The Internal Anatomy of Metoponorthus pruinosus (Brandt)

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The internal anatomy of *Metoponorthus pruinosus* has been studied. The circulatory system lies in the mid-dorsal line of the body. It consists of an oval heart, the opthalmic artery and a dorsal abdominal artery which supply blood to all parts of the body.

The digestive system comprises a wide, large alimentary canal and two pairs of digestive glands and occupies most of the body cavity. The alimentary canal consists of an oesophagus, a proventriculus, midgut and the short proctodaeum or hindgut. The digestive glands are very well-developed and beaded in form ; each pair lies on either side of the alimentary canal.

The reproductive organs are well-developed in the two sexes. The male reproductive organs consist of paired testes and their ducts, the vasa-deferentia. In female the reproductive organs consist of paired bilobed ovaries and oviducts.

The nervous system consists of a cerebral or supra-oesophageal ganglion, a sub-oesophageal ganglion and seven thoracic ganglia innervating all parts of the body. The supra-oesophageal ganglion is united with the sub-oesophageal ganglion by means of circum-oesophageal commissures, whereas the thoracic ganglia and sub-oesophageal ganglion are connected with each other by paired connectives.

The organs of respiration are the gills and tracheae. The gills are borne on the bases of the pleopods and enclosed in the branchial chamber, while the tracheae are located on the lateral lobes of the first two pleopods only.

INTRODUCTION

Metoponorthus pruinosus (Brandt) is an Isopod met with commonly in humid and semi-humid places usually underneath such objects as flower pots, loose bricks in gardens, organic debris around fields and even on the buried roots of certain vegetables of the family Cucurbitaceae. It belongs to the family Porcellionidae of the suborder Oniscoidea. The distribution of most of the described species in Oniscoidea is wide, if not cosmopolitan. *M. pruinosus* originated in the Mediterranean region and has now acquired a world-wide distribution.

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Most of the work on Oniscoidea and many related Crustacea is restricted in the form of notes, scattered in smaller or larger monographs, on the distribution and taxonomy of this group (Richardson, 1905; Attems, 1928; Barnard, 1932; Vandel, 1943; and Hely, 1958). The information on the biology of Oniscoidea is particularly scanty and virtually no references are available on the detailed external and internal anatomical features of this otherwise very familier group.

This apparent neglect of the study of morphology and anatomy of Isopoda may be attributed to the greater attention given by the Zoologists to the insects than other groups of Arthropoda. This is, however, not wholly justified in view of the great economic importance of the Isopods. Recent work point out that the Isopods, which apparently seem to be harmless are not so in reality. These small Crustaceans frequently become pests in the vegetable and flower gardens as well as in glasshouses. Damage to plants by these creatures has been recorded by Anderssen (1946), Cloudsle-Thompson (1958), Hely (1958) and Anonymous (1935). Theron (1961) has invited attention to another important aspect of this problem. He has shown that the habitat favouring woodlice and other Arthropods will consequently be suitable for terrestrial molluscs. According to him plants damaged by millipedes and woodlice, also invariably suffer damage from slugs and snails.

It is clear from the foregoing account that the woodlice are not so harmless as they appear and, therefore, require much greater attention than has hitherto been accorded to them. In this paper, the internal anatomy of one of the Isopods, *M. pruinosus* met with so commonly under suburban vegetation in areas around West Pakistan Agricultural University, Lyallpur, has been depicted. The study of these Arthropods require much further work before all the aspects of the biology and control of this important and so far neglected group could be covered.

MATERIALS AND METHODS

The grown-up specimens of *M. pruinosus* (Brandt) used in the present studies were collected from a number of ecologically varied niches. The adults avoid exposure to direct sun-light due to their delicate structure and danger of desiccation and remain sheltered underneath decaying plant debris, clods, and in crevices during the day and come out to feed at night. The sowbugs breathe by means of gills which must be kept moist, and on this account they frequent damp situations. The places of collection mainly included roots of Cucurbitaceous and other vegetables grown at the WPAU University Farms, heaps of loose bricks and organic debris near the water taps and around tanks and soil patches covered by flower pots. The specimens were carefully swept with the help of a camel hair brush into small glass tubes measuring 3×1 inches and were brought to the laboratory where these were introduced into a large (1' ft. diameter) glass trough. Soil taken from flower pots and containing roots of grasses and plants was put at the base of the trough. Some dried and decaying leaves taken from under the mango (*Mangifera indica*) tree were spread over the soil to serve as cover for the living specimens. Several such troughs were maintained in the laboratory. Water was frequently sprinkled in the troughs with the help of a wash bottle to provide proper moisture and humidity for the sowbugs. These troughs were covered with a piece of muslin cloth to prevent the escape of living animals and to provide sufficient aeration for them. Thus, the supply of the fresh specimens required for the study of internal anatomy was regularly available at hand. The specimens preserved in alcohol, were sent to Prof. A. Vandel in France who identified them as *M. pruinosus* (Brandt).

For the study of internal anatomy, fresh specimens were subjected to chloroform and their lateral tergal folds were clipped off. The terga were removed one by one under a binocular microscope by lifting them with the help of a pair of fine forceps, thus exposing the underlying viscera. Dissections were made in distilled water, stained and counterstained in pictic acid and fast green. This imparted a deep green hue to the animal body and helped in tracing even the fine ramifications of the nerves and arteries which were visible as shining silvery tubes with this differential staining.

The drawings illustrating this paper were made in free hand and were later rendered in ink.

THE INTERNAL ANATOMY

Circulatory System (Fig. 1)

The circulatory system in *M. pruinosus* lies in the mid-dorsal line of the body and consists of an oval heart, the opthalmic artery and a dorsal abdominal artery.

The heart (*g*) is situated in the dorsal region of the thorax on segments V & VI and is roughly oval, muscular organ. From its anterior end a medial opthalmic artery (*a*) arises which passes forwards in the anterior region of the body and supplies blood to the eyes and the brain. Posteriorly, the heart gives out a large dorsal abdominal artery (*e*) which passes backwards in the hinder region of the body and bifurcates in the last abdominal segment to suppy blood to the uropods. On its way, the dorsal abdominal artery issues out a pair of segmental arteries (*f*) in each segment of the abdomen and supplies blood to the body wall and the respective segmental organs.

Besides, the main body of the heart gives out three pairs of arteries

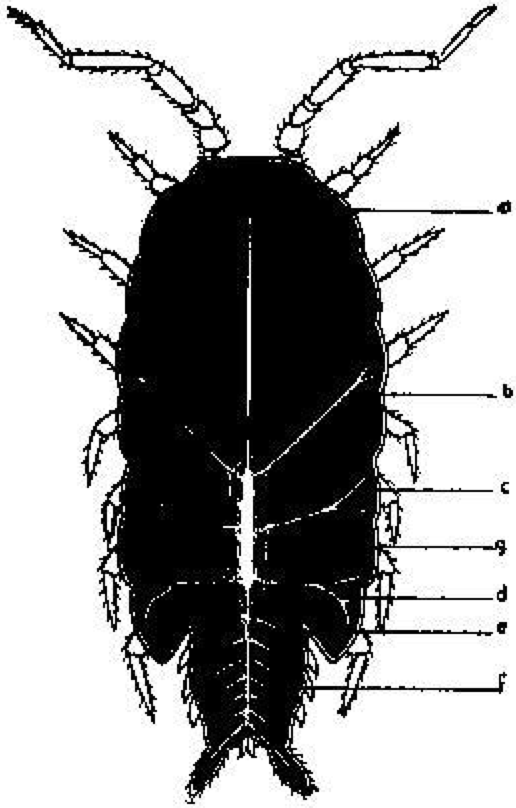

Fig. 1.—Circulatory System
a—Opthalmic Artery; *b*—Antennary Artery; *c*—Hepatic Artery; *d*—Genital Artery; *e*—Abdominal Artery; *f*—Segmental Arteries; *g*—Heart.

laterally. The antennary arteries (*b*) arising from the anterior end, pass forwards and downwards to supply the antennae, antennules and the mouth-parts. The hepatic arteries (*c*) arise from the middle of the heart extending laterally to supply the alimentary canal and the digestive glands. The third pair of arteries which arise from the posterior angle of the heart are the genital arteries (*d*) and supply blood to the reproductive organs.

All these arteries branch extensively in the various body organs they supply, becoming divided into smaller and smaller ramifications which finally end in microscopic vessels called capillaries.

Digestive System (Fig. 2; A & B)

The digestive system consists of a wide, large alimentary canal and two pairs of digestive glands occupying most of the body cavity.

The alimentary canal is more or less a straight tube lying immediately

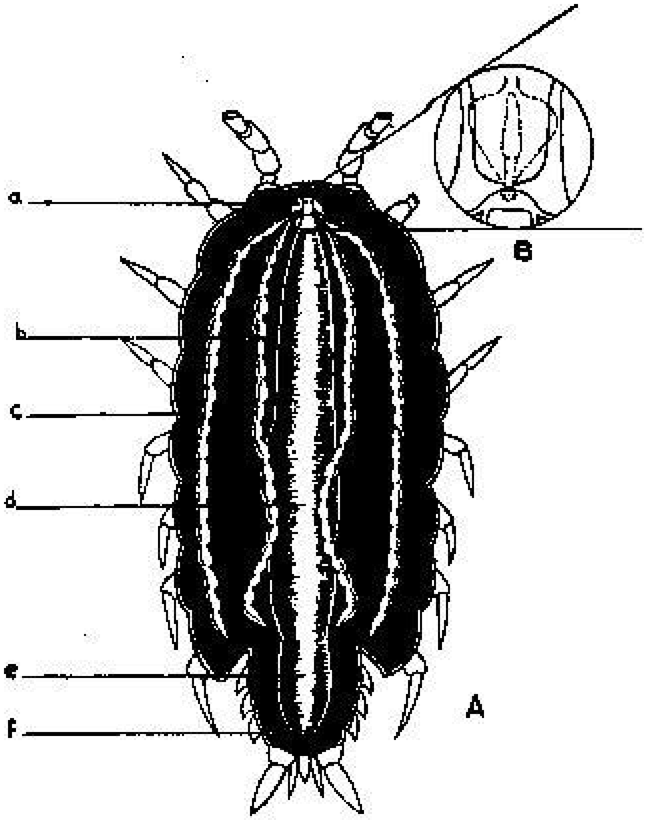

Fig. 2.—A, Digestive System, B, Oesophageal Valve
a—Oesophagus; *b*—Proventriculus; *c*—Digestive Gland; *d*—Midgut;
e—Proctodaeum; *f*—Anus.

below the circulatory organs in the mid-dorsal line of the body. It extends from the mouth to the anus. The mouth leads into a short narrow gullet or oesophagus (*a*). The oesophagus widens to open into a large, capacious proventriculus (*b*) which extends up to the middle of third thoracic segment where it merges into a wider chamber, the midgut (*d*). The latter extends up to seventh thoracic segment and passes into a short, broad chamber, the proctodaeum (*e*) which opens externally through the anus (*f*).

A valve (B) is internally present at the junction of the oesphagus with the proventriculus which probably regulates the flow of food into the proventriculus and *vice-versa*. The ducts of the digestive glands also open at the base of this valve.

The digestive glands (*c*) are paired structures lying on either side of the alimentary canal and open into the oesophaus, at the base of the oesophageal valve through a common duct. Each pair occupies the whole of the thoracic region and presents a beaded appearance.

Reproductive System (Fig. 3 & 4)

M. pruinosus is dioecious and presents sexual dimorphism. The reproductive organs are well-developed in the two sexes.

(A) **Male** (Fig. 3). In the male the reproductive organs consist of a pair of testes and their ducts. Each testis (*a*) lies on either side of the alimentary canal in the second and third thoracic segment and bears anteriorly three follicle-like structures. It gives off from its posterior side a long, slightly convoluted duct, the vas-deferens. Each vas deferens (*b*) extends up to the seventh thoracic segment to open separately into the paired penis (*c*).

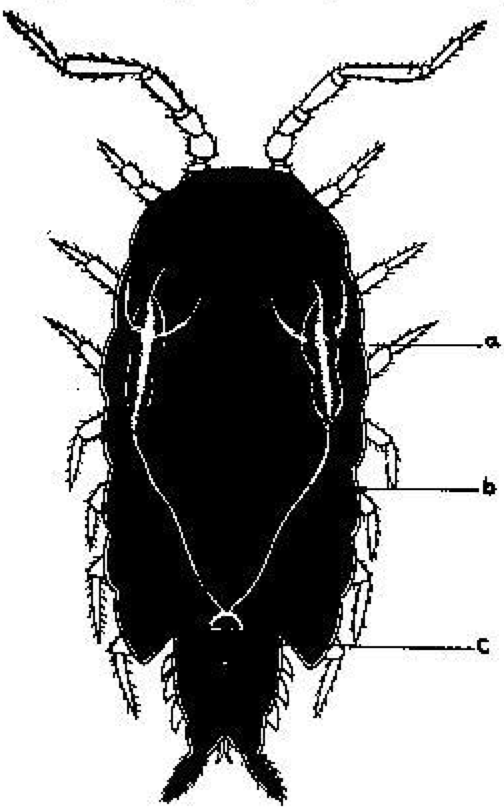

Fig. 3.—Male Reproductive System.
a—Testis; *b*—Vas-Deferens; *c*—Penis.

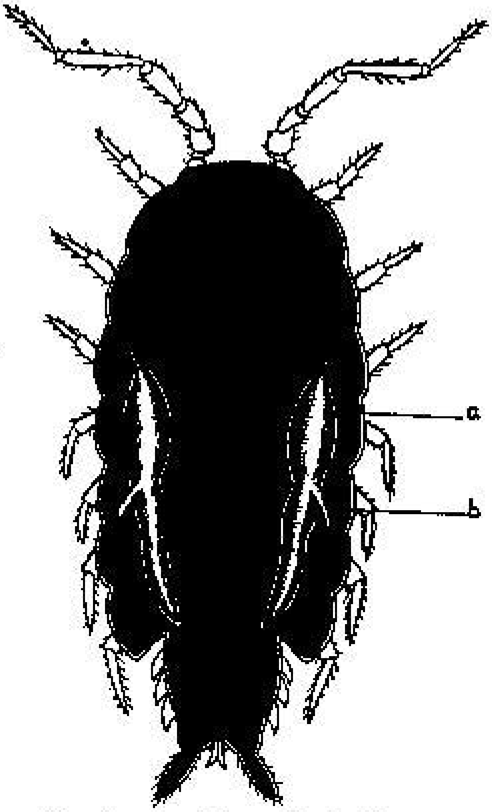

Fig. 4.—Female Reproductive System
a—Ovary; *b*—Oviduct

(B) **Female** (Fig. 4). The female reproductive organs consist of a pair of bilobed ovaries and their ducts. Each ovary (*a*) is similarly situated to the testis and gives out a thin-walled short oviduct (*b*) which passes backwards and downwards, without convolutions to open separately on the sternum of fifth thoracic segment.

Nervous System (Fig. 5)

The nervous system consists of a cerebral or supraoesophageal ganglion and a ventral nerve cord united by circum-oesophageal commissures.

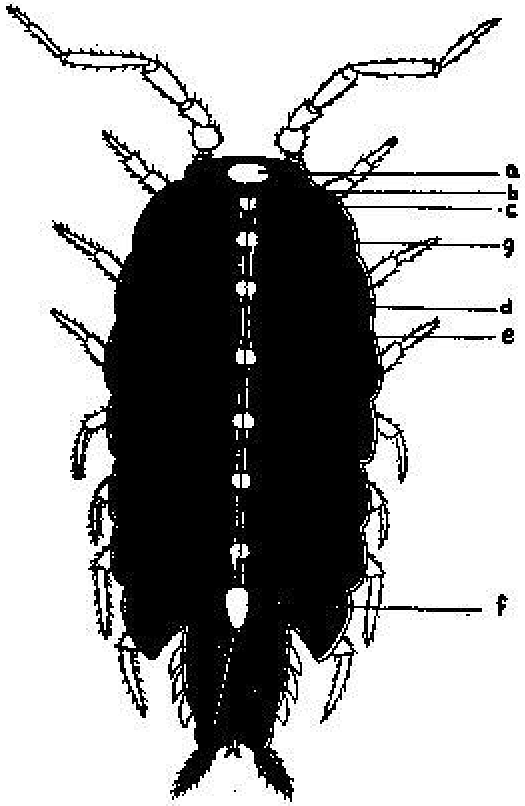

Fig. 5.—Nervous System

a—Cerebral Ganglion; *b*—Circum-Oesophageal Commissure; *c*—Sub-Oesophageal Ganglion; *d*—Connective; *e*—Transverse Nerve *f*—Seventh Thoracic Ganglion; *g*—First Thoracic Ganglion.

The cerebral ganglion (*a*) is dorsally located in the anterior region of the head and innervates the antennae, the antennules and the eyes. Two long commissures, the circum-oesophageal commissures (*b*) pass back to the sub-oesophageal ganglion from its posterior side.

The sub-oesophageal ganglion (*c*) is located at the posterior side of the head and supplies nerves to the mandibles, maxillae, maxillules and the maxillipeds.

All the thoracic segments have each a pair of ganglia innervating their respective segments. All the seven thoracic ganglia are united through a pair of connectives (*d*). A pair of transverse nerves (*e*) arises from the nerve cord in between the thoracic ganglia. The last thoracic ganglion (*f*) is conspicuous by its large size and triangular shape and supplies nerves to the abdominal segments. No ganglion has been observed in the abdominal region. Each pair of ganglia is closely fused and appears single instead of double.

Respiratory System (Fig. 6 & 7)

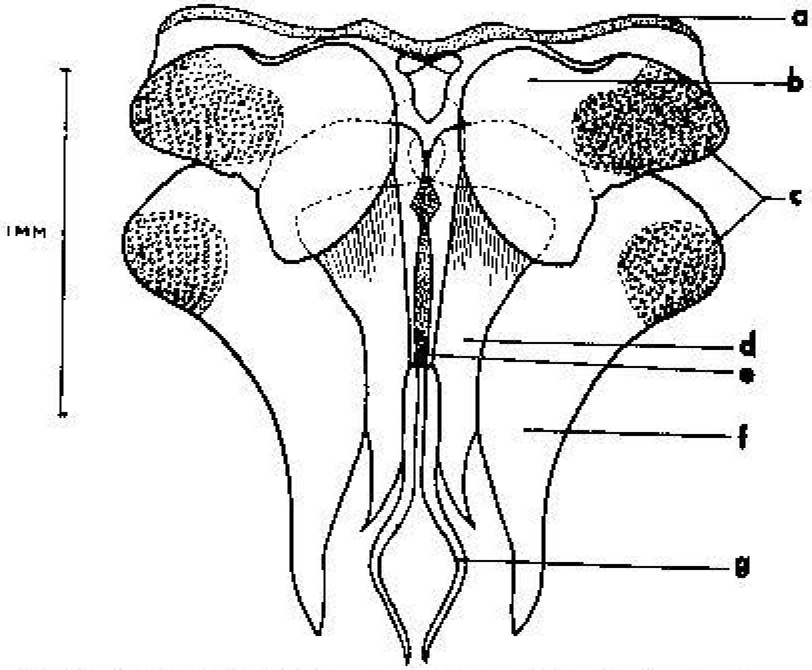

Fig. 6.- First and Second Pleopods and Penis of Male Showing Respiratory Organs (Tracheae) in Exopodites

a—Protopodite *b*—Exopodite of First Pleopod *c*—Tracheae
d—Epipodite of First Pleopod *e*—Penis *f*—Exopodite of Second Pleopod
g—Endopodite of Second Pleopod

Like other Isopods, the respiration in *M. pruinosus* is accomplished by the gills (Fig. 7; N h) borne on the bases of the pleopods and enclosed in the branchial chamber. The branchial chamber is formed by the large, soft lobes, which are the exopodites of the pleopods, located on the ventral surface of the abdomen.

The respiratory organs for air breathing are located on the lateral side of the first two pleopods (*c*). These organs appear as conspicuous white bodies within the expodites of the first and second pleopods in the two sexes. These

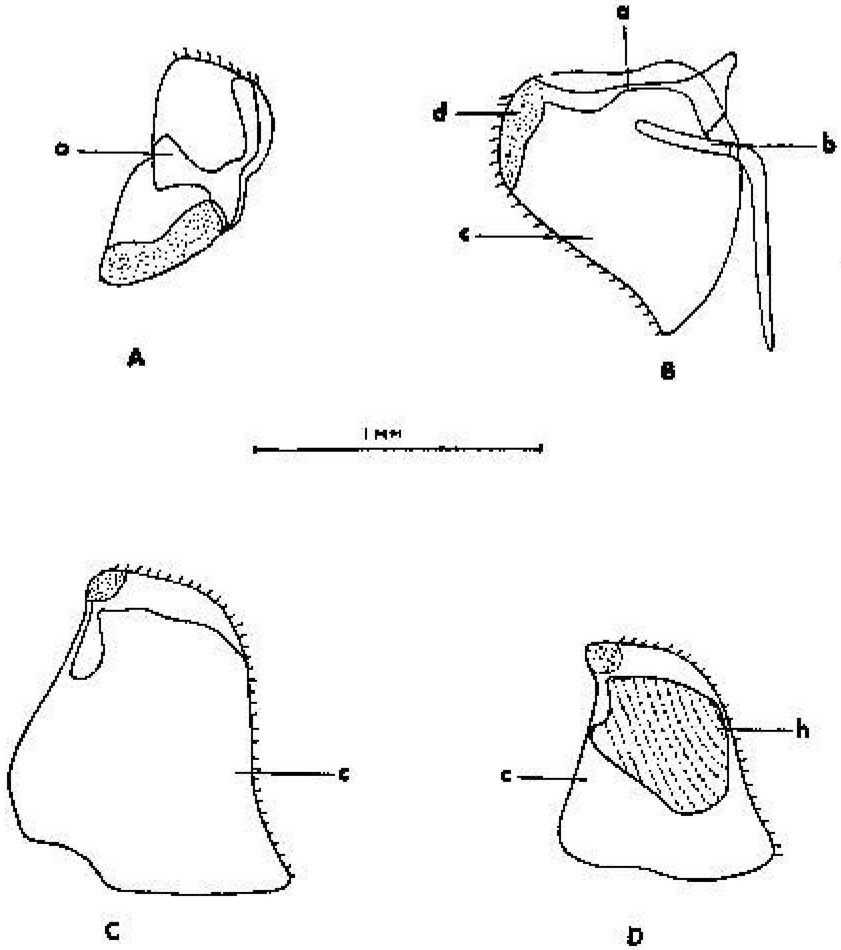

Fig. 7.—Pleopods A, First (Male) B, Second (Male) C, Second (Female) D, Fifth (Male)

a—Protopodite *b*—Endopodite *c*—Exopodite *d*—Epipodite *h*—Branchiae (Gills)

white bodies, as examined under the binocular consist of numerous, hollow lobes having a soft grandular texture which may be homologous to the primitive tracheae. These tracheae open through apertures in the posterior margin of the expodite.

DISCUSSION

The transformation from aquatic to terrestrial mode of life is one of the most constant tendencies in the Animal Kingdom. There is hardly any group of animals which does not contribute in this direction. All those animals that have shifted from one mode of living to another exhibit certain changes in their morphology and physiology a systematic study of which provides important clues to the evolutionary history of such animals. In passing from an aquatic to a terrestrial mode of life an animal has to undergo some basic changes: (1) It must liberate itself from watery surroundings in which it has lived so far. (2) It must adapt itself to wider range of thermal variations. (3) It must adapt itself to live in a dry atmosphere which requires a physiology altogether different from those organisms who lead aquatic life. For this, some organ systems undergo vital modifications.

The most remarkable changes are exhibited by modifications in the functioning of respiratory and excretory systems. The mode of locomotion, reporductive and sensory systems may also be affected.

In the most primitive aquatic Isopods the endopodites which are only well-developed in the last three pairs of pleopods are transfotmed into the vascular sacs or branchiae which serve as respiratory organs. The Oniscoides possess five pairs of exopodites on the abdomen which cover the underlying endopodites and function as opercula. In *Ligia* it is the exopodite that plays major role of respiration, the endopodite seems to have a secondary role (Remy, 1925). In the Oniscidae, on the contrary, the endopodites play the chief role and the respiratory function of the exopodites is of lesser importance (Verhoeff, 1920). In the more advanced Isopods the appearance of pseudotracheae has led to a change in the respiratory mechanism in these animals. The blood lies chiefly in the exopodites containing pseudotracheae and absorbs atmospheric oxygen directly.

In terrestrial Isopods, whose exopodites are usually devoid of pseudotracheae, the pleopods are constantly bathed by a thin layer of water. This implies that the pleopods function as branchiae and not like the apparatus meant for absorbing the air from the atmosphere. The branchial functioning of endopodites in terrestrial forms is rendered possible by their constant contact with moisture in habitats. The moisture is provided by the secretion of cutaneous glands, (glands of Weber) which maintain continuously high humidity on the pleopods and prevent their desiccation (Remy, 1928). The regular supply of water to the pleopods is also maintained in these animals by a very peculiar system known as 'Aquefere System'. Two grooves situated at the base of the thoracic legs receive the water from the body and carry it to pleopods (Verhoeff, 1920). A thin layer of water is also found between the exopodite and the endopodite. In some forms, such as *Ligia*, the endopodites of the uropods meet to enclose a capillary tube for sucking water.

In *M. pruinosus*, a very peculiar respiratory mechanism has been observed. The exopodites of the first two pleopods in both sexes bear laterally a well-marked respiratory lobe accommodating numerous tracheae therein. Besides, the exopodites of the third, fourth and fifth pleopods hide underneath small delicate branchiae or gills. This means that in this species the respiratory mechanisms are modified to assure the absorption of air dissolved in water (through gills) as well as to breathe air directly from the atmosphere (through tracheae). Such condition has also been reported in *Porcellio* and *Armadillidium* (Snodgrass, 1956). These animals constitute an intermediate group between the aquatic and terrestrial Isopods, exhibiting transitional transformation in the respiratory mechanisms and thus serve as an important link to prove that these animals have changed from aquatic to terrestrial habitats. The principal role of respiration is probably performed by the tracheae and the branchiae have become secondary in function. More elaborate research is needed before any generalisation regarding the mechanism of respiration in this specialised group could be understood. Such studies, if extended to other terrestrial and aquatic Isopods, may bring out more useful data for comparison to trace out their affinities and phylogenetic inter-relationships.

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