1950

International Commission
for the
Northwest Atlantic Fisheries

1970

RESTRICTED

Serial No.2406
(D.c. 9)

ICNAF Res.Doc.70/64

ANNUAL MEETING - JUNE 1970

Some Biological Data of Argentine (*Argentina silus Ascanius*) from the Nova Scotia area

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I. INTRODUCTION

Among the publications dealing with argentine the most noteworthy are those by Borodulina /1964/, Emery /1966/, Keysler /1968/ as well as Wood and Raitt /1968/. In these papers the problems connected with biology and distribution of this species are extensively dwelt upon.

The present paper aims to add more information on the biology of argentine, as well as to furnish further data for estimation of the abundance of the stocks of this fish. As it is known actually there is only limited exploitation of this species by fisheries. Therefore it is necessary, just now, to establish fundamental parameters of its rate of growth and total mortality, which in the present conditions of fishing seems to be almost equal to natural mortality.

II. MATERIAL AND METHOD

The materials were collected from trawl catches carried out in the fishing grounds of Sable Island Bank, Emerald Bank, Sambro Bank and Browns Bank. in the years 1964-1968. In total 10 651 fish were measured. Detailed analysis was performed on 1915 individuals among which 1 760 were read for age. Back readings for the rate of growth were performed for 479 individuals.

The measurements of fish included body length /longitudo corporis/ and were performed with the accuracy of 1 cm. The age was read from concave surface of unpolished otoliths in reflected light, immersed in 1:1 mixture of ethyl alcohol /96%/ and glycerine. Back readings for the rate of growth were based on otoliths readings. This served as a basis for calculation of theoretical growth by means of the v.Bertalanffy equation.

Mortality coefficient, corresponding to the slope of the straight, has been calculated by the method of least squares. Catches for sampling were made with trawls, adapted in such manner for the purpose as to eliminate as far as possible the effect of selectivity upon collected samples.

III. RESULTS OF INVESTIGATION

1. A g e

The results of investigations on age in the years 1964-1968 are given in the Figure 1.

In 1964 the most abundant were fish 4 and 5 years old, born in the years 1959 and 1960. In total their number in the catches exceeded 45%. The participation of 3 years old fish and 6 to 11 years old amounted in total to abt. 50%. Only a small number of individuals represented older fish.

In 1965 predominant were fish 4, 5 and 6 years old. Hence we may conclude that the year-classes born in the years 1959 - 1960 were abundant ones. Comparatively small was the participation of older age groups, 8 years old.

In 1966 the participation of particular year-classes did not show the predominance of whatever year-class as was the case in previous years. The most abundant were fish in the age from 4 to 13 years. Also in this years the fish of the age 6 and 7 years, i.e. the year-classes born in 1959 and 1960, were abundant.

In 1967 predominated older fish, of the age 11 and 12 years. Fairly good was the participation of fish 8 to 10 and 13 to 16 years old.

In 1968 occurred in samples considerably younger fish than in previous years. Most probably this year were encountered concentrations of juvenile fish which do not occur along with adult fish and remain in different regions.

2. L e n g t h

The results of length measurements for the period of 1964 - 1968 are given in the Figure 1.

A number of distinctly marked peaks may be noted in 1964. They were connected with length-classes of 15, 19 and 28 cm. It may be assumed that the presence of three predominant length - classes was connected with the occurrence of a number of strong populations.

In 1965 most abundant were fish in lengths from 19 to 23 cm. Modal value was established with the length-class of 22 cm. In this year occurred fish of a relatively large range of lengths, from 14 to 42 cm. Simultaneously there could be noted some increase of mean length in comparison to preceeding year /Table 1/.

In 1966 the abundance of particular length-classes of fish occuring in the catches did not show any considerable differences. There was noted however slight predominance of fish in the length-class 26-27 cm.

In 1967 the majority of fish were in the length range from 30 to 35 cm. The peak was noted in the length-class 32 cm.

In 1968 the length of fish was confined to the range of 21-25 cm, with a very distinct predominance of the length-class of 23 cm.

Following the changes in the length of argentine within the period of several years, starting with 1965, we note the tendency of modal value to shift towards right hand side of the graph, i.e. towards the range of larger fish. This tendency remains until 1967.

The decrease of the lengths in 1968 seems to be accidental since it is based on comparatively scarce material, collected only in the 1st quarter of this year.

Table 1

Mean lengths of argentine from the fishing grounds of Neva Scotia

Year	Sex ♂		Sex ♀		Sex ♂ + ♀	
	n	cm	n	cm	n	cm
1964	99	23,8	112	22,4	211	23,0
1965	257	23,3	243	25,5	500	24,3
1966	455	28,3	440	31,0	895	29,6
1967	173	30,5	78	32,0	251	30,9
1968	30	22,6	30	23,0	60	22,8

3. The rate of growth

In the papers Borodulina /1964, 1968/, by Emery and Mc Cracken /1966/ and some others the rate of growth of argentine was determined on the basis of mean lengths of fish in particular age groups.

In the present paper in order to obtain more representative data, particularly for the youngest and oldest age groups - it was decided to determine the rate of growth of argentine also by the method of back readings of otoliths. To adopt this method the relationship between rate of growth of fish and length increase of its otolith was determined. In the literature this problems is dealt with by Ketchen /1964/, Jensen /1938/, Trout /1954/, Cięglewicz et al /1969/. Depending on fish species and the section plane of otolith the ration of fish length and the length of otolith radius may be depicted either by curve or by straight line. As regards argentine the considerations of this problem have not been encountered in literature and therefore before back readings the above ration was subject to detailed examination.

The measurements of otolith radius along the axis connecting the nucleus with the edge of rostrum and the nucleus with the edge of antirostrum showed that for back readings of the growth rate the first of the two axes is more suitable and this for the following reasons:

1. With the same length of fish any possible error in the measurement of shorter radius effects in a greater extent the final result;
2. The zones /rings/ of annual length increase on the rostrum show more contrast and therefore enable to obtain better accuracy of the measurement;
3. The distribution of the points in the graph, showinh the relation between the length of rostrum radius and the length of fish body is of the rectilinear character /Fig.2/

On the basis of empirical data was derived the following linear equation:

$$R = 0.168 + 0.14$$

where:

R - the length of otolith radius in mm
L - the length of fish body in cm

This equation shows that the application of Einar Lea formula /Waluś-Karpińska, 1961/ gives the results of back readings with a slight error only. An ideal equation for above relation should have the parameters: $b = 0$ /$y = ax$/. The value of $b = 0,14$ in above equation might be either the result of dispersion /scattering/ of empirical data or appears as the consequence of disproportion between the growth of otolith and the length increase of fish body. For practical purpose there was made the assumption that both these characteristics are directly proportional.

The growth of argentine was finally characterized on the basis of back readings by means of the von Bertalanffy equation:

$$L_t = L\infty \; /1 - e^{-K\,/t - t_o/} \; / \quad \text{/Beverton and Holt, 1957 /}$$

where:

L_t - Length of fish in the age t

$L\infty$ - asymptote of curve of growth in length

e - the base of natural logarithm

t_o - arbitrary origin of growth curve

K - the parameter of katabolism

The methods of calculation of above parameters have been described in detail in the papers by Allen /1966/, Cięglewicz et al. /1969/ and Ketchen /1964-1966/. For this reason only the values of these parameters are given in the Table 2 and graphic presentation of the rate of growth plotted on the basis of above equation.

Table 2

The parameters for the v.Bertalanffy equation

Region	Parameters					
	$L\infty$		K		t_o	
	♂	♀	♂	♀	♂	♀
Nova Scotia	37,9	41,4	0,145	0,129	-0,75	-0,75

Both the empirical data and the data calculated on the basis of parameters / $L\infty$, K, t_o/ fairly well coincide. This fact speaks in favour of the adoption of the v.Bertalanffy equation for the determination of the characteristics of the rate of growth of argentine.

On the basis of obtained results we have to conclude that argentine from Nova Scotia region is characterized by relatively good length increase in the age from 1 to 8 years. In this period the annual increase fluctuates within the range of 4.0 - 1.8 cm. In older age the length increase drops markedly, being within the range 1.5 - 0.5 cm. per annum /Fig. 5/.

No essential differences were noted in the length increase between males and females /Figure 4/. First in the age of 8 years and in elder age the length increase in females is greater than in males.

4. M o r t a l i t y

It was found suitable to use data characterizing age composition of argentine in particular years for determination of the coefficient of total mortality /Z/. This coefficient may be calculated by means of the equation:

$$Z = l_n \frac{No}{Nt}$$

where:

No - abundance of fish at the time t_0

Nt - abundance of fish at the time t_1

The application of this formula requires however further numerical data on participation of fish in particular age groups, such as captured per one unit of fishing effort in consecutive years. Hence it appears that besides the knowledge of age composition of the catches it is also necessary in this case to have detailed statistical data on the catches of the investigated species. Since such statistics are not, as yet, available the determination of the index of total mortality was based on age composition.

If we assume the mortality of fish of different age to be similar then the index according to Ricker /1958/ may be calculated from the catch curve.

When the participation of particular age groups is expressed in values of l_n the right hand section of the curve thus obtained becomes approximately linear. With the simplified assumption that the abundance of the stock in the region of

Browns Bank has not been subject to any considerable fluctuations in the recent years - the slope of this straight may be interpreted as the coefficient of total mortality.

In order to apply this method there has been compiled data on mean age composition, from which it appears that starting with the fifth year of life the rate of mortality is higher than the rate of recruitment. The obtained mean age composition was recalculated in the values of l_n. The right hand slope of the curve is presented as a straight line by means of the method of least squares /Fig. 5/.

The curve for the age composition of the catches, plotted on the basis of the data for the years 1964-1967 may be not sufficiently representative. This presents however the preliminary estimation of the mortality for that period when the intensity of fishing is still very low. In such case the calculated total mortality might give the value similar to that of natural mortality.

The slope of the straight for the age from 5 to 20 years, obtained from the calculation by means of least squares, equals 0.280. This parameter is simultaneously the coefficient of total mortality /Z/ for the period of one year and points to the reduction of the populations by 24.4% per annum.

From the value of the above parameter we may conclude that the stock of argentine is at the present time characterized by low total mortality.

4. S u m m a r y

As the result of investigations it was found that the most abundant were 1959 and 1960 year-classes. The age of fish occurring in the catches ranged from 3 to 29 years, their lengths being from 13 to 42 cm. Sporadically occurred larger fish, up to 52 cm in length.

Argentine of the age of 1 to 7 years shows relatively good growth. Generally females grew faster than males. This difference increases along with the age.

Natural mortality was found to be low and the coefficient of total mortality - 0.280. This points to the fact that the increase of fishing effort may effect the stock of this species. An excessive fishing intensity may therefore lead to fact decrease of the stock of this fish. In view, however, of a low as yet exploitation of this stock some expansion of the fisheries for this species is undoubtedly possible.

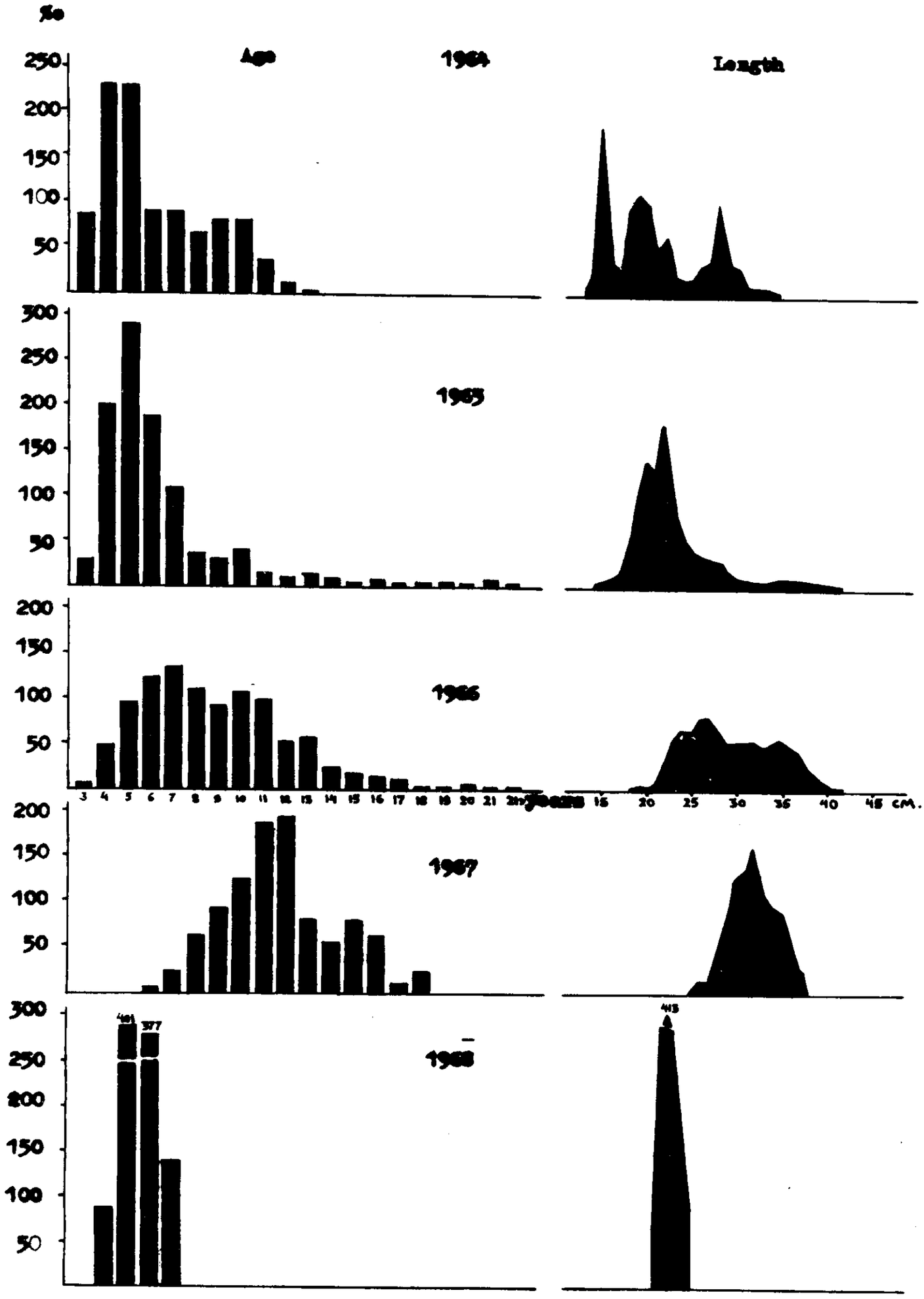

Fig. 1. Age and length of argentine in the catches

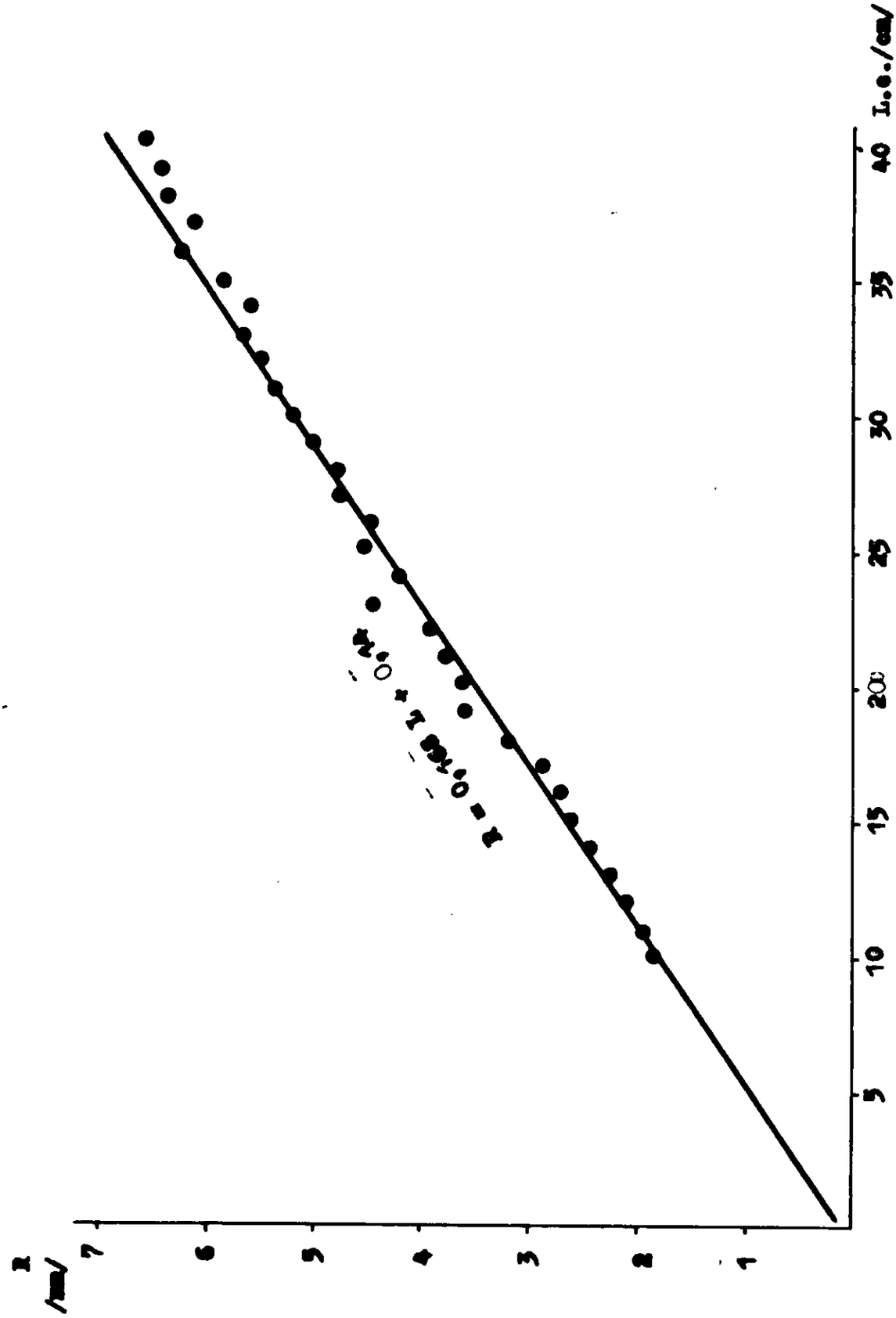

Fig. 2. Relationship between the length body /L.e./ of argentine and the longer radius of its otolith /R/

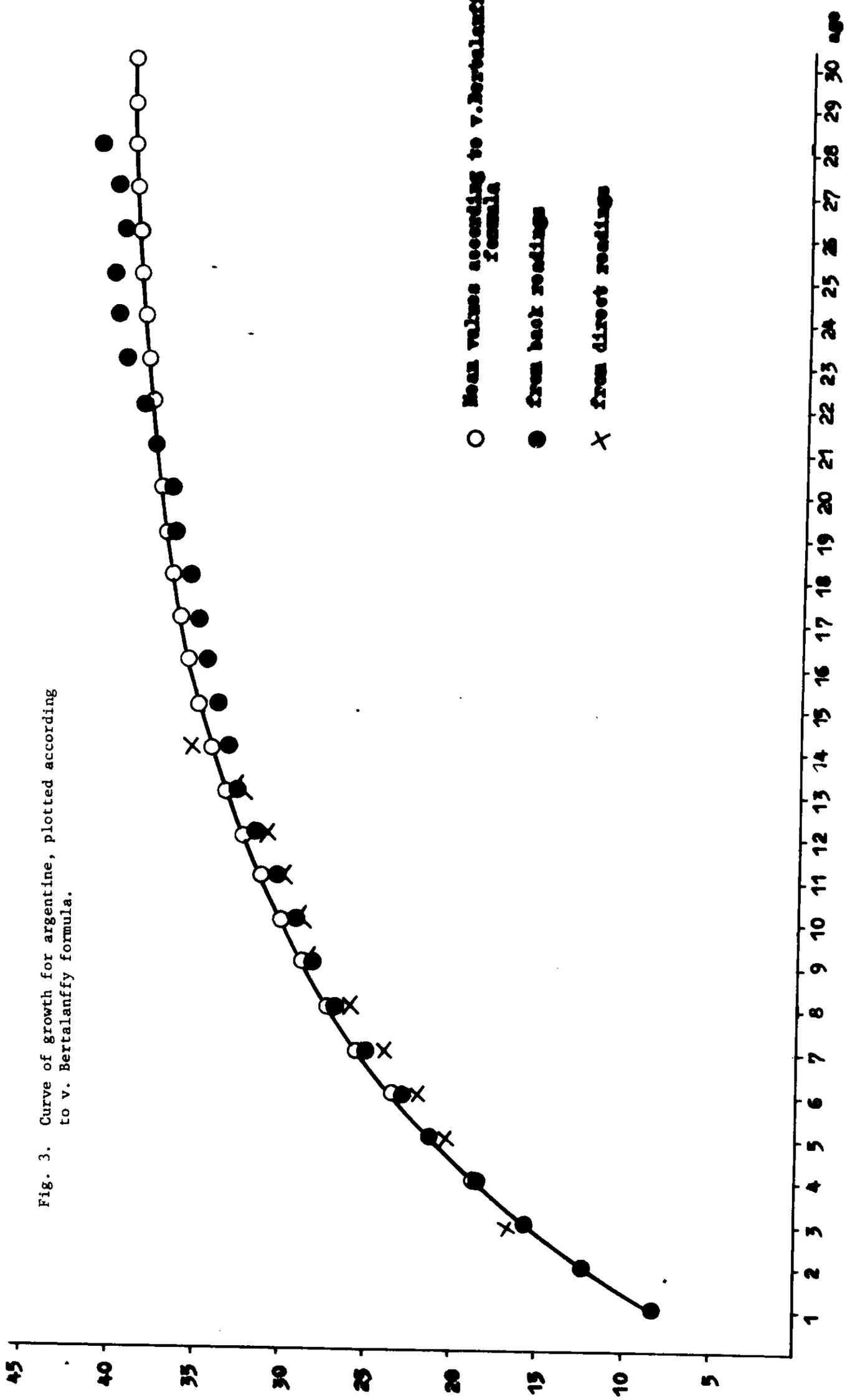

Fig. 3. Curve of growth for argentine, plotted according to v. Bertalanffy formula.

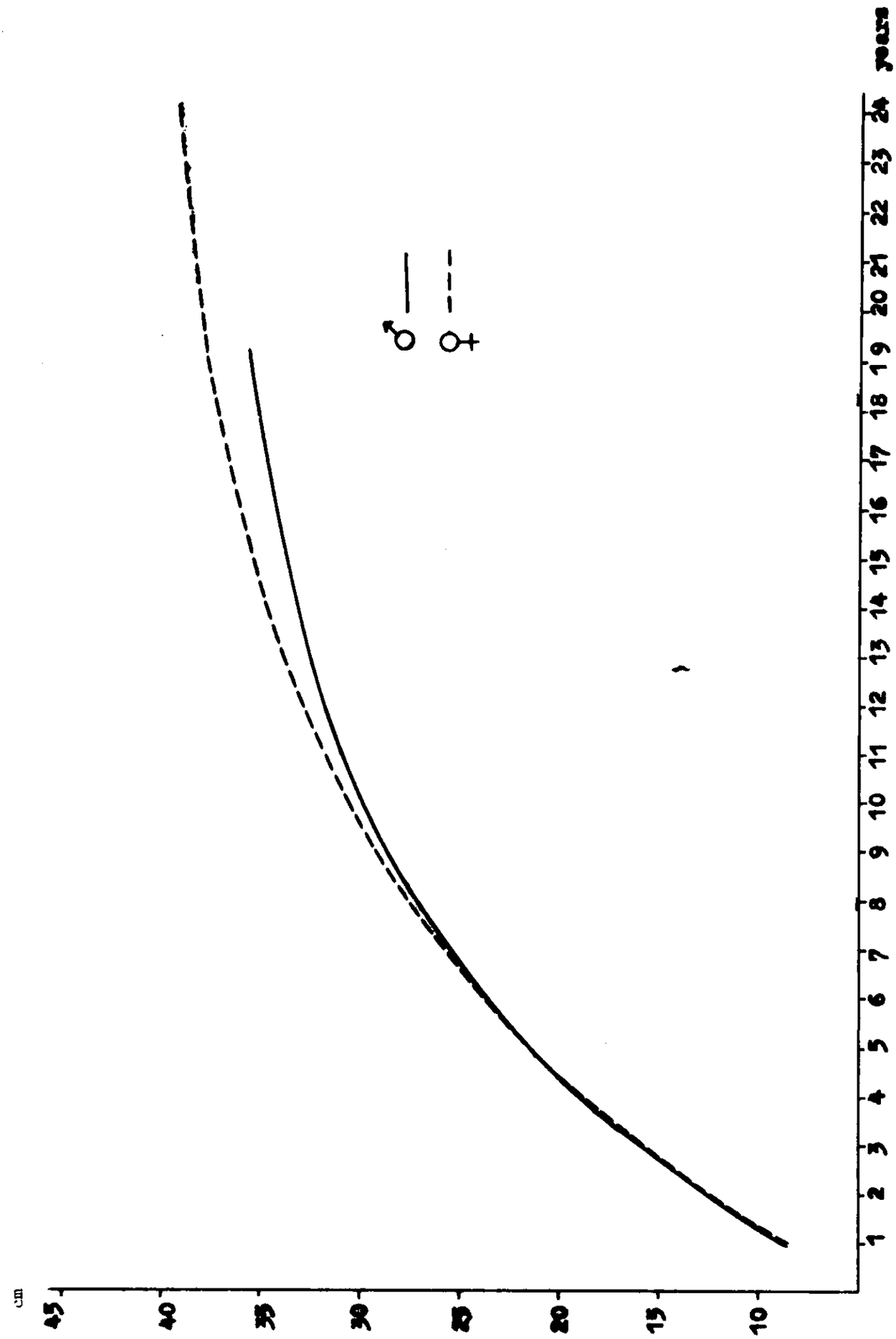

Fig.4. Curves of growth for males and females of argentine plotted according to the v. Bertalanffy formulae.

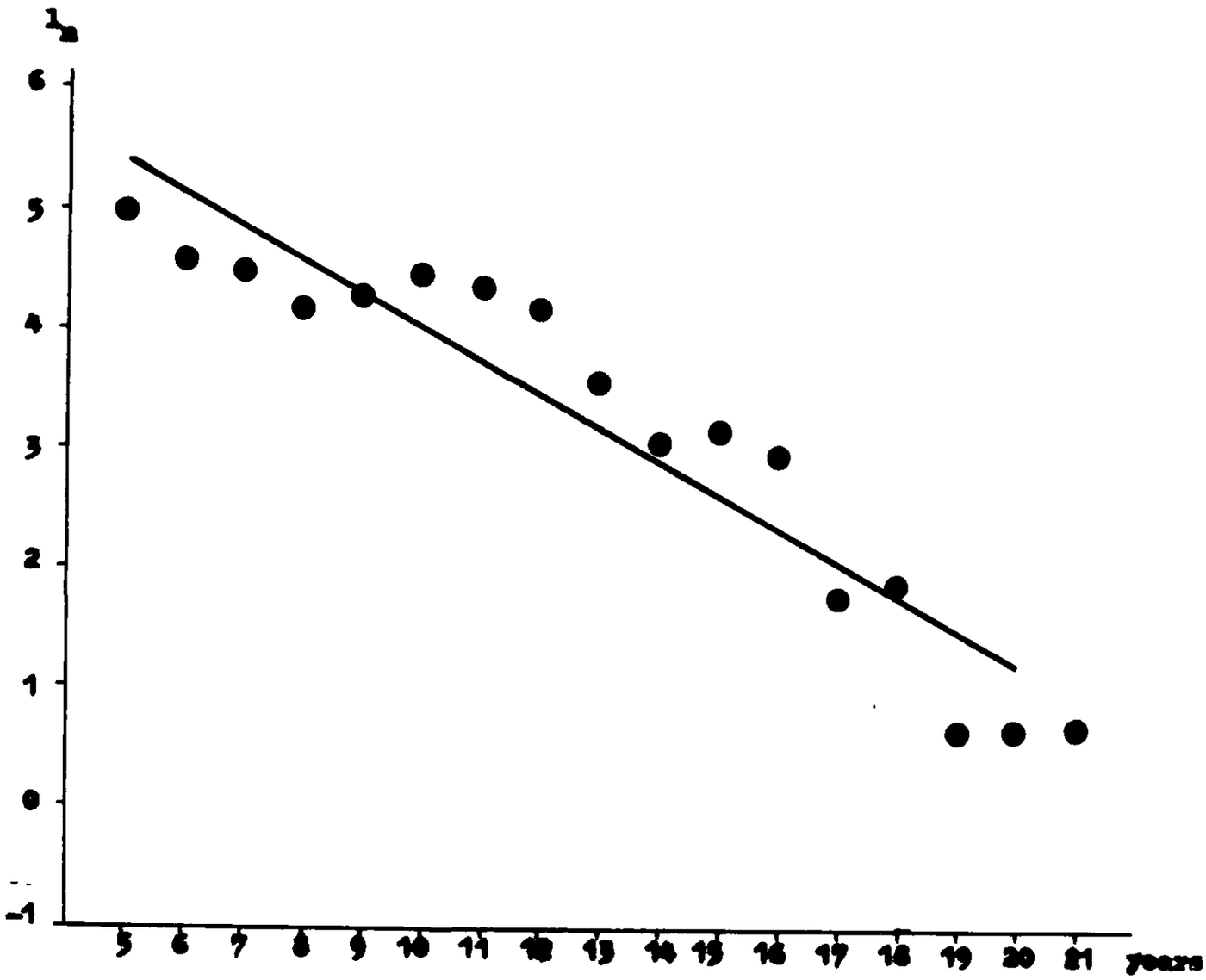

Fig. 5. Mortality of argentine expressed in l_n plotted against age.