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Part I - Systematic account of shipworms along the South-west coast of India.

A brief review is given of the previous work on the taxonomy of the teredinids of India.

Synonyms, descriptions and illustrations are furnished of twenty eight species of shipworms enumerating the salient features, ecotypical variations together with concise notes on the ecology, previous records of occurrence and range of distribution.

The pattern of distribution of shipworms exhibits marked variation along the east and west coasts. Of the 40 species belonging to 13 genera, 30 are active along the east coast, 34 along the west coast. Twenty two are common species along the east and west coasts of India.

The occurrence, relative abundance and activity of the borers exhibit remarkable variations and fluctuations in the different areas along the coasts of India, each having its own dominant set of species and an assemblage of less important forms.
Part II - Distribution, relative abundance and seasonal variations of wood-boring molluscs along the backwater systems of Kerala.

A brief review is given of the previous work on this aspect in India and the importance of such a study along the backwater systems of Kerala.

The adverse effects are indicated of timber destroying organisms on fishing and aquaculture operation with particular reference to Kerala context.

A detailed account is provided of the distribution of wood-boring molluscs in relation to the prevailing hydrographic conditions from the major backwater systems of Kerala. The results of the present study are discussed based on reports of previous investigators.

The mean of both atmospheric and water temperatures was maximum during the pre-monsoon period and minimum during the monsoon. The water temperature was higher than the air temperature in all the systems particularly in the pre-monsoon period.

The pH of the water remained at the alkaline side throughout the period of investigation in almost all the systems and in all the seasons, except in the retting and other polluted
areas, more especially during the pre-monsoon period.

Wide fluctuations were recorded in the salinity spacially as well as seasonally within and between the different backwaters. Conditions varied from limnetic to that of mixohaline in all the systems. In general, salinity was high during the pre-monsoon, declining during the monsoon periods with a slight increasing trend during the post-monsoon period.

The dissolved oxygen values were high during the monsoon period followed by the post-monsoon and least during the hot highly saline pre-monsoon period. Variations also existed in the oxygen values between stations in the backwaters. Very low oxygen values were noted in certain backwaters of southern Kerala probably on account of the retting activities prevalent in these systems.

Fifteen species of molluscan boreres, 12 belonging to the family Teredinidae and 3 to the family Pholadidae thrive in these backwater systems and cause heavy damage to water front structures.

Among the shipworms Lyrodus pedicellatus and Teredo furcifera and among the pholads Martesia striata were the most widely distributed species in almost all the backwaters.

Species such as Lyrodus massa, L. triste, Teredo clappi, Dicyathifer manni, Nausitora dunlopei, N. hedleyi,
N. oahuensis, Spathoteredo obtusa, Bankia carinata, B. campanellata, Martesia sp. and Lignopholas sp. were the other molluscan borers associated with the dominant species in the backwaters.

Results on the seasonal incidence and relative abundance of wood-boring molluscs in five backwater systems of southern Kerala viz. Kayamkulam, Paravur, Edava-Nadayara, Akathumury and Kadinamkulam revealed marked variations.

The pre-monsoon period recorded the highest intensity of attack followed by the post-monsoon and least destruction was noticed during the monsoon period.

A brief account is appended of the distribution and relative abundance of individual species of molluscan borers in these water bodies.

**Lyrodus pedicellatus:** Among the teredinids *L. pedicellatus* was by far the most widely distributed species in the backwater systems of Kerala and was found to be active from the barmouth to the river side region irrespective of wide fluctuations in salinity both spatially as well as seasonally.

**Lyrodus massa:** Noticed in the Korapuzha, Chettuva, Kodungalloor, Vembanad and Ashtamudy backwaters, *L. massa* was active in the barmouth region, where salinity was moderately high. This is the first report of this species from the Kerala waters.
Teredo furcifera: Distributed well in all the backwaters from Nileswaram to Ashtamudy, Teredo furcifera was found active in the barmouth and middle regions of the system, where the salinity values were comparatively high. It was predominant during the pre-monsoon period and less active during the monsoon period.

Teredo clappi: This is the first report of this species from Kerala waters and its incidence was noticed only in the Nileswaram backwater.

Dicyathifer manni: Confined to the northern backwaters of Kerala, viz., Nileswaram, Valapattanam, Korapuzha, Badagara, Kallayi and Beypore, D. manni was highly destructive to water front structures including even living trees.

Nausitora hedleyi: This species was present in the Valapattanam, Badagara, Beypore, Kodungalloor and Vembanad backwaters. This was the most dominant species in the Vembanad Lake and was found to thrive well in almost all areas irrespective of wide variations in salinity.

Nausitora dunlopei: This typical brackish water species was very rare in the backwaters of Kerala, as it was found only in three widely separated systems during the present study and represented by a total of only nine specimens.
Bankia carinata: Noticed in some isolated areas of Nileswaram,
Kallayi and Vembanad bakwaters, B. carinata being a stenohaline
species was active in areas where salinity was near to marine
condition.

Bankia campanellata: Noticed only in the Nileswaram backwater
and Valapattanam estuary, B. campanellata was rare in the
Kerala waters.

Martesia striata: This pholad was fairly well distributed
in the Chettuva, Kodungalloor, Vembanad, Kayamkulam, Ashtamudy
and Kadinamkulam backwaters, while in the Nileswaram, Vala-
pattanam, Korapuzha, Badagara, Kallayi and Beypore, it has
not been quite successful since another pholadid borer Martesia
sp. has apparently taken its place.

Martesia sp.: This borer which was present in large numbers
in living trees as well as in the dead stumps of mangroves
in the northern backwaters such as Nileswaram, Valapattanam,
Korapuzha, Badagara, Kallayi and Beypore, differs conspicuously
from all other recorded species of this genus from India
viz. Martesia striata and M. fragilis.

Lignopholas sp.: The present species which differs from the
other two species described earlier was found active in the
low saline areas of the Vembanad and Akathumury Lakes.
Its incidence was minimum during the pre-monsoon period
but gradually increased during the monsoon to attain a peak during the post-monsoon period.

The present observations on the nature of incidence and relative abundance of all the above mentioned species have been discussed on the basis of information available from earlier observations.

Part III - Marine wood-boring molluscs of the Lakshadweep Archipelago

A survey has been conducted during May 1987 in nine atolls - 4 inhabited and 5 uninhabited - of the Lakshadweep Archipelago, to examine the nature of incidence and distribution of the wood-boring molluscs.

Quite contrary to conditions prevailing in the backwaters, the hydrographic features in the insular situations showed only slight variations and the values were characteristic of marine condition.

A total of 19 species of molluscan borers, 18 shipworms belonging to seven genera and one piddock of the genus Martesia occur in the different atolls.

The dominant and most destructive endemic species are Teredo clappi, T. fulleri, T. furcifera, Lyrodus massa and L. pedicellatus.
Species such as *Teredothyra excavata*, *T. smithi*, *Teredora princesae*, *Uperotus clavus* and *Martesia fragilis* are probably not endemic to the archipelago as none of these could be collected from fixed timber structures. *Psiloteredo senegalensis* is reported from the Indian waters for the first time.

*Teredo palauensis*, *Teredo aegypos* and *T. somessi* are reported only from these areas in the Indian waters. Similarly the present study extends the range of distribution of a few species such as *Teredo fulleri*, *T. triangularis*, *Uperotus rehderi* and *U. clavus* to the west coast as well.

The occurrence of shipworms in drift wood and the role of such substrate in the dispersal of shipworms are also discussed.

**Part IV - The anatomy of *Dicyathifer manni***

Previous work on the anatomy of shipworms, and the structural and functional peculiarities of these highly specialised boring bivalves have been briefly reviewed.

The shell that covers only a small portion of the anterior region of the body has lost its protective function, and acts as a drilling tool for the excavation of the burrow. The unique shape of the shell, its elaborate denticulations, the development of additional faces for the insertion of the
adductor muscles, acquisition of secondary articulations for facilitating rocking movement, are all suggestive of this function.

The pallets, a pair of calcareous structures at the posterior end of the body is a simple, solid structure, more or less triangular with a long thick stalk, is used for sealing the entrance of the burrow when the siphons are withdrawn.

As the shell has lost its protective function, protection for the elongated naked body is afforded by the development of a calcareous lining - which is moderately thick in this species - on the inner aspect of the burrow.

The mantle margins are fused ventrally to form a tube with an anterior opening for the foot and posteriorly modified as the two siphons, for the entry and exist of the physiological current of water. The mantle shows variation in thickness in the different regions of the body and is composed of three layers, an outer epithelium, an inner epithelium and a middle layer of loose connective tissue containing blood spaces, muscle fibres and nerves.

The foot, situated at the anterior end of the visceral mass, is circular with a wrinkled periphery covered by ciliated columnar epithelial cells and central disc-like area or sole, formed of an outer layer of non-ciliated cells. The foot is provided with glandular cells and musculature.
The siphons formed by the fusion of the mantle at
the posterior end of the body, when extended to the outside
are the only visible soft parts of the animal in its natural
habitat. Between the outer and inner layers of epithelium
lining the outer and inner surfaces of the siphons, are disposed,
several layers of muscles, circular, longitudinal and radial.
These muscles are almost uniformly distributed with little
local differences in their extent and disposition along the
entire length.

The adductor muscles - the anterior and posterior
stretch across the shell valves in the anterior and posterior
regions of the shell valves respectively are formed of closely
packed striated muscle fibres.

Considerable variations exist in the anatomical details
of the different parts of the alimentary canal. The mouth
located below the anterior adductor and above the foot is
bounded laterally by the labial palps which are rudimentary.
It communicates with the stomach through a small oesophagus.
The stomach is globular, and thin-walled with additional
pouches such as the appendix, dorsal caecum, lateral pouch
and the crystalline style sac and a series of ridges, grooves
and ciliated tracts. The appendix is moderate in length,
thin walled and doubled back on itself, without any typhlosole.
The crystalline style sac with its contained style, projects into the foot and opens into the stomach.

The digestive diverticula which opens into the stomach consists of two types of tubes histologically and they appear in three masses, one just anterior part of the stomach, the second lateral and scattered over it and the third posterior to it extending posteriorly beyond the caecum.

The midgut takes a straight forward course after its origin from the stomach, loops over the crystalline style sac in the foot, turns sharply back to pass along the ventral side of the stomach and extends posteriorly along the left side of the digestive diverticula. At about the middle of the digestive diverticula the midgut creeps above it and takes a forward course along the dorsal surface of the gland and below the pericardium to the posterior adductor muscle and then bends around the anterior face of it and continues a short distance beyond it to open in the anal canal through the anus. The opening of the anal canal into the epibranchial cavity is regulated by muscular folds. The anterior part of the midgut is provided with a highly coiled typhlosole. The alimentary canal in almost all areas is lined by ciliated columnar epithelial cells with oval nuclei.

The ctenidium is composed of an anterior part consisting of seven filaments on either side of the labial palps and
a posterior part which is blade-like, extending from the posterior end of the visceral mass up to the base of the siphons in the branchial cavity. These two are connected by a shallow ciliated groove – the branchial groove. Each filament is V-shaped with a well-defined food groove and composed of three types of cells. The inter-filamentar space is filled with connective tissue and the spaces within the gill laminae are packed with the glandular tissue referred to as the glands of Deshayes.

The pericardial cavity enclosing the heart is considerably elongated occupying one half of the length of the animal and extends from the posterior adductor muscle to the anterior end of the gill. The ventricle is short, broad and inflated, while the auricles are long and tubular.

The kidney and the ureters lie on the upper side of the pericardial cavity and ventral to the anal canal. The kidney, a creamy-white mass consists of an irregular mass of compactly arranged tubules composed of an epithelium of vacuolated cuboidal cells. The ureters are four in number, two afferent renal ducts and two efferent renal ducts, lined by vacuolated cells.

The gonads occupy the available space between the posterior end of the digestive glands and the visceral ganglion and even extending beyond it. It is composed of branching
tubules terminating in closely arranged follicles. The gonoducts, that are
distinguished towards the posterior region of the gonad, pass beneath the organs found in the terminal part of the reno-pericardial ducts and the visceral ganglion and open into the epibranchial cavity by separate openings.

The nervous system consists of the cerebral ganglia found dorso-lateral to the mouth behind the anterior adductor muscle, the pedal ganglion, in the mid-dorsal part of the foot, the cerebro-pedal connectives connecting the cerebral and pedal ganglia and nerves arising from it.

The present findings are discussed in detail in the light of other observations of earlier workers. The probable course of evolution within the Teredinidae is discussed with the help of the available evidence based on the present study.