ON THE STUDY OF A SAMPLE OF GASTEROPODS (*PROSOBRANCHIA*) FROM THE IMPERIAL RANGE OF AZORES

by

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INTRODUCTION

According to MOTOMURA (1932) the geometrical progression law gives a good idea of the relative abundance of the animal species living in the intertidal region. The author's study of the population structure of 23 molusc, 5 echinoderm and 1 crustacean species from the different levels of the intertidal region lead to these conclusions (*cf.* INAGAKI, 1967).

Nevertheless, MOTOMURA's deduction can be argued in two ways: on one hand, the tidal zone presents several environ-

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ments at different levels and in distinct regions, and for this reason, the structure of a settlement living in an homogeneous diverse environment is described by MACARTHUR's broken-stick model. On the other hand the application of MOTOMURA's model demands the correct delimitation of the settlements which are submitted to the same environmental aspects. These give them their own individuality that can be seen in a specific characteristic profile which if it is not found, leads to the un-adjustment of the model.

For these reasons, ARRUDA (1979 a, b; in press) in previous works dealing with intertidal fish studied the application of MOTOMURA's model to settlements living in different biotops and compared the goodness of the adjustments obtained.

This present work aims to test the model's adjustment to a gasteropod community of intertidal prosobranchs living under accentuated hidrodinamic conditions and subjected to intensive fishing at Laginha, a place around an island (Fayal) of the Azores archipelago.

The coast of these islands is difficult to approach, being formed by huge irregular rock formations or by vertical cliffs to the sea. So a *pahoehoe* type lava area with a slight declivity was chosen as field work. There it is possible to approach the surf zone during low tide.

It must be referred to as a point of interest, that limpets are much consumed on these islands and so their commercial value should not be under-estimated. Those environmental conditions make the collecting of these species easier.

MATERIAL AND METHODS

During the most favourable late afternoon tides in August and September 1980, 1432 specimens covering 8 different species which live at the different intertidal levels were collected.

The general aspects of the zonation of the living organisms distributed over that area were briefly studied by ARRUDA (1979 a).

The species determination was done according to NOBRE (1938-40) and NORDSIECK (1968).

Littorina striata (King) was the most abundant species collected (1090 specimens). It occurred mainly in the irregular surfaces of the supralittoral decreasing in number as the lower levels were reached.

Thais haemastoma (L.) was the second largest number of species collected (164 specimens). It occurred mainly in the infralittoral range.

Littorina neritoides (L.) was found in the supralittoral range, especially in its lower area, reaching a relative medium abundance (91 specimens). As *L. striata,* it occurred in rocks of irregular surface, with crevices and other cavities.

Columbella rustica (L.) was common in the lower part of the midlittoral rocks occuring also among infralittoral seeweeds. It was found mostly in sheltered places with a slight slope, being rare in areas directly exposed to waves (61 specimens).

Patella vulgata (L.) was also found in the midlittoral rocks (8 specimens). Another species of the same genus, *P. aspera* Lamarck (3 specimens) occurred in the upper part of the infralittoral.

Mitra cornicula (L.) was found in large pools with infralittoral characteristics where its frequency was low (14 specimens).

It was also in these pools that one specimen of *Haliotis tuberculata* L. was collected. It is a typical infralittoral species occuring at higher levels in pools and lagoons that never dry up, as has been referred to by STEPHENSON (1924).

The samples were taken from profiles drawn on the field before each collection, so that an unexplored area was always used. On each profile, areas of 25 cm square were delimited at different levels in the *Littorina*, *Chthamalus*, *Corallina* and *Cystoseira* zones, where all the prosobranchs gasteropods were collected.

RESULTS AND DISCUSSION

From a pratical point of view and according to DAGET (1976), a graph showing the frequencies distribution was made using semi-logarithmic coordinates which allow to forecast which model of relative abundance will best adjust to the community.

So having placed the species according to its order of importance on the X axis and plotted the logarithms of each species frequency on the Y axis it was obtained a graph of frequencies whose alignment leads to a straight line. From this distribution a geometric progression model, also know as MOTOMURA's model may be seen.

In order to appreciate the degree of adjustment to the model the correlation coefficient of BRAVAIS-PEARSON between the logarithms of the abundance and the ranks was calculated according to INAGAKI (1967). This coefficient is not a true test but simply an adjustment index. As a matter of fact, according to DAGET *et al.* (1969) this is not a linearity test

but if the points are almost in line which can be verified by the graph, the best linearity is when correlation coefficient is nearest to 1, as absolute value.

Thus, from correlation values (r) above 0.95 and below 0.98 the law is shown to be approximately verified. For values above 0.98 and below 0.99 the adjustment is rather better and above 0.99 the adjustment is exact.

The absolute value of the correlation coefficient obtained by means of an electronic calculator between the abundance logarithms of the 8 species and the respective rank numbers being equal to 0.9903, shows that the model exactly fits the settlement.

The same programme allowed to find $\log q = 0.40188\, i + 3.24882$, the straight line equation which represents the geometrical place of the scattergram.

The final adjustment to the model, based on the straight line equation values is drawn in Fig. 1.

According to DAGET (1976) MOTOMURA's model is perfectly determined by the value of the constant of milieu (m) which corresponds to the geometric series ratio (l-K).

So, from the slope of the regression line not only its value ($m = 0.396$) but also the value of the constant K, which represents the portion of the resources each species has taken to itself, can be determined.

Thus, according to the model's theory, *L. stricta* takes a fraction of the environmental resources equal to 60.4 %; *T. haemastoma*, the second species in abundance, takes an identical fraction of the un-occupied resources by the first species and successively for the whole nomocenosis species. Still following the model, the order of abundance found has no connection with the time of arrival of the species to the community but only with competitive success.

The species that usually live under low water line, such as *M. cornicula* and *H. tuberculata*, occur according to the law of geometric progression when the species-abundance relationship is considered. As a matter of fact, they have taken a

fraction of the available resources which allows them to remain in balance with the resident species.

This happens because the ecological barriers between the intertidal range and the subjacent marine environment are more overcome in regions where the former is permanently washed by the continuous wave action, as occurs in the Azores.

CONCLUSIONS

From the results obtained it can be concluded that the number of prosobranchs gasteropods of the studied settlement distribute themselves following the law of geometric progression.

According to the model's theory (INAGAKI, 1967; VIEIRA DA SILVA, 1979) this adjustment means that this is a pioneer community relatively simple and well-balanced where the strong competition, for either a new or unused resource, leads to a small number of species of similar size and ecological demands. Some of these species dominate the nomocenosis, therefore present an exponential growth where all the individuals have precisely the same minimum surface area to survive.

i	*log qi theoretical*	*qi theoretical*	*log qi adjusted*	*qi adjusted*
1	2.84694	703.0	2.93698	864.8
2	2.44506	278.7	2.53501	342.8
3	2.04318	110.5	2.13313	135.9
4	1.6413	43.8	1.73125	53.9
5	1.23942	17.4	1.32937	21.4
6	0.83754	6.9	0.92749	8.5
7	0.43566	2.7	0.52561	3.4
8	0.03378	1.1	0.12373	1.3
		1164.1		1432

Fig. 1 — Definitive adjustement to MOTOMURA's model.

When the conservation state of the nomocenosis is considered, the adjustment of the model shows that the amount of limpets that have been caught were not enough to change the community's equilibrium. Exploitation would only have caused an eventual change in the relative importance of these species inside the nomocenosis. The study of un-explored areas or the establishment of other areas — closed to human activity, would enable one to confirm or deny this hypothesis.

RESUMO

Neste trabalho, os autores estudam a aplicação do modelo de MOTOMURA a uma comunidade de gastrópodes prosobrânquios vivendo numa área da zona intertidal de uma ilha do arquipélago dos Açores (Faial).

Os resultados obtidos permitem-nos concluir que o modelo se ajusta rigorosamente ao povoamento estudado. Isto significa, de acordo com a teoria do modelo (INAGAKI, 1967; VIEIRA DA SILVA, 1979), que a comunidade é constituída por espécies com exigências ecológicas idênticas, em equilíbrio competitivo, portanto, onde todos os indivíduos dispõem de uma superfície mínima rigorosamente igual para subsistirem.

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