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COMPARATIVE ALLOMETRY GROWTH OF SOME MARINE FISH DIGENETIC TREMATODES

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Allometric growth variation was compared for Plagioporus idoneus, Lepocreadium pegorchis, Opecoeloides furcatus, Bacciger israelensis, Aphanurus stossichi *and* Parahurleytrema trachinoti *collected from East Mediterranean fishes. The pharynx, the oral and the ventral sucker diameters always showed a negative allometry. The other parameters tested were variable with the species. We study the effects of some environmental factors: the influence of the host species is analysed in* Plagioporus idoneus, *which parasitizes* Oblada melanura, Diplodus sargus *and* D. vulgaris *and in* Lepocreadium pegorchis, *which parasitizes* Pagellus erythrinus, Lithognathus mormyrus *and* Spicara smaris; *the influence of the microhabitat and the intensity of infection is analysed in* Bacciger israelensis *and* Aphanurus stossichi, *both parasites of* Boops boops. *We report significant differences with the host species, for the allometric growth of the testes; the effect of the microhabitat was revealed by the hindbody allometric value; no significant difference was detected in relation with the intensity of infection.*

Key words: allometry growth – marine fish – digenetic trematodes

Trematode allometric growth studies are rare. Apart from those of Thomas (1967) on the amphibian trematode *Mesocoelium monodi*, and Rohde (1966) on the *Chiroptera* trematode *Anchitrema sanguineum*, all the research has been carried out by Fischthal, who published data on 11 species on marine fish trematodes: *Pseudocreadium lamelliforme* and *Paracryptogonimus americanus* (Fischthal, 1978 a), *Multitestis rotundus, Stenopera equilata, Leurodera decora* and *Prosorynchus pacificus* (Fischthal, 1978b), *Asymphylodora fishelsoni* (Fischthal, 1979), *Lecithochirium magnicaudatum* (Fischthal, 1980), *Metadena globosa* (Fischthal et al., 1980), *Bucephalus gorgon* (Fischthal et al., 1982), *Lissorchis attenuatus* (Fischthal et al., 1982).

We have studied 6 trematode species belonging to genera which have never before been the object of such a study. These species are: *Plagioporus idoneus, Lepocreadium pegorchis, Opecoeloides furcatus, Bacciger israelensis, Aphanurus stossichi* and *Parahurleytrema trachinoti*. In addition to the study of the allometric growth of certain organs or organ distances, considered as such in the six species of trematodes, we have tried to determine the possible variations in the allometric indices as a function of the host, of the microhabitat and of the intensity of infection.

Methodology

For each of the six species studied, we examined a sample of 30 individuals collected either from the same or from different individual fishes and chosen to represent the various sizes as closely as possible, except otherwise stated. Depending on the trematodes, the organs or the organ parts examined were not necessarily the same, as dictated by the animal's anatomy.

The measurements were taken from individuals mounted *in toto*. In order to do comparisons, we applied the method used by Fischthal (1978). Allometric growth can be expressed by the equation: $y = bx^{\alpha}$, where y represents the organ or the organ part, x the body length and α the allometry exponent. This equation can be written in the form $Y = \log y = \log b + \alpha \log x$. We calculated the values of this equation by the least square regression method, and the lines were plotted on logarithmic paper. The value of α (slope) gives the required result. If $\alpha = 1$ the organ or the organ part has the same growth rate as the

TABLE I

Values of the allometric coefficient in the different species studied

	P. idoneus	*L. pegorchis*	*O. furcatus*	*P. trachinoti*	*B. israelensis*	*A. stossichi*
o.s.	0.7 (0.07)	0.4 (0.08)	0.2 (0.1)	0.1 (0.1)	0.4 (0.08)	0.6 (0.1)
v.s.	0.8 (0.07)	0.6 (0.08)	0.4 (0.1)	0.1 (0.1)		0.6 (0.1)
o.s.-v.s.	1.01 (0.1)	0.8 (0.09)	0.5 (0.2)	1.09 (0.2)	0.6 (0.1)	0.7 (0.1)
v.s.-ex	0.8 (0.2)	1.1 (0.06)	1.1 (0.3)	0.9 (0.1)	1.3 (0.1)	1.08 (0.08)
ph.	0.8 (0.1)	0.6 (0.07)	0.4 (0.2)	0.3 (0.1)		
t1	0.3 (0.2)	0.5 (0.09)	0.4 (0.1)	0.2 (0.1)		
t2	0.4 (0.1)	0.4 (0.09)	0.6 (0.1)			
ov.	1.1 (0.1)	0.7 (0.07)	0.5 (0.1)	0.02 (0.1)		
t2-ex.	1.1 (0.1)	1.3 (0.1)	0.9 (0.1)	0.8 (0.2)		
bl.					1.1 (0.08)	

TABLE II

Values of the allometric coefficient as a function of the host in *Plagioporus idoneus* and *Lepocreadium pegorchis*

	Plagioporus idoneus			*Lepocreadium pegorchis*		
	O. melanura	*D.. sargus*	*D. vulgaris*	*P. erythrinus*	*L. mormyrus*	*S. smaris*
o.s.	0.6	0.8	0.7	0.5	0.5	0.4
v.s.	0.5	0.6	0.8	0.8	0.8	0.6
o.s.-v.s.	0.8	0.7	1.01	0.8	0.6	0.8
v.s.-ex	1.2	1.2	0.8	1.06	1.2	1.1
ph.	0.8	0.8	0.8	0.5	0.7	0.6
oes.	1.2	0.9	1.3	2.3	1.5	1.07
t1	1.01	1.07	0.3	0.9	1.08	0.5
t2	0.7	1.05	0.4	0.8	1.3	0.4
ov.	0.8	1.1	1.1	0.8	0.7	0.7
t2-ex.	1.2	0.9	1.1	1.1	0.7	1.3

whole body; if $\alpha < 1$, it has a lower growth rate; if $\alpha > 1$ the growth rate is higher. The last two cases are known respectively as negative and positive allometry.

The following abbreviations are used for the different organs or organ distances: o.s. = oral sucker; v.s. = ventral sucker; o.s.-v.s. = distance between the anterior body extremity and the posterior end of the ventral sucker (forebody); v.s.-ex. = distance from the inferior extremity of ventral sucker to the posterior end of body (hindbody); ph. = pharynx diameter; t. = testis diameter; t1 = diameter of the anterior testis; t2 = diameter of the posterior testis; ov. = ovary; t2-ex. = distance separating the rear end of the posterior testis from the body end; bl. = bladder lenght; oes. = oesophagus.

Allometric growth in the various species studied

Table I shows the values of α (with standard deviation between brackets) for the different species and measurements.

The oral sucker diameter, the hindbody length and the forebody length were studied in six trematodes: *Plagioporus idoneus, Lepocreadium pegorchis, Opecoeloides furcatus, Bacciger israelensis, Aphanurus stossichi* and *Parahurleytrema trachinoti.*

One measurement, the oral sucker, shows a negative allometric growth in all the trematode species studied.

The other values range from negative to positive depending upon the species: – the hindbody length is positive in *A. stossichi, L. pegorchis, O. furcatus,* and *B. israelensis,* and negative in *P. idoneus* and in *P. trachinoti.* – the forebody length is positive in *P. trachinoti* and *P. idoneus* and negative in *L. pegorchis, O. furcatus, B. israelensis* and *A. stossichi.*

TABLE III

Values of the allometric coefficient as a function of the microhabitat in *Aphanurus stossichi* (a) and *Bacciger israelensis* (b)

	Aphanurus stossichi 3 different microhabitats				*Bacciger israelensis* 3 different microhabitats		
	O E 1	O E 2	O E 3		In 1	In 2	In 3
o.s.	0.3	0.2	0.01	o.s.	0.2	0.7	0.6
v.s.	0.4	0.6	0.3	o.s.-v.s.	0.6	0.9	0.9
o.s.-v.s.	0.8	0.6	0.9	v.s.-ex	1.4	1.05	0.9
v.s.-ex	1.1	1.2	1.02	bl.	0.9	1.1	0.9

TABLE IV

Allometric coefficient values as a function of the intensity in *Aphanurus stossichi* and *Bacciger israelensis*

	Aphanurus stossichi 5 different intensities						*Bacciger israelensis* 5 different intensities				
	5	14	26	46	84		6	18	30	62	97
o.s.	0.8	0.4	0.4	0.6	0.3	o.s.	0.9	0.6	0.4	0.8	0.7
v.s.	0.7	0.4	0.4	0.6	0.2	o.s.-v.s.	0.5	0.9	0.6	0.9	0.8
o.s.-v.s.	1.1	0.7	0.9	0.7	0.6	v.s.-ex	1.3	1.09	1.3	1.04	1.1
v.s.-ex	0.9	1.1	1.03	1.08	1.1	bl.	1.1	1.1	1.1	1.1	1.06

The pharynx diameter, ventral sucker diameter, testes and ovary diameters and distance between the second testes and the rear end of the animal were studied in *Plagioporus idoneus, Lepocreadium pegorchis, Opecoeloides furcatus* and *Parahurleytrema trachinoti.*

Some values always show a negative allometry: the ventral sucker, the pharynx diameter and the testes diameters.

The others vary according to the species: the ovary diameter and the distance between the testes and the rear end.

Variation of allometric growth with certain environmental conditions

Host species – The study was carried out on: *Lepocreadium pegorchis* which parasitizes *Spicara smaris, Lithognatus mormyrus* and *Pagellus erythrinus; Plagioporus idoneus* which parasitizes *Diplodus vulgaris, D. sargus* and *Oblada melanura.*

We chose parasites which were collected under similar conditions of infestation density so that any interference of the host influence with that of a possible intraspecific competition could be ignored. Table II shows the results of the measurements obtained for these two trematodes.

Microhabitat – The study was carried out on the 2 most frequent trematode species of *B. boops: A. stossichi* and *B. israelensis* (Table III).

In *A. stossichi,* the sectors studied concern the three portions of the oesophagus (OE1, OE2 and OE3) to which the trematode is generally limited.

For *B. israelensis,* we considered three sectors of the intestine marked as follows: In 1 (pyloric caeca and the contiguous part of the intestine), In 2 (anterior part of the intestine) and In 3 (median intestine), which are the three sectors of the intestine harbouring the highest proportions of the trematode.

Parasite intensity – This survey was carried out on *B. boops* trematodes: *A. stossichi* and *B. israelensis.* For each trematode, we studied allometric growth in five different infrapopulations. For *A. stossichi,* these infra-populations comprised 5, 14, 26, 46 and 84 parasites. For *B. israelensis,* they comprised 6, 18, 30, 62 and 97 parasites (Table IV).

Discussion

Our results concerning the general study of allometric growth in the six species of trematodes show similarities and differences as compared to those of preceding authors.

The similarities concern the measurements of the ovary, the oral and the ventral suckers, the pharynx and the post-testicular distance, which we can group into two categories: those which do not follow a strict rule, i. e. the ovary dimensions and the post-testicular distance and those which always show a negative allometry, i. e. the diameters of the oral and ventral suckers, and of the pharynx.

The differences are: the testes dimensions which always show a negative allometry in the species studied whereas the previous research indicated a variable allometry; the forebody distance which shows a highly variable allometry in our species whereas the preceding authors always mentioned a negative allometry; the hindbody distance which was always positive according to the preceding works, and showed a variable allometry in our species, though the α values were very close to 1 for the case of negative allometry.

Concerning the allometry variations as a function of the host, Fischthal's works (1980), on the trematode *Metadena globosa* collected from three different fish species, note the following conclusions: certain organs always show a negative allometry whatever the host; these are the sucker and pharynx diameters and the testes dimensions; the measurements always showing a positive allometry are the hindbody distance and the post-testicular space; finally, certain organ or organ distances vary with the host species; these are the forebody distance and the ovary.

In our study, the measurements taken on *L. pegorchis* and *P. obovatus* in different host species do not allow any logical interpretation except for the testes values which, both in *L. pegorchis* and in *P. obovatus,* show great differences according to the host species. This variation detected in the male gonad's allometric growth might imply that the mechanisms of resource allocation to reproduction, are different in a single parasite species when the host varies; this could mean that the parasite can find its optimal development in only one preferential host.

Regarding the allometric variations with the microhabitat, let us recall that many studies carried out on various animal parasites, have already shown that morpho-anatomical differences do exist in the same species of trematode according to the microhabitat in which they are collected. However, the only research concerning fish trematodes and considering the allometric variations as a function of the *site* is that of Fischthal et al. (1982): the authors study these variations on the trematode *Bucephalus gorgon* collected from the pyloric caeca and the small intestine of *Seriola dumerili.* In this work, most of the organs or inter-organ distances have a comparable allometry for the parasites of the two microhabitats; the ovary and testes diameters are the only measurements which show significant differences in the parasites of the caecas and the intestine.

We did not measure the genital organs in the two trematodes we studied since they were very difficult to observe in all the individuals of the same sample of parasites, but, from the measurements we did on the other organs or inter-organ distances, it is possible to formulate the following conclusions: in *A. stossichi,* the α values, although showing some variation, do not exhibit results significant enough to deserve discussion; in *B. israelensis,* the hindbody seems to provide an interesting result. Indeed the variation observed for the hindbody seems progressive in that α increases regularly as we pass from sector In 3 to sector In 1, where this coefficient reaches a maximal value of 1,4. In a parallel study (Fares-Saad, 1985), we demonstrated that this sector represents the preferendum of the parasite (the trematodes harboured there show the maximum sizes and densities). The fact that the trematodes present in this sector also show the highest allometric coefficient for the posterior part of the body which bears all the genital organs, confirms the existence of this preferendum which would appear to offer the best conditions for parasite reproduction.

Regarding the influence of the infestation intensity on the allometric growth, except for the work published by Fischthal et al. (1982) on the allometric growth of *Lissorchis attenuatus* studied in four different infestation intensities, there has never been any other research in the field, to the best of our knowledge. According to the authors, allometric growth values differing significantly with intensity are: the two sucker diameters, the forebody distance and the ovary and testes dimensions. The hindbody distance as well as the post-testicular distance and the pharynx diameter do not show such differences.

In our study, although the α values can be different in the different infrapopulations we studied, there is no clear relationship between allometric growth of any organ or inter-organ distance and the size of the infrapopulation. It is probable that, if the effect of any competition should interfere, it would occur at a threshold infrapopulation size which is outside the limits of this survey.

In conclusion, we can say that from all the measurements reported, the only values which exhibit a negative allometry in all cases and in all situations are the sucker diameters. The remaining organs or body parts measured (such as forebody, hindbldy, bladder size) showed a variable allometry which can be affected by various environmental factors.

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