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ON THE BURROWS OF ECHIURAN WORMS (ECHIURA): A SURVEY

A. S. F DITADI

Departamento de Zoologia. Universidade de São Paulo. 01000 C. Postal 6868, São Paulo, Brasil. (received 10.VI.1981)

RESUMO - Estudou-se o biótopo e a arquitetura das galerias dos equiúros *Lissomyema exilii* e *Ochetostoma erythrogrammon*, comparando-se os resultados com os existentes na literatura para outros equiúros. *Lissomyema exilii* constrói, com areia fina e lôdo, uma galeria em forma de U, dentro de conchas de moluscos e de carapaças de equinóides irregulares. As conchas estão enterradas entre 100 e 220 mm de profundidade na areia lodosa; o verme comunica-se com a superfície através de um par de canais estreitos, situados entre a galeria e o sedimento da superfície da praia. Os canais e a galeria são revestidos, internamente, com muco endurecido. No sedimento superficial as galerias de equiúros são identificadas, principalmente, por pequenos montes de pelotas fecais. *Lissomyema exilii* povoa uma pequena área de fundo de mar da região entre-marés no litoral norte de São Paulo, Brasil; a densidade populacional é de 11 animais/m^2. A macrofauna da área em estudo é composta principalmente de poliquetos, moluscos e crustáceos, a maioria dos quais vive em galerias ou apresenta tendências cavadoras. As galerias de *Lissomyema exilii* acomodam vários comensais entre eles, cinco espécies de poliquetos, duas de nematodes, duas de entoproctos, uma de nudibrânquio e um crustáceo. *Ochetostoma erythrogrammon* constrói tubos em forma de L, em praias de areia clara e grossa. Até o momento não foram encontrados comensais nestas galerias.

ABSTRACT - Field and laboratory investigations on the biotope and on the burrows' architecture of the echiuran worms *Lissomyema exilii* and *Ochetostoma erythrogrammon* were conducted, the results being compared with those on other echiurans. *Lissomyema exilii* builds a U-shaped gallery inside silt-filled shells of molluscs and irregular echinoid tests The shells containing echiurans are embedded 100-200 mm deep in the muddy sand; the worm comunicates with the surface through a pair of narrow channels localized between the burrow and the surface sediment. The channels and the burrow are internally lined with hardened mucus. On the surface sediment the echiuran galleries are identified mainly by small casts of faecal pellets. *Lissomyema exilii* populates a small piece of sea bottom of the mid-intertidal at the north littoral of

São Paulo, Brazil; the population density is 11 animals/m^2 The macrofauna in the area studied is composed mainly of polychaetes, molluscs and crustaceans, most of them showing burrow and tube building tendencies. The galleries of *Lissomyema exilii* harbor several commensals, including five species of polychaetes, two of entoprocts, one of nudibranch and a crustacean. *Ochetostoma erythrogrammon* builds L-shaped tubes in coarse clear sandy beaches. No commensals were found yet in these galleries.

KEY WORDS - Echiura, burrows, biotope macrofauna, energy commensals, *Echiurus echiurus, Lissomyema exilii, Ochetostoma erythrogrammon, O. capense, Urechis caupo.*

INTRODUCTION

Information on the architecture and/or construction of burrows by echiuran worms is restricted to the papers by Fisher & MacGinitie (1928) on *Urechis caupo*, by Gislén (1940) on *Echiurus echiurus*, by Jones & Stephen (1955) on *Ochetostoma capense*, by Chuang (1962) on *Ochetostoma erythrogrammon* , by Ditadi (1969, 1975) on *Lissomyema exilii*, and by Schembri & Jaccarini (1978) on *Bonellia viridis*. Sluiter (1883), Stephen & Robertson (1952), Menon et al., (1954) and Hughes & Crisp (1976), among others, write about the entrance - exit openings of the burrows of echiuran species but do not refer to the tubes' shape and/or building process. In papers of systematical approach references are frequently found on the substratum from where echiurans have been collected but less frequently there are informations on the burrows of the animals.

The present paper compares the galleries of *Lissomyema exilii* with those of other species, as well as summarizes the data on the associated infauna of echiurans.

MATERIAL AND METHODS

Field observations during low tide periods provided the clues to find the entrance and/or exit openings of the galleries of *Lissomyema exilii* and *Ochetostoma erythrogrammon*. Most of this work was carried out at a mud flat named Araçá (23° 48' S 45° 23' W), at the north littoral of the State of São Paulo, Brazil.

A saturated aqueous solution of titanium oxide or of carmine was used to trace the path of the gallery of *L. exilii*. As concerns *O. erythrogrammon* it was necessary to inject liquid polyethylene into the openings of the galleries to discover the burrow architecture. The plastic used for this purpose was obtained upon a mixture of 88% of polylite resin, 10% of styrene monomer and 2% of Peroxol; the mixture hardens some hours after injection. Thus on the next day one can easily dig out the gallery model.

FINDING PLACES OF ECHIURANS

A gentle sloping and protected beach is the apropriated place for the settling of intertidal echiurans. The substratum may be composed by clear sand, fine or coarse, or by deep black oozy silt; besides that, the sediment may include pebbles, molluscan shells, echinoderm tests, bits of coral, or it may be overlayed by a belt of angiospermae roots. Dead corals and rock crevices also provide hiding places for these worms. Occasionally they may be found in abandoned galleries of Teredinidae molluscs, on emply polychaete tubes or under algal roots. Wherever they are found, their galleries are internally coated with mucus, a fact not observed only in the burrows in coarse clear sand.

Echiuran worms which inhabit soft substrata between tide marks, usually build U-shaped galleries. This U-shaped gallery may have straight or somewhat convoluted arms, showing some remarkable specific particularities.

Urechis caupo, *Echiurus echiurus*, *Lissomyema exilii*, *Ochetostoma capense* and *O. erythrogrammon*, studied by Fisher & MacGinitie (1928), Gislén (1940), Ditadi (1969, 1975), Jones & Stephen (1955) and Chuang (1962) respectively, have galleries formed by compacted mud mixed with mucus secretion.

Brazilian echiurans belonging to the genus *Thalassema* build their galleries among branches of madreporarian corals such as *Mussismilia hispida* and *Madracis decactis* and among the ramifications of giant bryozoans such as *Schizoporella unicornis*, while species of *Lissomyema* were found within dead mollusc shells filled with silt, in barnacle shells and in tests of dead irregular echinoids. Other echiurans have been reported as inquilins of the galleries of polychaetes and crustaceans. Lankester (1881) found hundreds of *Thalassema thalassemum* (formely *T. neptuni*) living inside limestone galleries excavated by the bivalve *Gastrochaena*, while Wharton (1913) refers *Ochetostoma griffini* (described as *Thalassema griffini*) as commensal of the anomuran crab *Gebia*.

Bonelliids inhabit coraline rocks as well as rock crevices, although they do not bore the rocks by themselves as Ikeda (1904) referred to *Bonellia minor*. Obviously these soft bodied animals have no power to excavate into such hard substratum a fact clearly demostrated by Schembri & Jaccarini (1978) for *B. viridis*. Thus, instead of building its own burrow *B. viridis* profits of the multibranched system of galleries perforated by the crustacean *Upogebia deltaura*. Moreover, these authors observed that *B. viridis* does not inhabit blind burrows and is able to move out from its burrow an to rove under the rocks.

Each echiuran gallery, be it built of compacted mud or found among dead coral or within molluscan shells, has its internal walls coated by a mucous film. Macha & Ditadi (1972), using autoradiographic techniques, characterized the mucus of *L. exilii* as an acid sulfomucim, while Bosch & Michel (1979) found a sulphated and a carboxylated mucus in *B. viridis*. In echiurans from mud burrows this mucus acts as a cement, keeping the sand grains firmly bound together.

In order to better characterize the animal community at Araçá beach (See MAP I), comments are presented here regarding the macrofauna living in the general area where *Lissomyema exilii* is found.

Polychaetes, crustaceans and molluscs were found to be the most abundant both in number of individuals as well as in species.

Among the polychaete worms *Loimia sp* (Terebellidae) is the most frequent species at *Lissomyema*'s population site. The second more abundant family is the Chaetopteridae, represented by *Chaetopterus variopedatus*, *Mesochaetopterus xerecus* and *M. xejubus*, and *Thelepsavus sp.*Other very common polychaetes are *Ammotrypane aulogaster* (Opheliidae) and *Diopatra cuprea* (Onuphiidae) The occurrence of the families Polynöidae, Amphinomidae, Nereidae, Cirratulidae and Sabellariidae should also be mentioned.

Besides the Stomatopoda, a fairly common crustacean is *Upogebia affinis* (Callianassidae) Mention should be made also to *Corophium sp.* (Amphipoda), and *Lepidopa sp.* (Albuneidae).

Gastropods and bivalves constitute the representative molluscs in the studied portion of Araçá beach. Among the bivalves, the most frequently found are *Anomalocardia brasiliana* and *Dosinia concentrica* (Veneridae), *Phacoides pectinatus* (Lucinidae) and *Trachycardium muricatum* (Cardiidae) *Bulla striata* (Buliidae), *Cymathium partenopeum* (Cymathidae) and *Cerithium sp.* (Cerithidae) are the most common gastropods Aplysiids occur occasionally throughout the beach.

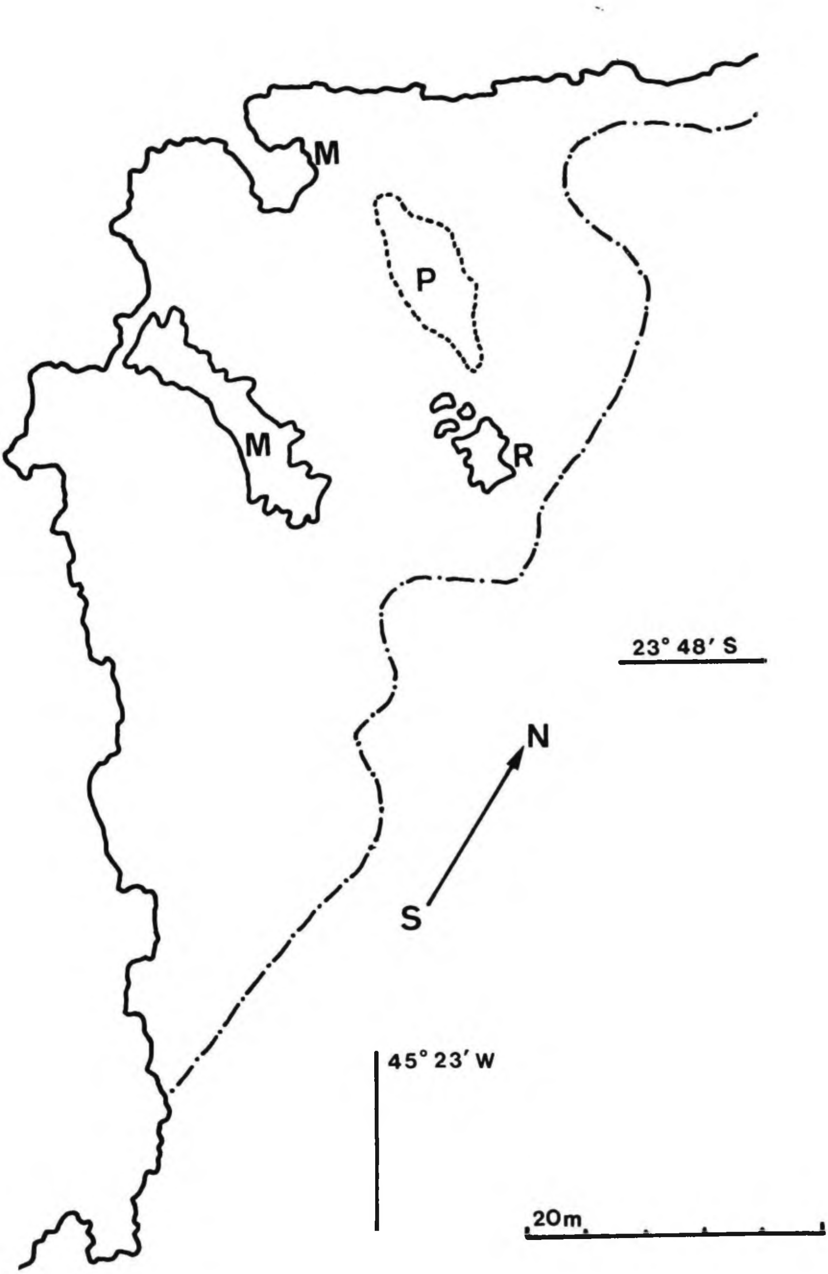
To the list on *Lissomyema exilii* accompanying fauna the following invertebrate groups may be added: sipunculans, hemichordates and nemerteans, the first two being tube building animals, the third group comprising many burrowing species. The constant occurrence of so many groups in such a small area throughout the years is a good indication that this area offers advantageous conditions for tube and burrow -dwelling animals.

Echiurus echiurus (Pallas, 1766)

The family Echiuridae was not hitherto reported for the Brazilian shelf, however Amor (1975) refers the presence of *Echiurus antarticus* Spengel in the extreme South America.

For the moment, the classic paper by Gislén (1940), on *Echiurus echiurus* provides the necessary information to outline the burrow of the species, as showed in Figure 1B.Though in this Figure 1 the side arms are shown as two vertical tubes, they may equally be represented by two somewhat oblique channels. *E. echiurus* builds up its gallery in well compacted sand clay bottoms where pieces of mollusc shells and echinoderm tests may be found; however the worms do not use molluscs or echinoderms to construct the burrows.

The horizontal segment of the burrow is at a mean depth of 10 cm. Faecal pellets may be deposited and pressed against the wall of the curves of this U-shaped burrows, the result



Map I - Map of the collecting place of *Lissomyema exilii* in South Brazil. M = mangrove trees; P = population area of *L. exilii;* R = rocky island; broken line represents the low tide limit (after Petersen, 1965) being a less sharp curvature than that shown in the Figure 1.

The mean diameter of the horizontal and vertical channels ranges from 2 to 3 centimeters while the entrance-exit openings are only 1,5 to 3,5 mm in diameter. These openings are commonly blocked by a plug of mucus and the measurements refer to the holes the worms pierce through. In aquaria (Gislén, l.c) the anal-side opening is usually blocked by loose mud at least in the beginning of burrow's construction. *E. echiurus* is able to turn in its burrow as well as to explore the surface sediment by extending the proboscis out of the openings. On performing this last activity the worm imprints food-tracks in the sand which radiate from the entrance opening(Fig. 1B)

Lissomyema exilii (F Müller, 1883)

Specimens of *Lissomyema exilii* from the Brazilian coast have been found mainly within bivalve and gastropod shells; and also collected from empty sand dollar tests dredged by Schaeffer (1972) When an echiuran occupies a bivalve shell, the valves remain so tightly closed that at first sight one may believe that the mollusc is still alive.

At what stage in its life history the worm enters the shell is unknown. The only relevant comment on the subject seems to be Conn's (1886), who reported". it enters the shell (a carapace of *Mellita*) at the oral opening while yet very small. ."

The molluscan shells inhabited by *Lissomyema exilii* are found in the muddy sand of the middle-intertidal at depths between 150 and 220 mm. In the boundary of *Lissomyema*'s area, near the mangrove (Map I, M), the sediment is very silty and usually only shell fragments are found; even there, it is always possible to identify a large shell fragment being used as the floor of the wider portion of the gallery.

A *Lissomyema* gallery is divided into two parts: the inhabiting chamber and the two lateral channels (Fig. 1A)

The chamber corresponds to the curvature of the U-shaped burrow. In cross section, it presents a circular contour with a mean diameter of 8 mm; this measurement was taken at the central portion of the chamber, since it narrows towards the lateral channels. The chamber may describe a few loops although they do not intercept one another.

The color of the chamber ranges from light to dark brown, contrasting with the surrounding greyish sediment. Moreover, due to the internal mucous lining, the colors are shining. The rusty color of both chamber and channels was attributed by Wilson (1900) as resulting from mucus oxidation, while Gislén (1940) interpreted it as a consequence of the aerated water current pumped by the echiuran through the inhabiting system.

Among hundreds of galleries examined, the channels were always directed upwards without bendings. The maximal slope presented by the channels in relation to the surface sedi -

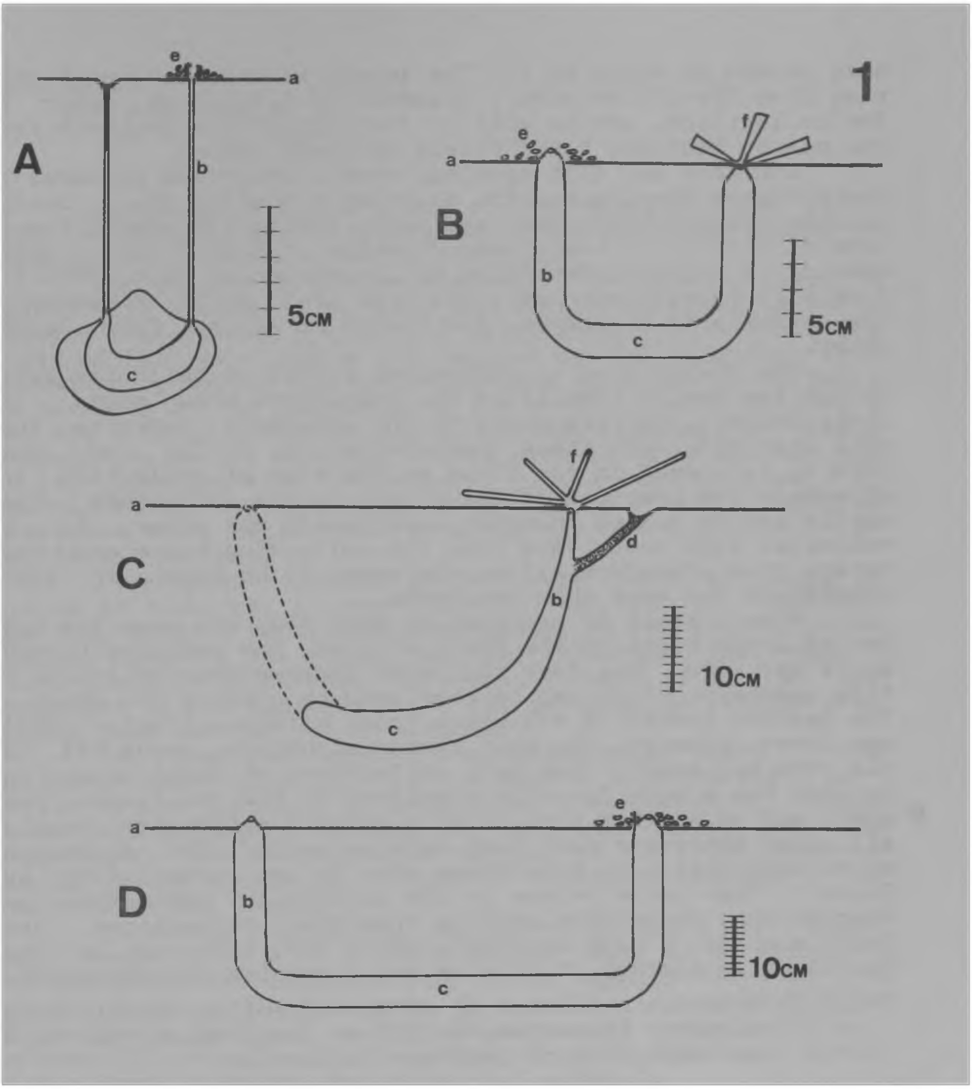


Figure 1 - Diagrammatic representation of echiuran burrows A, *Lissomyema exilii* builds a U-tube inside an empty molluscan shell (after Ditadi, 1969). B, *Echiurus echiurus* (from a description by Gislén, 1940). C, *Ochetostoma erythrogrammon* (present study; food tracks based on a sketch by Stephen & Robertson, 1952 and on a photograph by Chuang, 1962) D, *Urechis caupo* (simplified from Fisher & MacGinitie, 1928 and Lawry, 1966) a = surface sand, b = side arm; c = inhabiting chamber; d = extra side arm; e = faeces; f = food tracks Dotted lines represent possible burrow architecture.

ment showed an angle of 5^{o} The length of these channels varies from 100-200 mm with a diameter of 0.8-1.3 mm. After a few collections, one is able to distinguish the channels from the nearby sediment based solely on their color.

Entrance and exit openings show distinctive features : the entrance opening has the shape of a shallow cup, being usually plugged by surface sediment, making its identifica - tion difficult. It has a mean diameter of 6 mm. The exit opening is readily identified by a surrounding cast. This 3-5 mm high faecal cone has a basis of 10-15 mm in diameter . The channels of *Lissomyema* are 40-100 mm apart from each other.

The shells used by *Lissomyema exilii* to build its galleries are easily identified by conspicuous brown spots on their borders, corresponding to the chamber's entrance and exit openings. With these characteristics, shells do not need to be opened in the field at the time of collection to ascertain the presence of the worms. In the laboratory the shells can be placed together, one beside the other, in a container with muddy sand from the collecting place and sea water; this procedure allows the worms to be kept in good conditions for more than two years.

When a shell is occupied by more than one worm the number of brown spots on the shell doubles, the ratio being two spots per worm. This fact indicates independence of inhabi - ting chambers, which can be confirmed by opening the shell . The maximal number of echiurans found within a single shell was three; however, the most common situation, about 98%, is one worm per shell. From many collections at Araçá beach, only once was a worm found in a gallery of the crustacean *Upogebia* and at another time in an abandoned polychaete tube ; all other specimens came from mollusc shells. The abundance of mollusc shells in *Lissomyema* area is best exemplified by Table I. This datum refers to one particular collection among dozens, though the results from other collections are quite similar. I have recorded, until now, echiurans in the shells of 14 species of bivalve and 6 species of gastropods.

TABLE I. Relative abundance of different mollusc shells inhabited by *Lissomyema exilii* at Araçá beach, São Paulo, Brazil. Data from one collection.

Bivalve:	
Phacoides pectinatus	67
Anomalocardia brasiliana	11
Trachycardium muricatum	10
Chione sp.	9
Dosinia concentrica	8
Crassostrea sp.	4
Anadara notabilis	1
Macoma brevifrons	1
Macoma constricta	1
Mactra fragilis	1
Pinna carnea	1
Tellina alternata	1

Gastropod:

Bulla striata		1
	Total	116

The shape and dimensions of *Lissomyema*'s faecal pellets is usefull in identifying the openings of the inhabiting system of these worms in the field.

The pellets of *Lissomyema exilii* are usualy cylindrical with rounded tips. They are similar to those of *Thalassema thalassemum*, figured by Leigh-Sharpe (1928), being built of fine sand grains and vegetal debris, randomly agglutinated by mucus The mucus envelope of these faecal balls is secreted at the beginning of the presiphonal intestine. Even so, a large amount of waste material reaches the cloaca without the mucous packing. A worm with 20 mm of length had in its digestive tube 233 pellets, plus a double volume of non-packed detritic material. According to Gislén (1940),the digestive tract of *Echiurus echiurus* may store as much as 500 faecal pellets.

Lissomyema's largest pellets were 1.5 mm in length by 0.5 mm in diameter; in cross section they show a circular contour, without concentric arrangement of the grains. Moore (1932), studying the faecal material of marine gastropods , found specific differences in shape, as well as in the arrangement of the sand grains in the pellets. No similar study has been carried out in echiurans.

The first specimens of *Lissomyema exilii* were found by chance while digging for other marine invertebrates. Later on it was possible to distinguish *Lissomyema*'s casts from those belonging to other invertebrates living in the same beach. This permitted the mapping of the beach area occupied by the population, which has a maximum diameter of about 60 meters (Map I)

In twelve collections the number of casts per square meter ranged from 3 to 37, with a mean value of 11 casts/m^2, the lowest values corresponding to the samples taken at the border of the population area. In a collection performed at a previously selected square, the number of individuals recovered, in relation to the number of casts observed, agreed with a small standard deviation (± 2 worms.)

Ochetostoma capense Jones & Stephen (1955)

This species lives in U-shaped burrows built in mud sandy beaches of South Africa. According to Jones & Stephen (1955) the horizontal portion of the burrows may be as deep as 15-20 centimeters in the muddy sand while the two vertical channels are 12,5 to 20 cm apart from each other. No further data on the galleries is presented for this species.

Ochetostoma erythrogrammon Leuckart & Rueppell, 1828

This species has been reported from very different hiding places, as for instance, in rocky galleries excavated by the bivalve *Gastrochaena* (Wharton, 1913), under growing corals (Wesenberg-Lund, 1939, 1954) or under rocks at low tide (Stephen, 1952). Chuang (1962) found worms in galleries built in muddy sand shores, while in South Brazil the species has been collected on clean sandy beaches. Wherever *O. erythrogrammon* has been found in, the kind of substratum is usually the only reference to its habitat.

According to Chuang (l.c) *O. erythrogrammon* builds a U-shaped burrow with two vertical or oblique tunnels, each 20 cm long, connected by an horizontal tunnel 25-45 cm long (Fig. 1). The horizontal segment of the gallery may reach depths of 90 cm in the South African beaches (Stephen & Robertson, 1952) This measurement aggrees well with those I took from *O. erythrogrammon*'s burrows in South Brazil.

In Brazil this species lives in L-shaped tubes with oblique side arms. Besides this general L-shaped tube, the plastic model, upon which Figure 2 is based, reveals an unusual feature is echiuran burrows. Near the entrance opening there is a secondary side arm (Figs. 1C, 2), also present in the galleries of other invertebrates as *Sipunculus* and *Balanoglossus*.

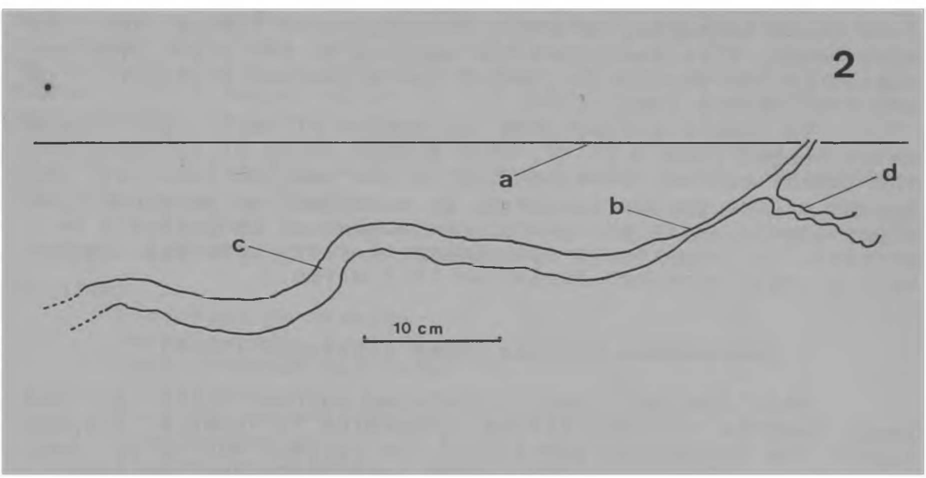


Figure 2 - Drawing from a photograph of a plastic model of the gallery of *Ochetostoma erythrogrammon*. a = surface sand; b = side arm; c = inhabiting chamber; d = extra side arm.

Indeed, the entrance openings of *O. erythrogrammon* , found in South Brazil, is composed of two holes about 5 cm from each other; one hole is about 5 mm in diameter being usually filled with water; the other is shallow-cup-shaped with a mean diameter of 15 mm. These two holes communicate by their respective channels, about 5 cm under the surface sand (Fig. 1). This somewhat different architecture of the *Ochetostoma* burrow, compared with that described by Chuang (1962) for the same species, may be related to the different kind of substrate in which the animal lives here, as Healy & Wells (1959) have also mentioned for *Arenicola pacifica*.This reasoning is enhanced by the fact that *O. erythrogrammon* diggs on muddy sand in Malaysia and on clear coarse sand in the South of Brazil.

Other traits of *O. erythrogrammon*'s burrow which are waiting to be unraveled are: the exact site of the exit opening(if really extant) and shape and dimension of the mud plug which blocks this opening. Even with polyethylene injections I could not reach the end of the burrow; moreover , I could not detect any clue at the beach on the position of this opening. It seems that the worm builds a blind tube with two entrance holes on sandy beaches.

Notwithstanding the world wide distribution of *O. erythrogrammon* no commensals or inquilins have been report until now.

Urechis caupo Fisher & MacGinitie, 1928

The family Urechidae contains the genus *Urechis* with four species only, *Urechis chilensis* (Max Müller) being the single species reported for the Southeastern Atlantic Ocean until now (Amor, 1975). Of the four species, only *Urechis caupo* Fisher & MacGinitie had been object of autoecological studies, by the authors which described it in 1928.

Urechis caupo is found in muddy sand flats on the coast of California, USA. It lives in U-shaped burrows (Fig. 1D) similar to those constructed by *Echiurus echiurus*, although *U.caupo* does not expose its proboscis on the surface sediment as the European species does.

Despite the fact that *U. caupo* may reach the amazing body length of 495 mm (Fisher & MacGinitie, 1928) the burrows do not go too deep in the muddy sand; the U-shaped tubes expand much more in the horizontal direction than in the height of the vertical channels. Since the burrows of *U.caupo* as well as those of *E. echiurus* are built very near the surface sediment, these species are more easily dislodged by storms which revolve the shallow sea bottom. They therefore are also more vulnerable to predators (v.g. fishes)

The fauna of echiuran burrows

Echiurans may harbor a considerable number of inquilins and commensals in their galleries. They may equally profit from the burrows of other invertebrates.Nielsen(1964)

TABLE II ENERGY COMMENSALS OF ECHIURANS

HOST	COMMENSAL	REPORTED BY
Anelassorhynchus mucosus	*Achasmea thalassemicola* (Bivalvia)	Habe (1962)
Echiurus echiurus	*Gattyana cirrhosa* (Polychaeta)	Gislén (1940)
Echiurus echiurus alaskanus	*Hesperonoë adventor* (Polychaeta)	Fisher (1946)
Lissomyema exilii	*Harmothoë imbricata* (Polychaeta)	Ditadi (1969)
	Bahwania goodei (Polychaeta)	Ditadi (1969)
	Nainereis setosa (Polychaeta)	Ditadi (1969)
	Podarke pallida (Polychaeta)	Ditadi (1969)
	Nematonereis unicornis (Polychaeta)	Ditadi (1969)
	Pinnixa sp (Crustacea)*	Ditadi (1969)
	Loxosomella ditadii (Entoprocta)	Marcus & Marcus (1968)
	Loxosomella zima (Entoprocta)	Marcus & Marcus (1968)
	Lophodoris scala (Nudibranchiata)	Marcus & Marcus (1970)
	Hesperonoë adventor (Polychaeta)	Fisher & MacGinitie (1928)
Urechis caupo	*Betaeus longidactylus* (Crustacea)	MacGinitie (1935)
	Crangon californiensis (Crustacea)	Fisher (1946)
	Pinnixa franciscana (Crustacea)	Fisher (1946)
	Scleroplax granulata (Crustacea)	Fisher & MacGinitie (1928)
	Clevelandia ios (Pisces)**	Fisher & MacGinitie (1928)
	Cryptomya californica (Bivalvia)	Fisher (1946)

* fortuitous commensal
** temporary inquilin

coined the expression "energy commensals" to designate those animals which benefit from the rich food- and oxygen-containing water pumped by the host.

The energy commensals of *Lissomyema exilii* will be placed here into three categories depending on the site they occupy in relation to the burrow and will be referred to as belonging to Categories I, II and III.

Category I

In this group are those animals which maintain a tiny communication with the echiuran gallery. Most likely they benefit from the water current produced by the host; however, they do not move into the lumen of the chamber or of the channels. They build their own galleries inside the walls of the burrows of *Lissomyema*.

At least two species of free living unidentified nematodes and one species of polychaete are included in this group; the polychaete, *Nematonereis unicornis* (Eunicidae), is a very thin animal. This is a very incomplete list for the infauna of "Category I"; the animals belonging to this category are usually minute and mimetic with the sediment, which renders it difficult to find and collect them.

Category II

The group includes sessile animals which have part of their bodies embedded into the wall of *Lissomyema*'s gallery, though most of their bodies hang free in the lumen of it.The group is represented by two species of *Loxosomella* (Entoprocta)

Such finding is worth some comments, since it provides a base to speculate about echiuran's life span. Thus, after a consideration on the slow process of sexual reproduction of entoprocts, Nielsen (1964) concludes: "This is no doubt the reason why no species of loxosomes have been found associated with short-lived host species. This fact emphasizes that loxomoses are indeed closely adapted energy commensals, each species displaying a strong affinity to one or a few host species" On this reasoning a fairly long life span is assumed for *Lissomyema exilii*. Another evidence for echiurans longevity was furnished by MacGinitie & MacGinitie (1968), which reported *Urechis caupo* living as much as 25 years! Furthermore, specimens of *L. exilii* have been maintained with a healthy aspect, in an aerated sea water aquarium, for over two years, while De Jorge et al. (1969) were able to maintain *Lissomyema* in fasting conditions for more than six months.

The settlement of entoprocts in the galleries of *Lissomyema* lead us to consider these constructions as stable. In fact it is possible to collect loxosomes along the whole extension of *Lissomyema*'s chamber down to the inferior three fourths of the channels. The lack of entoprocts on the upper fourth could be atributed to the poorly compacted muddy sand there; moreover, in this final segment of the channels no mucus sheath could be detected. Till now, only two species (see Table II) of *Loxosomella* were found in this site of the burrows of *Lissomyema*.

As there are no differences in diameter and length, between the entrance and exit channels, both being equally populated by bryozoans, it is reasonable to suggest that *L. exilii* is able to change its orientation inside the chamber. In the field, one can frequently observe two casts, instead of one cast and one cup, heading the channels. Indeed, the inner diameter of the chamber is large enough to allow easy bendings of *Lissomyema*. Fisher & MacGinitie (1928) and Gislén (1940) also reported turning of echiurans inside the burrows.

Category III

Grouped under this title are the following non-sedentary animals: a crustacean, a nudibranch mollusc and four polychaetes.

Two young individuals of the pinnotherid crab *Pinnixa sp.* were the only crustaceans found in more than 200 galleries of *Lissomyema* examined. They certainly entered there while in the larval stage, and on growing could not escape from the chamber through the channels, so the Pinnotheridae may be considered fortuitous commensals of *L. exilii*. These crabs are well known commensals of *Chaetopterus variopedatus*, a common polychaete at Araçá beach.

Lophodoris scala (Goniodorididae) in the second described species of this nudibranch genus (Marcus & Marcus, 1970) This slug is the only commensal observed creeping on the host's trunk. From one to four slugs have been collected in each gallery examined. The nudibranchs feed upon the loxosomes, and lay hyaline egg masses over the sand grains on the galleries' walls.

The four polychaetes are: *Harmothoë imbricata* (Polynoidae), *Podarke pallida* (Hesionidae), *Bahwania goodei*(Chrysopetalidae), and *Nainereis setosa* (Orbiniidae) Of these, only the first mentioned species was already known as an echiuran commensal. The others show pronnounced commensal habits, as observed by Pettibone (1964); however, their occurrence among echiurans had been report only by Ditadi (1969, 1975). It is usual to find one polychaete per gallery, although two and even three different species may cohabit a single chamber. When a mollusc shell, which contains an echiuran, is opened, the polychaetes hide under its host,much the same as *Harmothoë adventor* does in relation to *Urechis caupo* (Fisher & MacGinitie 1928)

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