FUNCTIONAL ANATOMY OF BRACHIDONTES SOLISIANUS (ORBIGNY, 1846) (BIVALVIA: MYTILIDAE)

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RESUMO - A anatomia funcional de *B. solisianus,* foi estudada com especial atenção ao funcionamento dos sifões, palpos,ctenídios e estômago. Procurou-se dar ênfase às adaptações daquelas estruturas ao meio em que o animal vive. Foram analisados com detalhe a motilidade e sensibilidade dos sifões, a estrutura muscular, o pé e o bisso, a movimentação e ciliação dos palpos, a forma e ciliação dos ctenídios, a estrutura e funcionamento do estômago e os órgãos excretores. Em *B. solisianus,* os sifões são do tipo A (II)(Yonge, 1948), os ctenídios do tipo B (I) (Atkins, 1937a); a relação entre os palpos e ctenídios pertence a categoria I (Stasek, 1963), as estruturas labiais são do tipo simples (Bernard,1972). O estômago é do tipo III (Purchon, 1957), ou da Secção I de Dinamani (1967), apresentando mecanismos de triagem dos tipos A e B de Reid (1965).

ABSTRACT - The morphology of *Brachidontes solisianus* was studied, with special attention to the functional patterns of the siphons, palps, ctenidia and stomach. The similar adaptive relationships of these structures with the particular environments where the animal lives were emphasized. The following aspects were analyzed in detail: the motility and responsiveness of siphons, muscular structures, foot and its byssus, movements and ciliation in the palps, morphology and ciliation of the ctenidia, and structure and functioning of the stomach and excretory organs. The siphons belong to type A (II) (Yonge, 1948), the ctenidia to type B (I) (Atkins, 1937a), and the relationship between palps and ctenidia should be assigned to category I according to Stasek (1963). The lip structure is of the simple type (Bernard,1972)whilst the stomach is allotted to type III (Purchon, 1957) or to the Section I of Dinamani (1967): the mechanisms for particle selection in the stomach are classified as type A and B of Reid (1965).

INTRODUCTION

According to Klappenbach (1965) the Genus *Brachidontes* is represented by three sub-genera with four species and one sub-species in Brazil, *Brachidontes (Brachidontes) rodriguesi* (Orbigny, 1846), *B. (Hormomya) exustus* (Linné, 1758), *B. (Hormomya) darwinianus mulleri* (Dunker, 1875) and *B. (Mytilaster) solisianus* (Orbigny, 1846).

Lange de Morretes (1949) and Gofferjé (1950) noted its occurrence in Paraná. Klappenbach (1965) cited its appearance in Campeche (México) and in Brazil from Rio Grande do Norte to Torres, Rio Grande do Sul. Rios (1975) noted the presence of this species in Brazil from Fortaleza to Torres, and even as far as Uruguay.

In Brazil only few genera of the Mytilidae have been studied with respect to functional anatomy: *Mytella charruana* (Orbigny,1846) (Narchi & Galvão Bueno, 1983) and *Brachidontes darwinianus darwinianus* (Avelar & Narchi, in press).

In this study we correlate the animal's structures, ciliary food currents and other functional adaptations to their life surroundings.

MATERIAL AND OCCURRENCE

The animals were collected on the "Lamberto" beach in Ubatuba (23°30'S, 45°04'20"W) and on the "Cabelo Gordo de dentro" beach in São Sebastião (23°48'07"S,45°23'22"W). They live fixed by byssus threads to rocky substratum in the in-tertidal zone of creeks and bays, where they can form agglomerates of many hundreds of individuals.

In order to collect these Bivalvia we used a spatula to cut the byssus filaments by which they stick to the substratum.

The animals were kept alive, under good conditions,for about two months in aquaria seawater in circulation, at a temperature of 22°C. Thus, it was possible to study the functional anatomy.

Shell

The shell is rather small, mytiliform, equivalve, inequilateral. It has an angle on the back, the posterior edge curved and the ventral side slightly concave and the umbo is subterminal, characteristic for this species.

The dorsal angle of *B. solisianus* (Fig. 1) is of about 30°, differing from the *B. darwinianus darwinianus* specimens of the same size (Avelar & Narchi, in press) This fact also drew the attention of Wilson (1967) for *Xenostrobus pulex* and *X. inconstans*. The posterior region of *B. solisianus* is truncated and forms an angle of about 90°, with the dorsal and ventral mantle margins. This gives it a rectangular aspect, the dorsal and ventral margins being parallel in the posterior region. The anterior ventral part is slightly con-
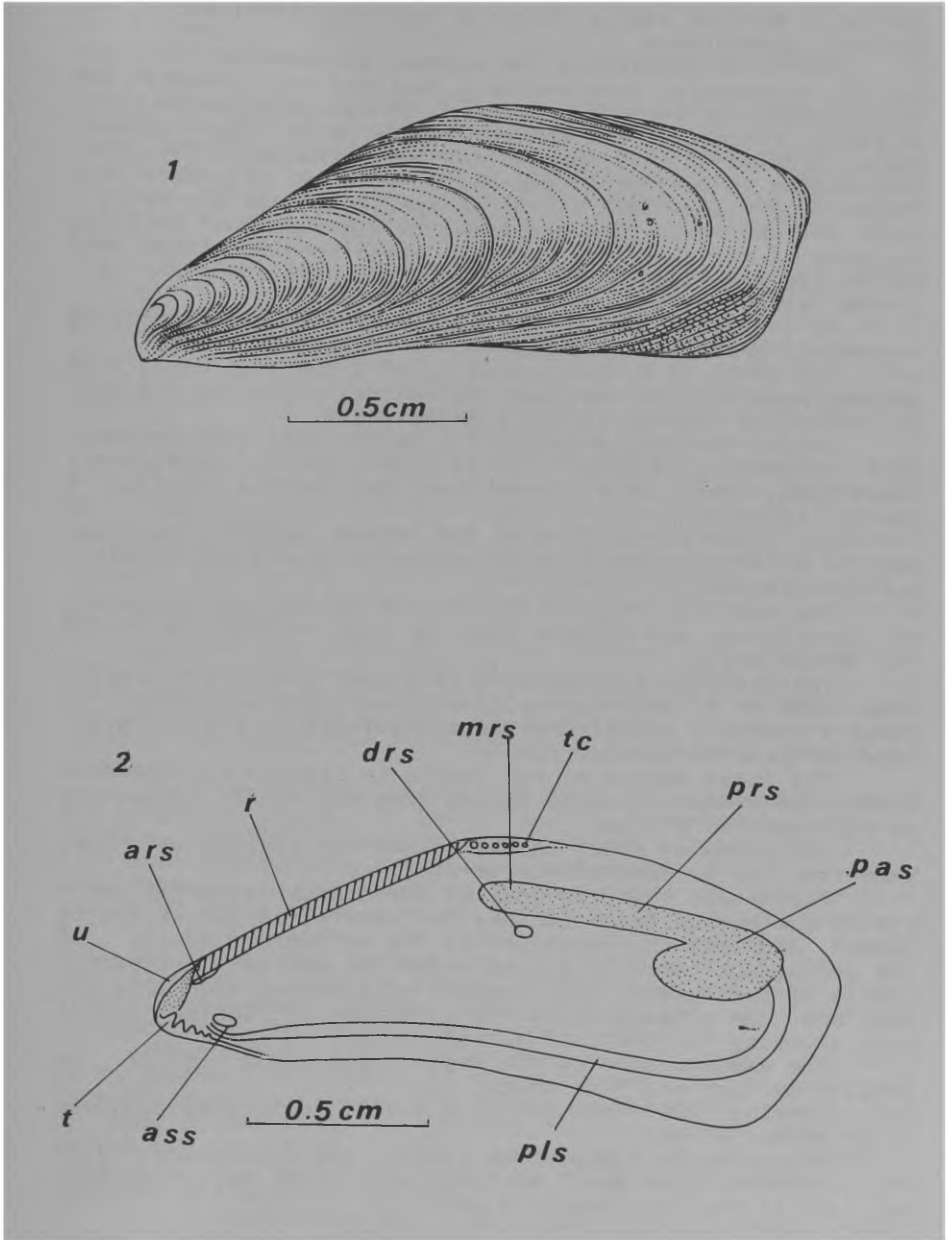
Figure 1 - *Brachidontes solisianus*. External view of left shell. Figure 2 - *Brachidontes solisianus*. Internal view of the shell valve.

vex as in *Mytilus edulis* (Yonge & Campbell, 1968) and *B. dar_
winianus darwinianus*.

The outer surface of the valves is smooth and only un-
der the microscope, some scarcely distinct radial lines   are
recognizable. In very few specimens it was possible to obser_
ve radial riblets in the ventral region under   the   umbonal
ridge, because in this species the periostracum in the ante-
rior region is very prominent and often worm. This fact   was
observed by Klappenbach (1965) in specimens from Rio de Ja -
neiro and São Paulo, and according to him this must be a con_
sequence of the size they reached, since specimens from Mexi_
co, Recife and Alagoas, of smaller size, have their perios ¯
tracum fairly intact.

On the outer face of the valves we also noted numerous
concentric grooves, corresponding to the growth lines.

The shell of *B. solisianus* is of a purplish blue,   the
periostracum is dark tan, and the ventral region of the val-
ve, below the umbonal ridge, appears white.

Behind the lunula there is a smooth area with an obso-
lete sculpturing, similar to that formed in   *B.   multiformis*
(Soot-Ryen, 1955) and *B. darwinianus darwinianus*   (Avelar &
Narchi, in press).

The inner purple face of the valves, slightly nacreous
has the anterior ventral surface lighter like in *B. darwinia_
nus darwinianus*.

The resilium (Fig. 2) is similar to that of *B.darwinia_
nus darwinianus* and extends from the umbo to near the top of¯
the dorsal angle.

The marginal scalloppying is formed behind the   resi -
lium, like in *B. darwinianus darwinianus,* and according   to
Yonge & Campbell (1968) this is characteristic for the Myti-
lidae of reduced specialisation.

The inner margin of the lunula is limited by dissodont
teeth, the number of which varies from two to six   depending
on the specimen's size.

The muscular scars in the valves are similar to   those
described for *B. darwinianus darwinianus*.

That means that the scar of the medium retractor mus -
cle of the byssus never reaches the ventral margin of the li_
gament, and that the insertion of the retractor   muscle   of¯
the demibranch (drs) is placed under the medium   retractor
muscle of the byssus, thus forming an isolated scar (Fig.2).
This scar had already drawn the attention of Ihering   (1897)
when studying the shell of *B. solisianus*.

The maximum size of the present specimens   is   17   mm
long, 6 mm high and 8 mm thick.

Ihering (1897) and Gofferjé (1950) registered   lenghts
of 24 mm and 17 mm.

According to Klappenbach (1965), the specimen's   size
may vary from 12 mm to 17 mm long, and in the region of Tor-
res (RS) it can even reach 18 mm.

Siphons

The siphons belong to type A (II) of Yonge (1948) They
occupy the animal's body; the exhalant siphon is situated in
the postero-dorsal region, the inhalant one in the posterior
and ventral part of the shell. The branchial septum is situa_

ted between the two apertures.

The siphons are brown, inside and outside, darker   at the margins.

The inhalant siphon (Fig. 3) whose dorsal edge is for-med by the fusion of the inner mantle lobe, has its   ventral limit functionally separated from the foot aperture by   the apposition of the mantle lobes, as generally in   Mytilacea (Morton, 1973) It is bigger than the exhalant one and bears a series of papillae around the aperture; the exhalant si - phon has a smooth margin.

The papillae are very numerous with spots of an irides cent green. They are similar to those of *Musculista senhau- sia* (Morton, 1974) and *B. darwinianus darwinianus* (Avelar & Narchi, in press), i.e. finger-shaped and sometimes have   a subdivided top. Their task is to restrain or amplify   the inhalant aperture by controlling the water current which rea ches the pallial cavity, as in *Mytella charruana* (Narchi & Galvão Bueno, 1983) and *B. darwinianus darwinianus*.

Yonge (1948) and Morton (1974) did not consider this as a real siphon, but only as an aperture, as the mantle ed-ges, separating the inhalant aperture are not fused.

The inhalant siphon has well defined limits,   without tentacles on the margin, and its walls can control the water current. The ventral part of the inhalant siphon is conti - nued into the pallial cavity as a tube, which also controls the water current.

Between the apertures of the inhalant and exhalant si-phon lies the branchial septum, which, according to   Morton (1974) restrains the size of the inhalant aperture and fixes the ctenidium to the mantle, separating the siphon from the inhalant aperture, and thus the upper and lower   branchial chambers.

In *B. solisianus* as well as in *B. darwinianus darwinia nus* (Avelar & Narchi, in press) and in *Limnoperna fortunei* (Morton, 1974) the branchial septum takes a horizontal posi-tion when the siphons are dilated and folds itself up when they retract. It has muscular filaments and a   conjunctive tissue by which it is able to diminish the inhalant aperture.

In *B. solisianus* the branchial septum presents itself like two triangular projections, one of them turned to the pallial chamber, and the other, shorter than the first,turn-ed to the exhalant chamber, and limiting also the exhalant aperture so as to control the water current.

The surface of the branchial septum consists of cilia-ry epitelium with patches of brown pigment, as was observed in *Mytilus edulis* (White, 1937) and by the authors in *B. dar winianus darwinianus*. The ciliary currents on the branchial septum are rejective, as they curvey the particles dorsal - wards into the rejection groove at the tangent between   the inhalant and exhalant siphons.

In *B. solisianus* the siphons are sensitive and react to the least trepidation or to the slightest observation of the aquarium. This fact had already been observed in various Bivalvia like *Glossus humanus* (Owen, 1953);*Anomalocardia bra siliana, Tivela mactroides* (Narchi, 1972a) and *B. darwinia - nus darwinianus*.

According to Owen (1953) and Narchi (1972) this sensi-tivity is connected with the animal's life in quiet waters.
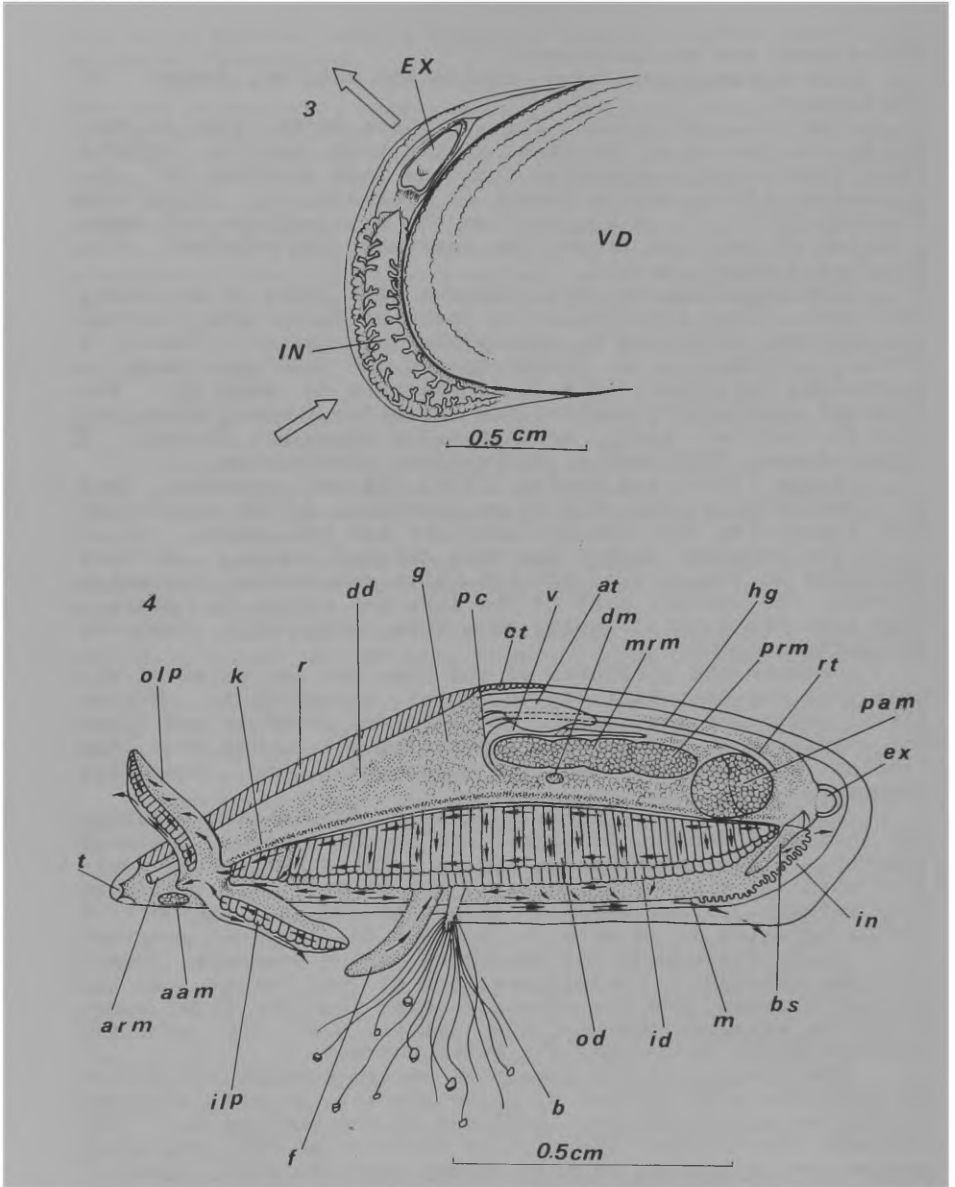
Figure 3 - *Brachidontes solisianus*. External appearance   of
the siphons showing the inhalant (in) and exhalant   openings
(ex). Figure 4 - *Brachidontes solisianus*. Mantle cavity view-
ed from left side after removal of left   shell valve and man-
tle lobe.

Mantle

The mantle edge is similar to that of other known Myti
lidae and is similar to the one described for *Mytella char -
ruana* (Narchi & Galvão Bueno, 1983) and *B. darwinianus darwi_
nianus* (Avelar & Narchi, in press).

Mantle cavity

The position of the organs in the mantle cavity   (Fig.
4) was exposed by removing the left valve of the shell   and
the correspondent mantle lobe.

Musculature

The musculature (Fig. 5) is similar to that of the My-
tilidae e.g., *Mytilus edulis* (White, 1937), *Musculista se -
nhausia* (Morton, 1974) and *B. darwinianus darwinianus*.
However the muscle of the demibranch (dm) leaves   a
mark in the shell, under the insertion of the medium retrac-
tor muscle of the byssus, different from that of *B. darwinia_
nus darwinianus*. According to Atkins (1944) this muscle be ⁻
longs to type (b). In these animals the task of the demi -
branch muscle is to avoid an excess of particle to reach the
pallial cavity and fall on the ctenidia.

Foot and Byssus

Anatomy, ciliary currents and general conformation of
the foot and byssus (Fig. 6) are similar to those described
for *B. darwinianus darwinianus,* with one exception: the dis-
tal extremity of the foot groove presents no brown   pigment
in *B. solisianus*.

Ctenidia

The ciliary currents upon the ctenidia were   observed
by adding carborundun powder, carmine or aquadaq, in the me-
thod used by various authors.
The demibranchs are homorhabdic as Ridewood (1903) Kel_
logg (1915) and Atkins (1937) observed. They belong to type
B (1) described by Atkins and are characterized by the pre -
sence of two marginal grooves (Fig. 7), one in the inner and
other in the outer demibranch, both of similar aspect   and
about the same size typical for Mytilidae and Pinnidae.
The marginal groove in *B. solisianus* and *B. darwinia -
nus darwinianus* is rather shallow in comparison with that of
Adula (Botula) falcata (Fankboner 1971) which can be   about
1 mm deep. The depth of this groove varies from 40 to 60 µm,
depending on the degree of distention. According to   Atkins
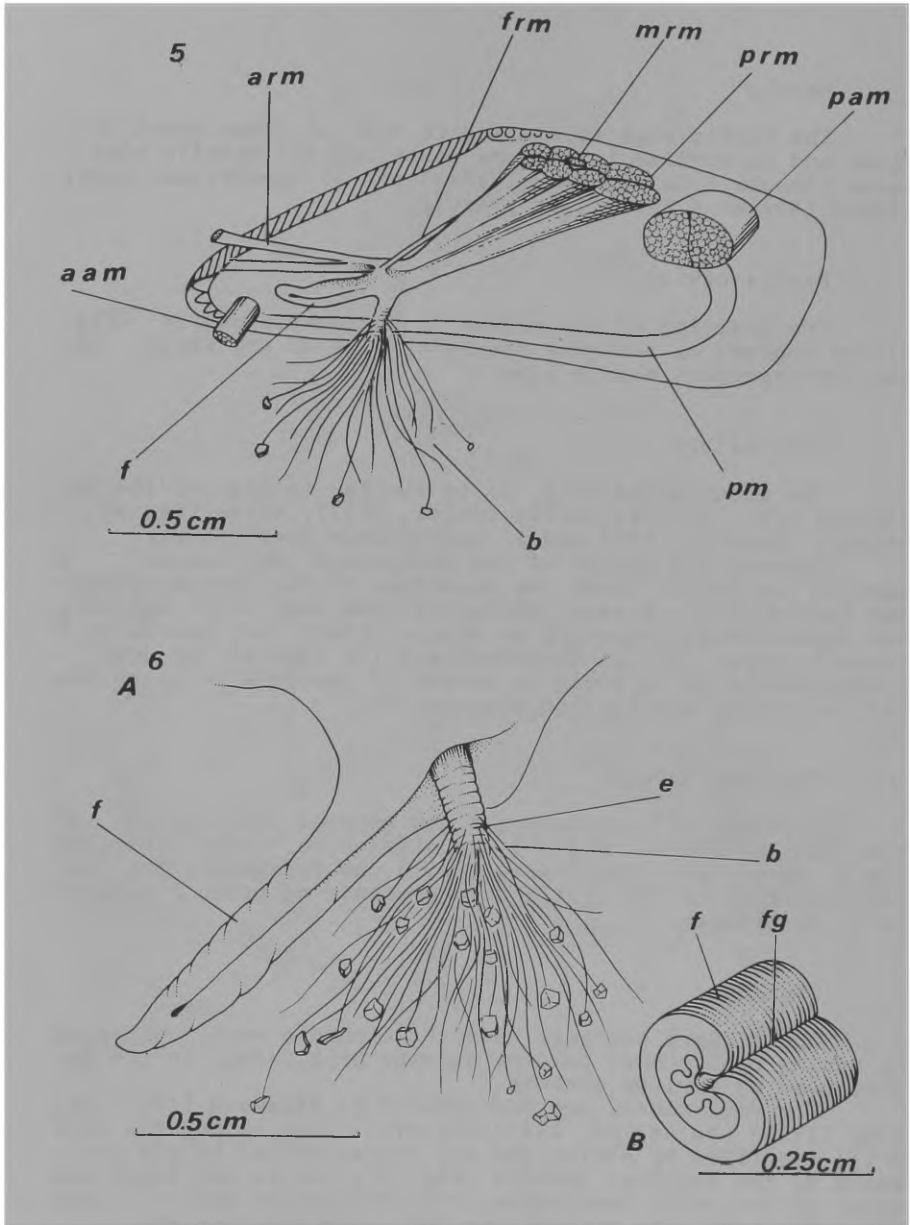(1937a) this groove is connected with the sorting mechanism,

Figure 5 - *Brachidontes solisianus*. Lateral view of muscles, after removal of left shell valve, mantle lobe and visceral mass. Figure 6 - *Brachidontes solisianus*. A, Foot and its byssus. B, Transverse section of foot.

and it restricts the size of the particles by opening   or
shutting.
     We can recognized on the ctenidia five oralward   cur-
rents (Fig. 7), two in the marginal grooves, one along   the
axis of the ctenidia between the descendent lamella of   the
outer and inner demibranchs, one between the ascendent lamel
la of the outer demibranch and the mantle, and the last bet-
ween the ascendent lamella of the inner demibranch and   the
visceral mass. The ciliary currents convey the particles in-
to the free margins of the demibranchs, with exception of a
narrow strip in the dorsal region of the inner and outer de-
mibranchs, where the currents are ascendent. This disposi -
tion of the ciliary currents is one of the   characteristics
of the Mytilidae.
     In *B. solisianus* the outer demibranch has 8 to 10 fila
ments less than the inner one. This fact was already   known
and observed in *Petricola pholadiformis* (Purchon, 1955) *Adu-
la falcata, A. californiensis, Lithophaga bisulcata, Mytilus
edulis* (Fankboner, 1971), *Limnoperna fortunei* and *Musculista
senhausia* (Morton, 1973, 1974), *Brachidontes darwinianus dar
winianus* (Avelar & Narchi, in press). According to   Purchon
(1955) and Morton (1974) this reduction makes the contact of
the marginal food groove of the demibranchs with the labial
palps more efficient.
     In *B. solisianus,* as well as in the Mytilidae in gene-
ral, the cohesion between the filaments, is maintained   by
means of ciliary disks.
     The descending part of each filament is fused to   the
ascending part of the same by interlamellar junctions.   Ac-
cording to White (1937) these junctions are   characteristic
for the Mytilacea.
     The ciliary arrangement of the branchial filaments(Fig.
8B) in *B. solisianus* is practically the same as that describ
ed for *B. darwinianus darwinianus* (Avelar & Narchi, in press)
with some small differences, as the presence of sensitive ci
lia (Fig. 8A, ssc) in triangular tufts of about 20 µm length
and a base of 11 µm, which occur principally on the   ascend-
ing lamella of the outer demibranch. According to   Atkins
(1937) they are found in *Arca tetragona, Glycymeris glycyme-
ris, Heteronomia squamula, Monia squama* and *M.   patelliformis*
and probably have tactil function.
     The filaments of the ctenidia in *B. solisianus* are se-
parated by the eu-latero-frontal cilia (Fig. 9) of about   19
µm length. These cilia alternate and form a kind of a grate,
thus protecting the interfilamentary passage. They were des-
cribed in the Mytilidae: *Mytilus edulis, Modiolus modiolus ,
M. adriaticus, Musculus marmoratus, M. discor*   (Atkins   ,
1938), *Mytella charruana* (Narchi & Galvão Bueno, 1983) and
Brachidontes darwinianus darwinianus.
     The lateral cilia (lc), situated inwards to the eulate
ro-frontal cilia, are about 12 µm long and occupy the latero
-distal face of the filaments.
     All around the filament surface there are the   frontal
cilia (fc), about 9 µm long, which send food particles   to
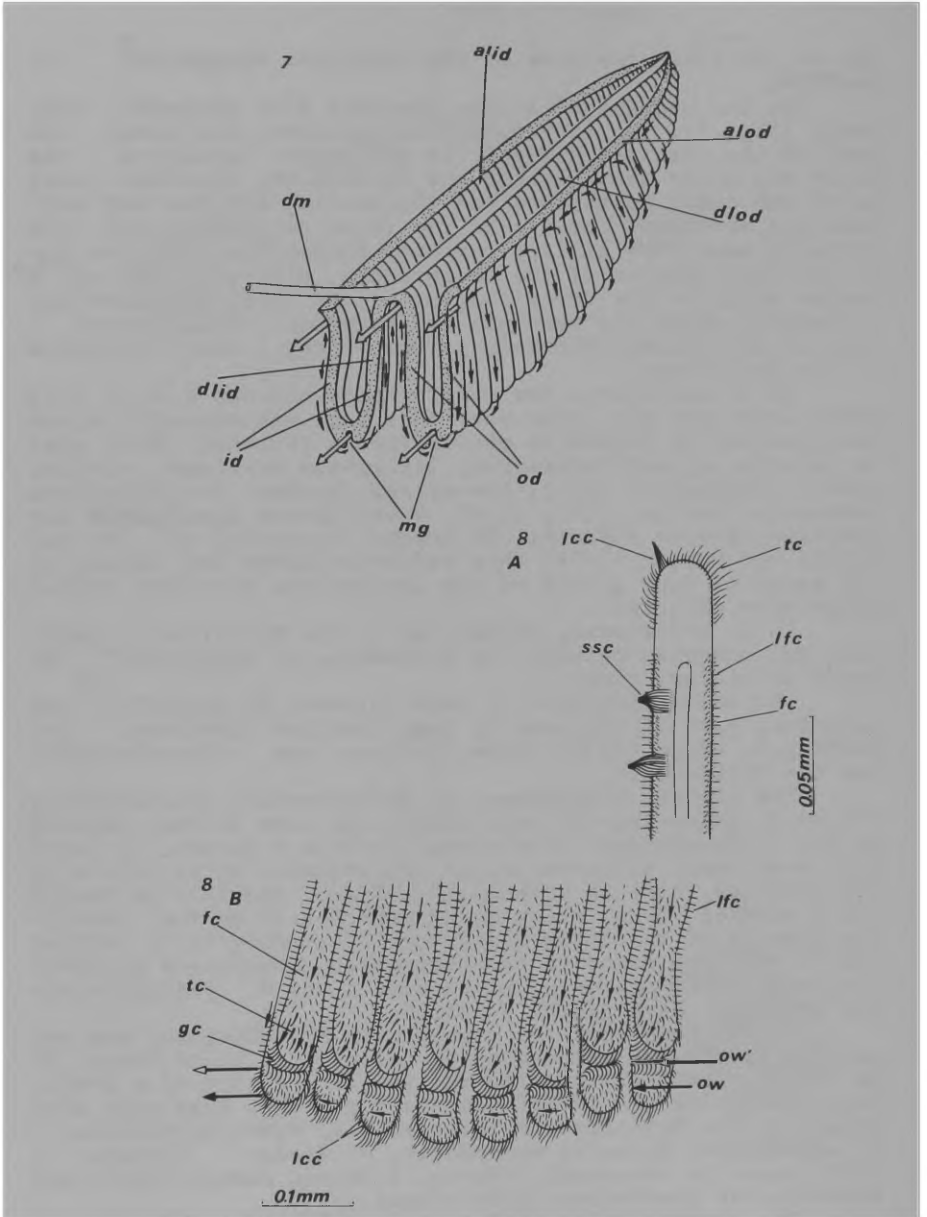the free margin of the ctenidium.

Figure 7 - *Brachidontes solisianus*. Diagrammatic section   of
ctenidium to show mode of action of frontal cilia, and demi -
branch retractor muscle. Arrows indicate direction of ciliary
currents, including oral one. Figure 8 - *Brachidontes solisia
nus*. A, Lateral view of branchial filaments to show sensitive
cilia. B, Extremity of filaments showing guarding cilia   and
the oralward currents.

The frontal cilia give place to the terminal   cilia (tc) on the free margin of the filaments, which are bent for wards. The terminal cilia can be as long as 19 μm on the ex-tremity of the filament and are responsible for an oralward current.

No pro-latero-frontal cilia were observed,   although they may occur in Bivalvia with eu-latero-frontal cilia. According to Atkins (1938) these cilia always occur in the Mytilidae but are not always laid open owing to the difficulties of observation and preservation of the material. Moore (1971) and Owen (1974) confirmed the presence of these cilia for *Mytilus edulis* with scanning microscope.

B. solisianus has guarding cilia (gc) up to 30 μm long: they occur also in other Mytilidae. These cilia have been re gistered in *Modiolus, Musculus* (Atkins, 1937a), *Adula* (Fank-boner, 1971), *Brachidontes* (Avelar & Narchi, in press).

So, the marginal groove has two channels with oralward currents, one formed by the guarding cilia and the other by the terminal cilia.

On the hind third of the demibranchs, at the free ex - tremity of the filaments, there is a triangular tuft of ri - gid cilia which are called cirrum (lcc) They are 20 μm long and their function is probably correlated with the selection of large particles of sand grains. The presence of these cilia was registered by Atkins (1937) in many bivalves. Yonge (1946) ascribed to them the function of agitating large particles and masses which tend to accumulate on the free mar - gin, thus reforcing the action of the terminal cilia. In *B. solisianus,* as well as, in *B. darwinianus darwinianus*   they are frequent in the hind region of the demibranch and dimi - nish gradually towards the front region.

Labial palps

The labial palps are triangular, flattened, long, and extremely mobile (Fig. 10)

The faces turned to the branches are covered with folds and the opposite ones are smooth.

The inner demibranch keeps in contact with the   fold bearing face of both palps, and the inicial filaments of the inner demibranch are not fused to the oral groove. That   is why the association ctenidium - labial palp belongs to cate-gory I (Stasek, 1963), typical for Mytilacea.

The food particles are sorted by muscular or   ciliar activity (Kellogg, 1915; Ansell, 1961; Narchi, 1972a)

The particles which reach the palp are sorted according to their size. Those which fall onto the smooth face of the palp are conveyed by the cilia of the dorsal edge   to the folded face from where they are carried off the   margin of the longitudinal fold.

Small particles which fall upon the folded face   are transported rapidly over the surface of the folds to   the mouth. Bigger particles are directed from one crest   to the other to oral region where they are subjected to selection.
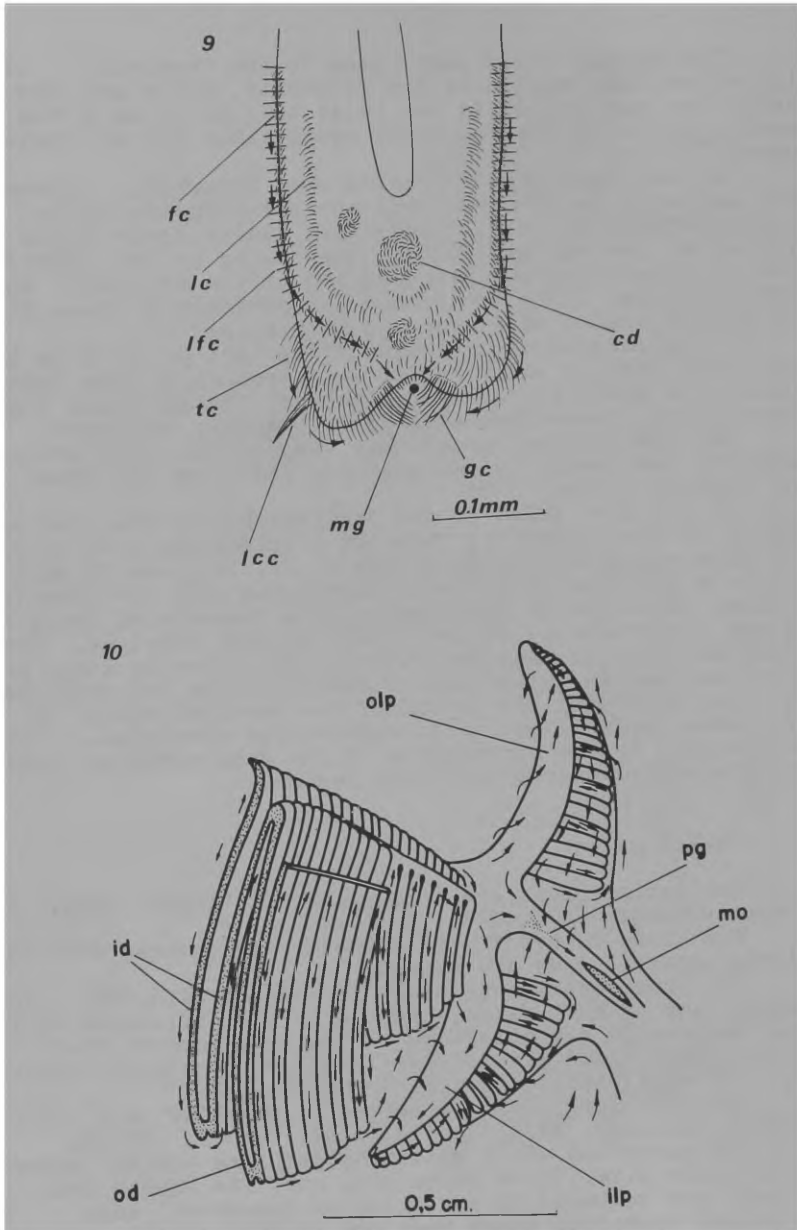
Figure 9 - *Brachidontes solisianus*. Ventral end of living fi
lament in side view showing position of groups of   guarding
cilia around marginal groove. Figure 10 - *Brachidontes soli-
sianus*. Labial palps and ctenidium of right side showing ci-
liary currents.

The ciliary currents which were observed, are similar
to those of *B. darwinianus darwinianus* (Avelar & Narchi, in
press).

The labial structure in *B. solisianus* is of the simple
type (Bernard, 1972).

It is rather difficult to observe the ciliary current
at the labial region, as the cilia of this region may be sub
ject to nervous control and show a rhythm of activity   and
inactivity. Hence the possible cessation of ciliary activity
in the mouth region may be due to the accumulation of mucus,
together with the contraction of the surface tissue (Purchon
1955a).

Food particles which reach the mouth sorted by the la-
bial palps, are not totally accepted as they may be rejected
by the lips when the mouth closes and the ciliary palpita-
tions are paralysed.

Analysis of the size of the particles contained in the
stomach of *B. solisianus* revealed a more homogeneous sorting
of particles than that found in *B. darwinianus darwinianus*
The size of the particles varied from 3 μm to 23 μm in *B. so
lisianus*, from 3 μm to 160 μm in *B. darwinianus darwinianus*.

On the visceral mass there are rejecting currents   ,
which convey particles sidewards,so that they can be either
reaccepted by the labial palps or rejected by the visceral
mass currents.

The particles rejected by the palps and the visceral
mass are transported by the rejecting currents of the mantle
to the base of the inhalant siphon, from where they are eli-
minated.

Ciliary currents on the mantle surface

In order to study the ciliation of the inner   mantle
surface, the visceral mass and the ctenidium were removed ,
after which seawater was added to the preparation and it was
left standing so as to obtain a certain relaxation of   the
muscles.

To make the ciliary currents visible, particles of car
mine powder were applied.

In *B. solisianus* (Fig. 11) the ciliary currents are re
jecting ones. They conduct the particles from the dorsal to
the ventral regions, the area being totally provided with ci
lia.

On the free mantle edge the currents send the parti -
cles from the anterior to the posterior region, from where
they are eliminated as pseudo-faecis, at the base of   the
first papilla of the inhalant siphon, by a rapid contraction
of the adductor muscle.

Alimentary canal

General structure - The alimentary canal (Fig. 12) was
dissected from live specimens, which were anesthetized befo-
re hand with magnesium chloride; also animals preserved in
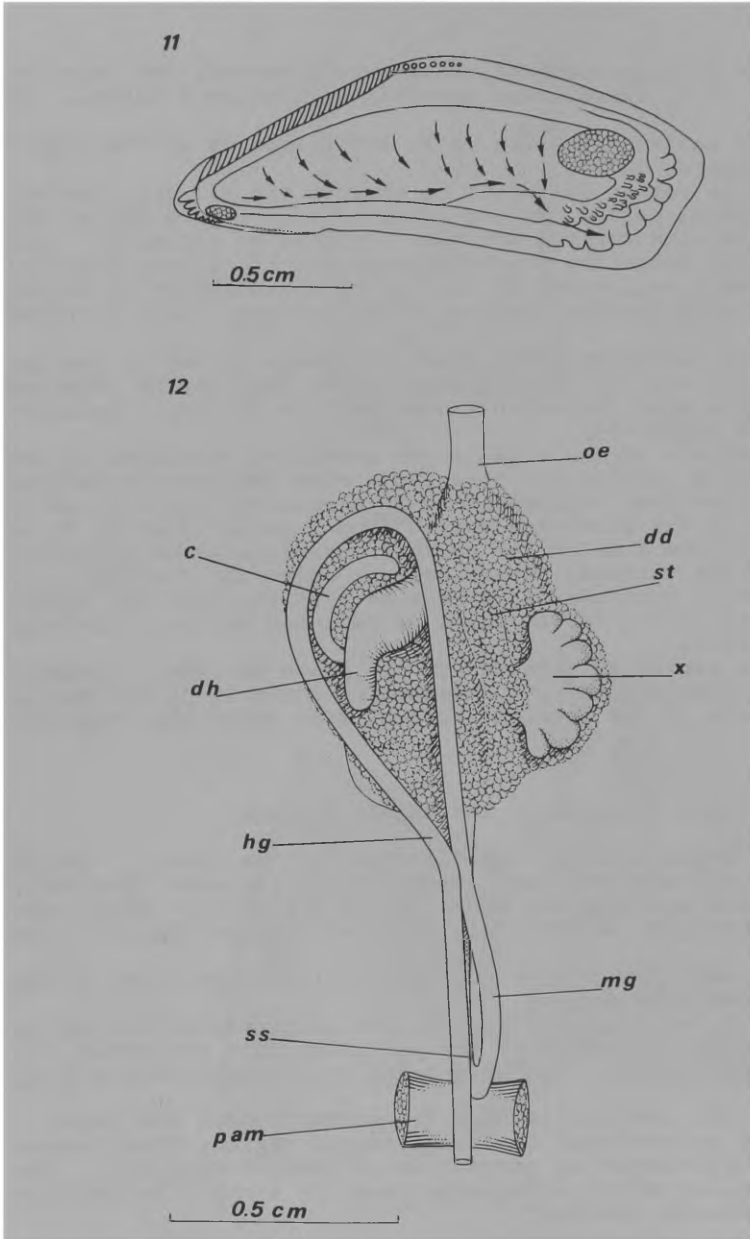
Figure 11 - *Brachidontes solisianus*. Inner surface of right mantle lobe to show ciliary cleansing currents. Figure 12 - *Brachidontes solisianus*. Dorsal view of the alimentary channel.

formol 4% were utilized.

The short oesophagus (oe) ends in the anteroventral re
gion of the stomach. The style sac (ss) and the   intestine
are united, separating near the dorsal region of the poste -
rior adductor muscle, like in *B. darwinianus darwinianus* (A-
velar & Narchi, in press)

The intestine of *B. solisianus* is similar to that   of
B. darwinianus darwinianus differing only in the position of
the anterior intestinal loop which occupies a left-latero -
dorsal position. In *Xenostrobus* (Wilson, 1967) the intesti -
nal loop does not reach the stomach.

Into the postero-lateral wall of the stomach opens the
multilobate appendix (x).

In *B. solisianus* the dorsal hood, well developed   in
this species lies in the left dorsal region of the stomach.

Structure of the stomach

The stomach was opened by middorsal incision. The ci -
liary currents were observed by the use of a suspension   of
Carmine, Aquadag and very fine Carborundum. The nomenclature
is the same as that used by Graham (1949), Owen (1953), Pur-
chon (1955) and Dinamani (1967).

The stomach of *B. solisianus* (Fig. 13) belongs to type
III in the classification of Purchon (1957).

The minor typhlosole (mt) ends near the orifice of the
midgut on the right posterior wall of the stomach. The major
typhlosole (ty) accompanied by the intestinal groove (ig) be
gins in the posterior region, passes over the floor of   the
stomach from right to left, and penetrates into the sorting
caecum (fc)

The tongue of the major typhlosole (ty') in *B. solisia*
nus as Dinamani (1967) described for *Perna viridis, Modiolus*
undulatus, M. striatulus, Arcuatula sp, forms a curve whitin
the sorting caecum and returns to the stomach. Eight to ten
ducts of the digestive diverticulum open into the caecum, si
milar to *P. viridis* and *B. darwinianus darwinianus* (Avelar &
Narchi, in press)

On the anterior wall of the dorsal hood (dh) there is
a poorly developed sorting area (sa_4) as in *Neotrigonia mar-*
garitacea and *Lima fragilis* (Purchon, 1957).

In the ventral part of the gastric shield (gs)   there
is an widened depression that forms the left pouch (lp) into
which 3-4 ducts of the digestive diverticulum open   in
P. viridis, M. undulatus and *M. striatulus* (Dinamani, 1967).

The axial fold begins from the floor of the   stomach
above the sorting caecum. It emits two projections, one to -
wards the left pouch and the other dorsalwards to the roof
of the stomach, ending near the antero-dorsal tract (a).

Beside the lateral fold (lf), which is parallel to the
major typhlosole, there are four ducts of the digestive di -
verticulum (ddd) on the right, and only three on the left.

The posterior sorting area is situated at the right of
the lateral fold, being bounded by the rejection tract (rg)

The posterior sorting area does not extend into the   dorsal
hood like in *P. viridis* and *B. darwinianus darwinianus* (Ave-
lar & Narchi, in press).

The multilobate appendix has eight well visible   inner
folds and it is situated in front of the posterior   sorting
area.

The antero-dorsal tract begins on right anterior   wall
of the stomach and extends to the opening of the   dorsal
hood, like in *Mytilus edulis* (Reid, 1965).

Between the terminal region of the lateral fold   (lf)
and the major typhlosole (ty) there is a plain area (sa$_3$)   ,
which Reid denominates tract of the ducts of the   digestive
diverticulum on the right. This area had been observed in *Li
thophaga gracilis* (Dinamani, 1967), *L. nasuta* (Purchon,1957)
and *B. darwinianus darwinianus*.

Functioning of the stomach

The particles not rejected by the ctenidia and   the
palps are conveyed into the mouth, and reach the   stomach
through the oesophagus, embedded in mucous in the form of   a
mucous string that join   the crystalline style, where   the
particles are disintegrated and thrown either towards   the
sorting caecum or to the opening of the ducts of the digesti
ve diverticulum. Only the small, isolated particles reach the
ducts of the diverticulum, whereas the others enter or   not
into the sorting caecum. Large particles are driven into the
dorsal hood by the cilia of the wall of the axial fold,   and
later are recaptured by the crystalline style. Small parti -
cles that reach the sorting area (sa$_2$) situated on the wide
base of the axial fold are conveyed to the dorsal hood   ei -
ther by the ciliary currents of the anterior tract, or   by
the currents of the axial fold.

The particles triturated by the style, that fall onto
the floor of the stomach, are conveyed to the sorting caecum
through the major typhlosole or by the lateral fold.

The particles that fall into the widened   posterior
part of the lateral fold are directed to the sorting   area
(sa$_3$) whence the small, light particles are sent into   the
opening of the ducts on the right. The bigger particles   are
thrown onto the typhlosole and thence to the sorting caecum.

Particles that fall onto the anterior part of the late
ral fold are conducted towards the caecum or the antero-dor-
sal tract.

The particles that enter the sorting caecum and are re
jected there, return to the stomach, along the wall of   the
axial fold and thence are carried onto the dorsal hood,   or
are guided by the intestinal groove to the midgut. The mate-
rial accumulated in the dorsal hood is recaptured by   the
crystalline style.

Particles broken up in the crystalline style may   be
led to the left pouch by the ciliary currents of the   axial
fold.

In the zone of the left pouch two types of   currents
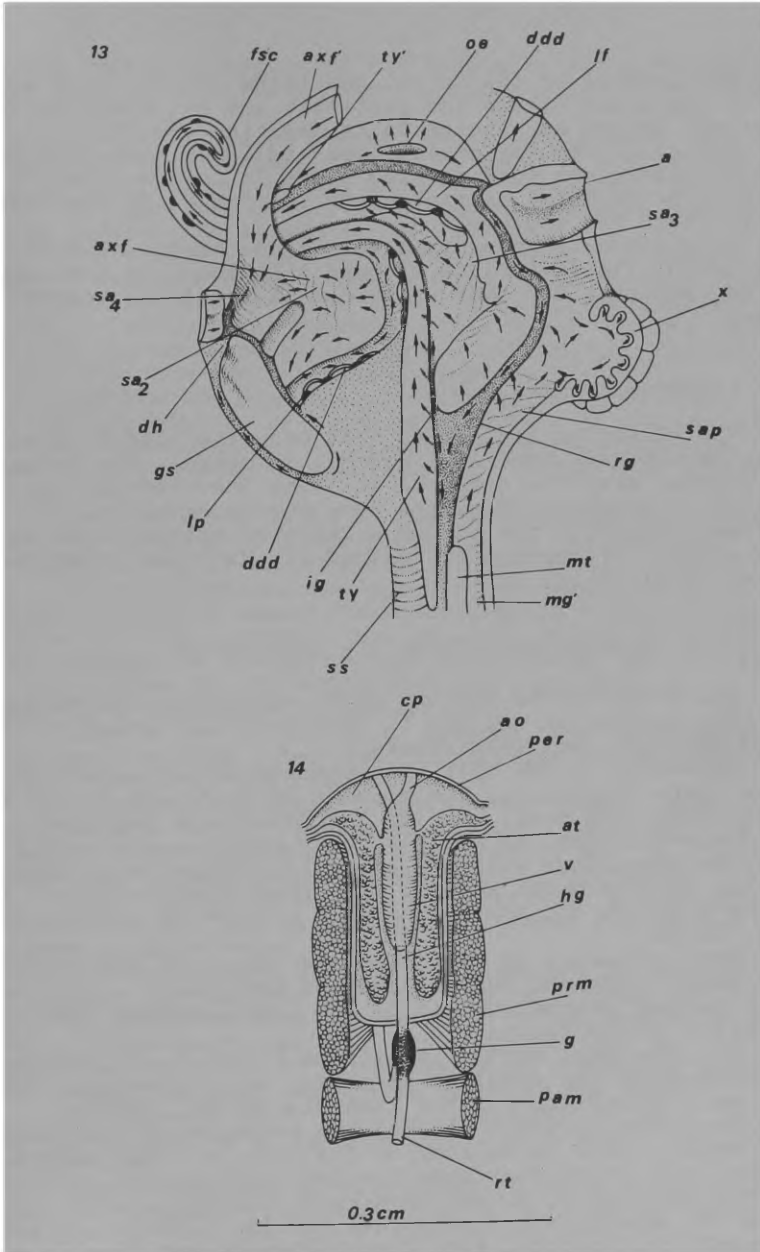appear, those which are directed to the posterior region to-

Figure 13 - *Brachidontes solisianus*. Interior of stomach opened by mid dorsal incision passing from oesophagus to midgut.
Figure 14 - *Brachidontes solisianus*. Dorsal view of pericardial cavity.

wards the opening of the ducts, and those of the   shallow
part of the pouch, where the particles are conveyed onto the
intestinal groove and thence to the sorting caecum.
     Material from the crystalline style may also fall into
the posterior right sorting area where it is submitted to se
lection. The rejected particles are carried on by the rejec
tion tract to the midgut.
     B. solisianus presents a sorting mechanism of type   A
and B (Reid, 1965) Sorting of type A is found in the   areas
sa_2, sa_3 and sap, and that of type B in the food separating
caecum.

Excretory organs

     The kidney is similar to that described for *B. darwi -
nianus darwinianus* (Avelar & Narchi, in press). The pericar-
dial glands, are also disposed as those described for *B. dar
winianus darwinianus*. They are very poorly developed in   *B.
solisianus* and give the atrium a brownish colour, like in *My
tilus edulis, Lithophaga cumingiana* and *Musculus marmoratus*
(White, 1942) (Fig. 14)

GENERAL DISCUSSION AND CONCLUSIONS

      The study of the anatomy of *B. solisianus* has revealed
that this species is adapted to that habit of living stick -
ing to rocks in sheltered creeks.
     Generally in the Mytilidae the siphons are short and ,
due to their simplicity, the sorting of particles is not ve-
ry efficient. The small size of the tentacular papillae   of
the inhalant siphon, as well as their position and simplici-
ty may be correlated with the animal's life on rocky substra
tum, the life in quiet waters. The great sensitivity of the
siphons would be an adaptation to a habitat in quiet waters
(Owen, 1953)
     Most probably, in Mytilidae the length of the siphons,
their sensitivity and the presence of tentacular   papillae
are in general characteristic of the family rather than   an
adaptation to the habitat.
     The branchial septum is extremely mobile. It   controls
the entrance of the inhalant aperture, and, moreover,   func-
tions as a protection for the ctenidia (Orton, 1912).
     According to Yonge (1948a) the presence of the   bran -
chial septum would be related to the life in muddy waters
However it is known that some species of Mytilidae,   among
them *Mytilus edulis, M. californianus* (Kellogg, 1915)   as
well as *B. darwinianus darwinianus* (Avelar & Narchi,in press),
do present this septum, even though they do not live in mud-
dy places.
     The musculature is similar to that of the Mytilidae in
general and presents the muscle of the demibranch. This mus-
cle is related to the retracting of the ctenidia when   a
great quantity of particles falls, by the inhalant flux, on

to the posterior region of the ctenidia. Among the Mytilidae this muscle had already been described only for *B. darwinianus darwinianus.*

The labial palps are extremely mobile and   efficient for the sorting of particles. They present a prominent muscular activity by preventing undesired particles from entering into the digestive tract. This fact had already been observed by Purchon (1963) and Narchi (1972)

The ctenidia are similar to those of the Mytilidae in general and according to Atkins (1937b) it is very difficult to correlate them with the animal's habitat and manner of life. *B. solisianus* has guarding cilia which Atkins associated with the presence of mud on the substratum. However this is not the case for the present species.

Perhaps the presence of these cilia is related   with the feeding habit, as these animals have to use the parti - cles in suspension to the utmost during the immersion pe - riod, as they remain exposed during the low tide periods for a long time.

The sensitive cilia on the demibranches may be related with the presence of large particles in the habitat.   This correlation had already been mentioned by Yonge (1946)

In *B. solisianus* the quantity of sensitive cilia   is smaller than in *B.darwinianus darwinianus* (Avelar & Narchi , in press) This is due to the animal's living in higher le - vels contrary to *B. darwinianus darwinianus,* which   settles on rocks close to the substratum where there is a   bigger quantity of particles in suspension.

Like in the Mytilidae in general, the inner demibranch is bigger than the outer one, which helps the sorting of par ticles to be more efficient.

B. solisianus shows in comparison with *B. darwinianus darwinianus* a smaller number of ciliary disks, perhaps as a consequence of adaptation to the habitat, as   *B. solisianus* shows a more homogeneous selection of particles.

Also the mantle surface cooperates in the selection of particles within the pallial cavity, where the currents are uniformely distributed.

The foot contributes to the cleansing of the mantle cavity, since the ciliary currents are rejective, which transport the particles from the anterior to the posterior region. Some of these particles join the branches and are   sorted again. When there is an accumulation of particles in the labial palps, the foot cooperates removing the excess.

The stomach of *B. solisianus* belongs to type III   of the classification of Purchon (1957) with style sac and in - testine fused.

The stomach has sorting areas of types A and B (Reid , 1965) Anatomically the stomach of *B. solisianus* appears mo- re elaborate than that of *B. darwinianus darwinianus*. Pro - bably this greater complexity is related with the size   of the particles. The analysis of the contents of the   stomach showed that *B. solisianus* deals with homogeneous and small sized material. The presence of an appendix functioning as a basis for stocking and sorting of food reveals that the ani- mal is adapted to a habitat where are many small   particles

in suspension.

In the classification of Purchon (1958) *B. solisianus*, due to its stomach, would be placed in the Gastrotriteia order of the subclass Polysyringia.

B. solisianus presents conchiological characteristics which permit its classification as an intermediate form between the isomyaria, scalloped bivalvia (*Crenella*, Morton, 1974) and anysomyaria bivalvia (*Mytilus*, Yonge & Campbell, 1968) One of these characteres is the presence of scallopings similar to theeth. The subterminal umbo is also an intermediate character since in *Mytilus* (White, 1937), *Xenos-trobus* (Wilson, 1967) and *Septifer* (Yonge & Campbell, 1968) the umbo is terminal.

The shell is slightly convex in the part before the ventral region, like in *Mytilus* (Yonge & Campbell, 1968) This condition is considered as a particularity among the more specialised Mytilidae.

ABREVIATIONS USED IN THE FIGURES

a - anterior dorsal tract; aam - anterior adductor muscle ; alid - ascending lamella of inner demibranch; alod - ascending lamella of outer demibranch; ao - anterior aorta; ars - anterior retractor muscle scar; arm - anterior retractor muscle; ass - anterior aductor muscle scar; at - atrium ; axf - axial fold; axf' - terminal portion of the axial fold; b - byssus; bs - branchial septum; c - caecum; cd - ciliar disk; cp - pericardial cavity; ct - crenulation; dd - digestive diverticula region; ddd - digestive diverticula ducts ; dh - dorsal hood; dlid - descending lamella of inner demi - branch; dlod - descending lamella of outer demibranch; dm - demibranch muscle; drs - demibranch muscle retractor scar; e - principal byssus axis; ex - exhalant siphon; f - foot ; fc - frontal cilia; fg - pedal groove; frm - retractor pedal muscle; fsc - food sorting caecum; g - gonad ; gc - guarding cilia; gs - gastric shield; hg - hind gut; id - inner demi - branch; ig - intestinal groove; ilp - inner labial palp ; in - inhalant siphon; k - kidney; lc - lateral cilia; lcc - cirrum; lf - lateral fold; lfc - latero frontal cilia; lp - left pouch; m - mantle; mg - marginal groove; mg' - midgut ; mrm - middle retractor byssus muscle; mrs - middle retractor byssus muscle scar; mo - mouth; mt - minor typhlosole; od - outer demibranch; oe - oesophagus; olp - outer labial palp ; ow - oralward current in the region of superficial marginal groove; ow' - oralward current in the region inside marginal groove; pam - posterior adductor muscle; pas - posterior adductor muscle scar; pc - renopericardial channel; per - pericardium; pls - pallial muscle scar; pm - pallial muscle ; pam - posterior adductor muscle; pg - proximal oral groove ; prs - posterior retractor byssus muscle scar; prm - posterior retractor byssus muscle; r - resilium; rg - rejection groove; rt - rectum; sa_2 - sorting area of axial fold; sa_3 - sorting area of right side of stomach; sa_4 - sorting area of dorsal hood; sap - posterior sorting area; ss - style sac;

ssc - sensitive cilia; st - stomach region; t - teeth; tc - terminal cilia; ty - major typhlosole; ty' - major typhloso- le tongue; u - umbo; v - ventricle; vd - right valve; x - ap pendix.

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