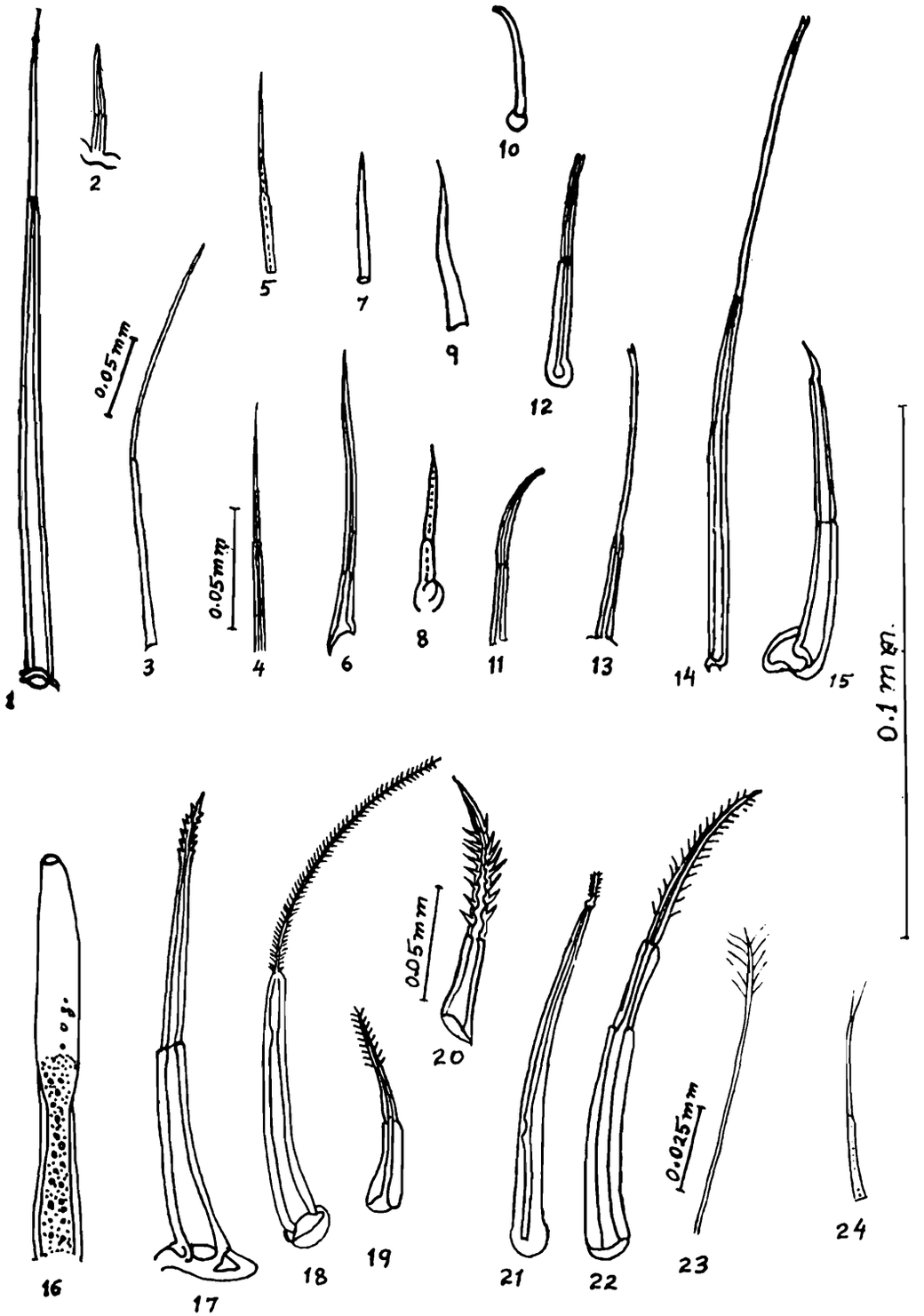
Group 1. *Simple macrotrichs* :

All the setae in this group except aesthetasc have a narrow lumen opening terminally or subterminally through a minute pore. An annulation is present about half-way along the length of the shaft. The shaft wall is without lateral projections and in all but the aesthetasc tapers gradually from a wide base to a narrow apex.

(a) *Simple setae* (Fig. 1-9) : These are flexible unmodified setae, circular in cross section, tapering gradually to a fine pointed apex and vary from 0.02 to 0.26 mm in length and 0.0015 to 0.004 mm in thickness. They occur on antenna 2, mandibular palp, maxilla 1, maxilla 2, maxilliped, pereopods, penial stylet, uropodal ramii and along the pleural edge in the abdominal region.

(b) *Hamate seta* (Fig. 10) : This is a unique hook shaped seta with a hemispherical basal region and is very small (0.034 mm in length and 0.0014 mm in breadth) compared with other setae. The tip of hamate seta is rounded and smooth, unlike other seta, the lumen becomes obliterated distally so that the hooked end is solid. This type of seta has been noticed on the peduncular segments of first and second antenna.

(c) *Rod setae* (Figs. 11-14) : These are relatively long setae, ranging from 0.035 to 015 mm in length and 0.002 to 0.007 mm in width, and taper gently from the annulation to the tip. The preannular portion of the shaft is columnar, the seta as a whole presenting a much more rod-like outline, with a blunt tip. The apices of these seta are cleft into small finger like lobes, the apical pore



Figs. 1-24. *Nichollsia menoni* Tiwari

1-9. *Simple setae* ; 10. *Hamate seta* ; 11-14. Rod setae ; 15. *Acuminate seta* ; 16. *Aesthetascs* ; 17-22. *Serrate seta* ; 23. *Pappose seta* ; 24. *Whip seta.*

being subterminal. The lumen which extends upto the pore, is conspecuous. These seta are more common than many others. They are distributed on first antenna on the distal ends of each segment either single or in groups of 2 or 3. They are also found around

the aesthetasc seta as protecting seta on the first antenna. Further they are found on antenna 2, maxilla 2, all the pereopods including gnathopods, and smaller sizes on the pleopods and outer ramii of uropods.

(d) *Aesthetascs* (Fig. 16.) : These are small seta usually 0.075 mm in length and 0.009 mm in breadth but the size varries according to the age of the animal. The annula is well marked, and distal to it the seta take on an elongated wide cylindrical tube, below the annulation the stalk is subequal to the main body i. e. the portion above the annulation of the seta. They are transparent and possess a large apical pore with a fluted margin. The body of the cylinder is thin walled while the stalk is thick.

In *Eurydice pulchra* according to Fish (1972) the annulation is absent and the stalk is very small. In *N. menoni* they occur on the distal 5 or 6 flagellar segments of the antennules. The newly hatched young possesses only one aesthetasc at the tip of the antennule. But the number increases in the adult animal. The normal function atributed to this seta is olfactory.

(e) *Acuminate seta* (Fig. 15) : This seta is not much variable from that of simple or rod seta but the only difference is that it has small terminal blade, like that of a surgical knife. The length of the seta is 0.0075 mm. It has been noticed on the distal posterior margin of basipodite, merus and dactylus of the peraeopods. Their number is very few.

Group 2. *Setulose macrotrichs* :

Setae in this group are characterised by fine setules arising from the shaft wall. The lumen does not project into these setules and their density, arrangement and stiffness varies considerably. Although all macrotrichs in this group have a terminal pore, some lack an annulation.

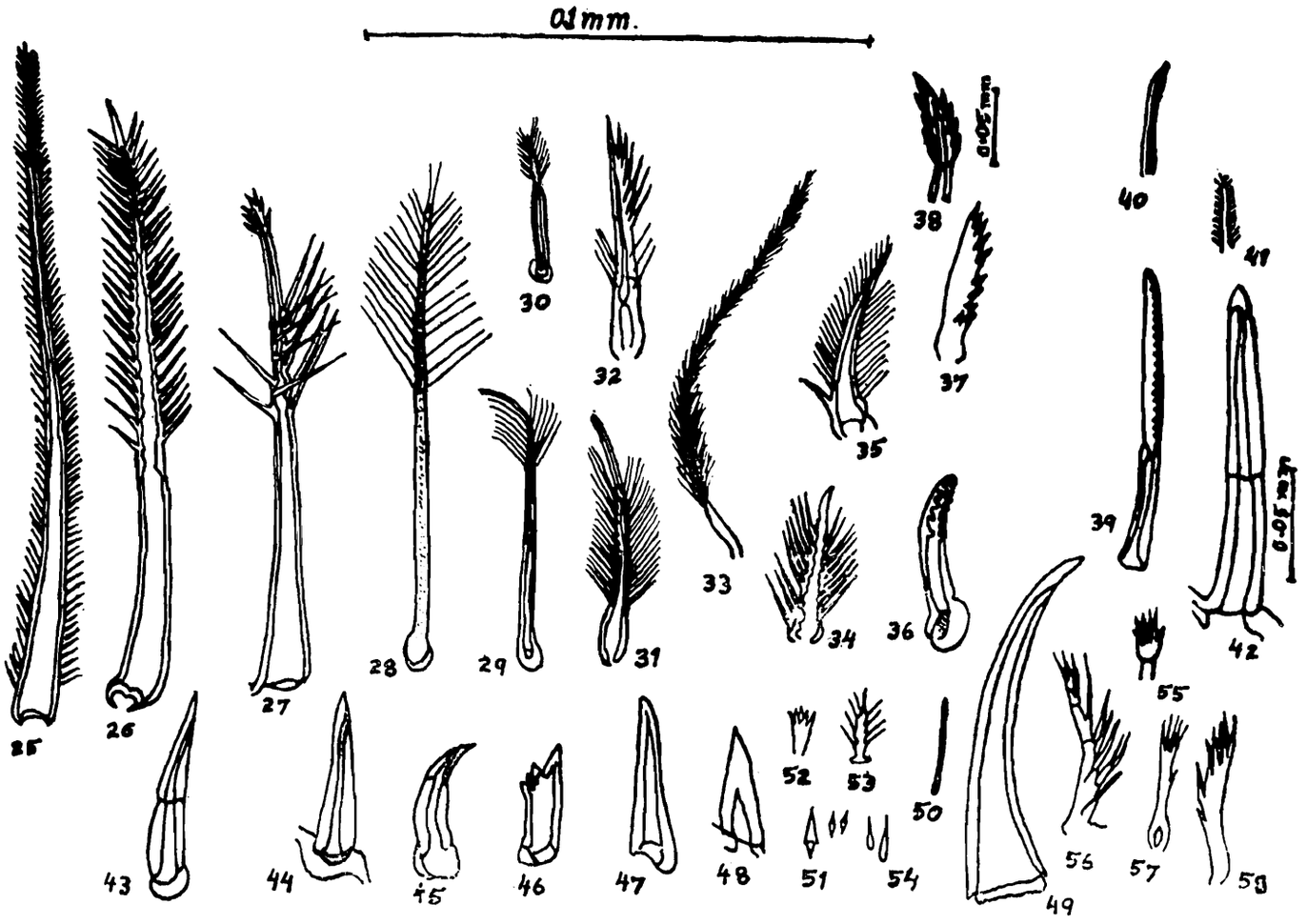
(a) *Serrate seta* (Figs. 17-22) : This type of seta has a fine pointed apex and short setules arranged in two rows usually distal to its annulation. This setal type has many varriations with the degree of serrations on the length of the seta above annulation. In some cases serration is confined to the terminal part (Fig. 17) only, while in still others only the half of the part beyond annulation is serrated (Fig. 19) while in normal course the complete portion beyond annulation is serrated. The length varies from 0.04 to 0.16 mm.

The distribution of serrated seta is confined to mandibular palp, gnathopod, other peraeopods and on the junction of the lobe of exopods in pleopods.

(b) *Whipseta* (Fig. 24) : This seta (0.035 mm long) is simple and has an annulation in the middle of the shaft and it bears two whip like fine long hairs or setules at its apex. This seta has been observed on the second peraeopod of the young, but its presence on adult is not confirmed.

(c) *Pappose seta* (Fig. 23) : The seta have extremely slender shaft and have sparsely distributed fine setules at their terminal portion. The annulation could not be detected. They are 0.085 mm in length and 0.0007 mm in breadth. They have been located on antennules only in youngs.

(d) *Plumose setae* (Figs. 25, 26, 28-32) : This type is the longest found on *N. menoni* reaching from 0.03 to 0.14 mm in length and 0.002 to 0.007 mm in breadth. Two rows of long stiff setules arise in opposite directions from the shaft wall and run from base to the apex of the seta. In such cases the annulation



Figs. 25-58. *Nichollsia menoni* Tiwari
25, 26, 28-32. *Plumose setae* ; 27. *Plumo-serrate seta* ; 33. *Brush seta* ; 34, 35. *Brush spine* ; 36-38. *Dentate seta* ; 39-40. *Denticulate seta* ; 41. *Comb seta* ; 42-45. *Cuspidate setae* ; 46-48. *Conate setae* ; 49. *Claw seta* ; 50. Pegs ; 51. *Triangular microtrichs* ; 52. *Multidentate hooks or spinnules* ; 53. *Setose bristles* ; 54. *Simple microtrichs* ; 55-58. *Digitate setae.*

has not been detected. In another type of seta the annulation is more or less demarcated by a cuticular inward thickening in the lumen of the shaft, and arrangement of setules is confined distal to the annulation (fig. 29). Plumose seta are distributed on the antennules, antenna, maxilliped, gnathopod, peraeopods and inner ramii of the uropods.

(e) *Plumo-serrate seta* (Fig. 27) : This type of seta is just like plumose seta but differs in the arrangement of setules. The long setules are arranged in the proximal half of the blade above annulation and few small setules are present in the apical region. The seta between the two setulose portions is naked and smooth. These types of setae are found on the maxillipeds and is approximately 0.1 mm in length and 0.005 mm in breadth.

(f) *Brush seta.* (Fig. 33) : These are long narrow and flexible setae with hairs around the shaft. These setae have been noticed on the margin of the molar ridge of the mandible in recently hatched young as well as adults. They are 0.07 mm in length and 0.0015 mm in breadth.

(g) *Brush spine* (Fig. 34, 35) : These are stout setae of smaller length but wider diameter with wide lumen and bulbus base. There is no annulation and shaft is armed with hairs from base to the tip. In one type there is a spine at the base of the shaft and in another type there is a terminal spine. Both the types of seta are found on the maxilliped and vary from 0.035 to 0.04 mm in length and 0.005 to 0.006 mm in breadth.

Group 3. *Denticulate macrotrichs.*

In the macrotrichs of this group serration which are a continuation of the shaft wall and are mostly in the forms of teeth, occur into two rows distal to the annulation. The lumen does not project into the teeth.

(a) *Dentate seta* (Figs. 36-38) : These are comparatively stout seta provided with blunt or conate teeth arranged in two rows. They may be long and the luman is wide. They vary from 0.035 to 0.22 mm in length and 0.005 mm in width in youngs. There is no annulation. This type of setae are found on the mandibles, maxilla 1 and maxilliped.

(b) *Denticulate seta* (Figs. 39, 40) : This seta has a smaller shaft with a long wide blade. They are 0.025 to 0.06 mm in length and 0.002 to 0.003 mm in breadth. The annulation is present. The blade has regular denticles arranged submarginally along its its whole length. This type of seta has been found on the maxilla 2 of the young and adult.

(c) *Comb seta* (Fig. 41) : This is a very small seta about 0.013 mm in length and 0.0015 mm in breadth and it gradually tapers towards its apex. There are two rows of fine serrations on the two sides of the shaft along its whole length. The lumen is almost absent. They are located on the peduncle of the antennule in youngs.

(d) *Digitate setae* (Figs. 55-58) : These are minute setae. The lumen in some is not clear, in others present. These seta terminally or subterminally develop fine finger like processes which do not appear to contain lumen extensions. This type of setae are found on the mandibles only. They range from 0.015 to 0.04 mm in length and 0.002 to 0.004 mm in width.

Group 4. *Non-denticulate and non setulose macrotrichs* :

All the macrotrichs in this group are well chitinized spines, having a thick shaft wall and narrow lumen and have wide base. An annulation is present. Apical region of the spine may be flattened and minutely ridged.

(a) *Cuspidate seta* (Figs. 42-45) : These are relatively long stoutly built setae varying from 0.03 to 0.15 mm in length and 0.006 to 0.018 mm in breadth. They are heavily cuticularized, fang like and possess a narrow lumen. The annulation is conspicuous with the shaft proximal to it becoming swollen. Their surface and outline are perfectly smooth, the lumen outline follows the outer contours of of the setal wall, except proximal to the annulation, where the lumen widens out in stages narrowing a little before it meets the integumentary canal. All these seta are fixed in elaborate sockets, their tips are rounded bearing a subterminal pore. These setae are found on the gnathopods and other peraeopods, lower margin of the telson and inner margin of the paragnath. There is a seta on the inner subterminal margin of penial stylet in males.

(b) *Conate setae* (Figs. 46-48) : These are relatively short setae always stoutly built and showing a considerable variation in size. The walls are very thick, the lumen is wide without any apical opening. The tip of the seta is very thickly cuticularized and is rounded. This type of setae are found at the inner margin of dactylus on all peraeopods and tip of outer ramii of uropods. It varies from 0.02 to 0.035 mm in length and 0.008 mm in breadth.

(c) *Claw seta* (Fig. 49) : These are elongated cones having much wide lumen which ends blindly. They are 0.07 mm to 0.11 mm in length and 0.013 mm in breadth and are found on the distalendite of maxilla-1 and end of all pereopods.

Microtrichs :

Apart from the macrotrichs described above there is a system of much smaller dimension, these have been called as microtrichs by different workers on carcinology. Their position on some of the appendages of *Nichollsia* signifies their importance. The general body surface of *N. menoni* is lacking microtrichs except few scattered macrotrichs This regressive character is the outcome of subterranean life. Here in *N. menoni* 4 types of microtrichs have been identified.

(a) *Pegs* (Fig. 50) : These type of seta are elongated fine setules which are having a more or less uniform thickness (0.00025 mm) through out their length (0.001 mm). There is no lumen. They are found on all head appendages, inner surface of the stomach and on the uropods.

(b) *Triangular microtrichs* (Fig. 51) : They are very minute in size of 0.007 mm in length and 0.0015 mm in breadth, normally arranged in crescentic rows. Some are with conical basal projection and some are with round basal projections. They are located on the the first segment of antennule, labrum, mandibular palp, maxilla, paragnath, maxilliped and along the inner margin of exopods of abdominal appendages.

(c) *Multidentate hooks or spinnules* (Fig. 52): These are small seta terminating into bifid or multifid hooks. These seta are found on the lateral ampullae of the stomach and help in tearing, puncturing and triturating the food in the stomach. They are 0.02-0.05 mm in length and 0.01 mm in width.

(d) *Setose bristles* (Fig. 53) : (0.03 mm in length). This type of seta have fine hairs on the thick, flat cuticular shaft, having both of its margins undulating. The stiff hairs arise from the elevations of the margins and form a fan like structure. This type of setae are found linearly arranged on the inner side of the bristle plates which form a part of the filter apparatus in the stomach.

(e) *Simple microtrichs* (Fig. 54) : (0.015-0.03 mm in length) These are very minute simple microtrichs of much smaller dimensions. They are found singly or in groups of 2 or more setae on the mouth parts, oral cavity, on the inner surface of the stomach and also on the inner surface of the penial stylet of male.

DISCUSSION

Although histological and experimental studies to determine the functions of the macrotrichs and microtrichs have not been carried out, it is possible to make an assessment of setal function based on distribution and morphological studies. The macrotrichs, on the basis of their presumed functions, could be of four types. Those which are

correlated with the mechanical functions are cones, comb, denticulate macrotrichs, cuspidate and conate setae. The brush spines, serrate setae and filter setae can also be included in it. They help in holding the objects, combing tearing, cutting pushing, brushing and sieving of the food material by the animal. All the plumose seta are supposed to be auditory (tactile) in function and they are concerned with the detection of the water currents. They also act as fiilter seta in some cases but their shaft is strongly built while in case of auditory the shaft is slender and attachment is more delicate and flexible and such type of seta are distributed on the proximal segments of the peraeopods and antennule and antenna and uropods. The olfactory seta are the aesthetascs which are confined to the antennules. They are no doubt chemoreceptors. The rod setae which are having terminal openings may be considered to have some sort of chemosensory functions, although they act as supporting setae around the aesthetascs. It has been found that *Nichollsia menoni* recognise its food only when it is within the reach of their antennules or sometimes below the mouth parts. The same food could not be detected although it was in touch with the long antennae. Aesthetascs have been found in almost all aquatic crustaceans, their number being variable in subterranean and surface water forms. The rod seta may also be one of the detectors of external pressure of the medium.

Like microtrichs which are also widely distributed may be shown to have different functions. All those present on the mouth parts and on the inner surface of the oral cavity have mechanical function and may have correlation with the thigmotactic behaviour of the animal. The microtrichs present inside the stomach of *Nichollsia menoni* have different mechanical function, the multidentate hooks help in tearing the food material while the setose bristles and other microsetae help in holding and filtering of the liquid food which passes to the hepatopancreas. Needham (1942) suggested that microtrichs are primarily exteroceptive and that in aquatic animals they are sensitive to movements on the surface of the body. However in *Nichollsia menoni* the microtrichs having conical basal projections are present on the inner margin of the exopods on anterior and posterior faces in the forms of crescentic rows. These crescents are arranged along the afferent canals of the exopods which indicates that they are perhaps related with the detection of nature and internal pressure of the blood in the animals.

When the setal armature of *Nichollsia menoni* is compared with the members of the family Phreatoicidae and Amphisopidae it is found that they are more profusely setose and have larger number and variety of setae (Nicholls, 1943). However there is a general tendency of reduction in the setal armature of subterranean forms of phreatoicidae. *Nichollsia menoni* is comparatively much smooth and less armed with setae, which shows that it has taken to subterranean life much earlier than members of the Phreatoicidae and Amphisopidae.

When one considers the setal armature of the foregut and mouth parts it is found that it is very much influnced by the food habit of the animal (Tiwari & Ram 1972).

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