Growth and Mortality of *Dagaa* (*Rastrineobola argentea*, Fam. Cyprinidae) in Lake Victoria

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Abstract

Growth and mortality parameters of the small Lake Victoria cyprinid *Rastrineobola argentea* were determined from length-frequency analysis, using the ELEFAN I and II programs. The results of two sampling programs, both performed during 1988, one in Uganda (mosquito seine) and the other in Tanzania (pelagic trawl), were highly corresponding. In comparison with previously published data on the growth of *dagaa* and some similar species, low values for L_∞ (65 mm standard length) and K (1 $year^{-1}$) were found. Total mortality (Z) amounted to 3.9-4.4 $year^{-1}$. A single annual breeding peak was observed both in Uganda (October/November) and in Tanzania (February/March).

Introduction

After the collapse of the Lake Victoria multispecies fishery, the small cyprinid *Rastrineobola argentea* (*dagaa*) remained the only indigenous species of importance (Ligtvoet et al. 1988). Besides being a commercially attractive fish (Okedi 1981), *dagaa* is a major prey species of the introduced Nile perch (*Lates niloticus*) (Ligtvoet 1988). This large predator currently comprises most of the catches from the lake (Ligtvoet 1988; Ligtvoet et al. 1988).

Despite the significance of *dagaa*, fishery biologists have not yet paid the species much attention though in the early 1970s, some work was done on its reproduction (Proude and Stoneman 1973; Okedi 1974). Proude and Stoneman also gave monthly length-frequency distributions for the Ugandan waters. Their paper, however, has never been published and only a few results were made public through their being cited in Rufli and van Lissa (1982). In the late 1980s, more ecologically oriented research has been started (Wanink 1988a, 1988b; Wanink and Goudswaard 1989; Wandera, in press).

In this paper we present some basic data on growth, mortality and recruitment of *dagaa*, based on length-frequency analysis. We have investigated two populations, one in the Ugandan and the other in the Tanzanian part of Lake Victoria. For comparison, we have estimated the growth parameters of the population studied by Proude and Stoneman (1973) from the information in Rufli and van Lissa (1982).

Materials and Methods

Study Areas

The Ugandan samples were collected from three sites around Buvuma Channel near Jinja, i.e., Tongolo, Nasu Point and Pilkington Bay. All data from the Tanzanian part of the lake originate from a standard sampling station G (depth = 14 m), located in the Mwanza Gulf and described by Witte (1981).

Sampling

Specimens from Buvuma Channel with the exception of Pilkington Bay were obtained from an experimental seine net. A 30-m long, 1-m deep mosquito beach seine net with 10-mm stretched mesh was operated by 50 m of rope attached to both ends. In Pilkington Bay, samples were obtained from small-scale fishers using the same gear, except that they used kerosene-pressure lamps to concentrate the fishes before these are hauled ashore.

In Mwanza, Gulf data were collected by surface trawling during 1988. The cod end of the net amounted to 5-mm stretched mesh. Between 19.30 and 21.30 hours, four trawlshots of 15 minutes each were made, using a 7-m long open boat with a 25 hp outboard engine. Samples were stored in 4% formalin immediately after collection.

Laboratory Work

At the laboratory, a subsample of the catch or the total catch when numbers were low, was taken to establish the length-frequency distribution. Standard length was measured to the nearest mm. The Ugandan samples were grouped into 4 mm classes with midpoints at 10 mm, 14 mm, etc. Since some of the samples from Mwanza Gulf showed overscores for sizes such as 10 mm, 15 mm and 20 mm, all values have been lumped into 5-mm length classes (midpoints at 10 mm, 15 mm, etc.) before further analysis was performed.

Analysis

The length-frequency distributions were analyzed using the ELEFAN I and ELEFAN II computer programs (Pauly 1987), in order to estimate parameters describing growth, mortality and recruitment.

Results

Growth

The original length-frequency data (Tables 1 and 2) were restructured with ELEFAN I (Fig. 1). This program also

Table 1. Length-frequency distributions of *Rastrineobola argentea* caught during 1988 (except the December sample, which is from 1987) by beach seining in the Buvuma Channel. The values for standard length (SL) represent the midpoints of 4-mm size classes.

SL (mm)	15/01	15/03	15/05	15/06	15/07	15/08	15/09	15/12
10	50							
14	57	1						
18	12							
22		1						
26		3						
30	1						2	
34		6		2	1	4	5	
38	3	8		3	11	7	9	5
42	13	15	2	9	8	5	8	34
46	73	184	20	21	36	10	9	98
50	22	108	107	9	94	22	28	93
54	3	9	175	1	63	19	42	5
58			49	1	10	8	14	
62		1	2				2	
Sum	234	336	355	46	223	75	119	235

Table 2. Length-frequency distributions of *Rastrineobola argentea* caught during 1988 at station G in Mwanza Gulf by nightly surface trawls. The values for standard length (SL) represent the midpoints of 5-mm size classes.

SL (mm)	08/01	08/02	04/03	08/04	03/06	14/06	26/09	06/10	22/11
10								3	
15	1	3				1		8	
20	1	2				7	7	31	
25	7	4					139	118	2
30	4	2	9				151	94	27
35	68	23	41	3			84	72	407
40	355	153	56	19			35	73	489
45	259	346	212	127	8		13	23	103
50	56	170	99	93	177	8	2	28	12
55	15	36	24	12	144	12	2	22	10
60		1	2	1	4		1	1	
Sum	766	740	443	255	333	28	434	473	1,050

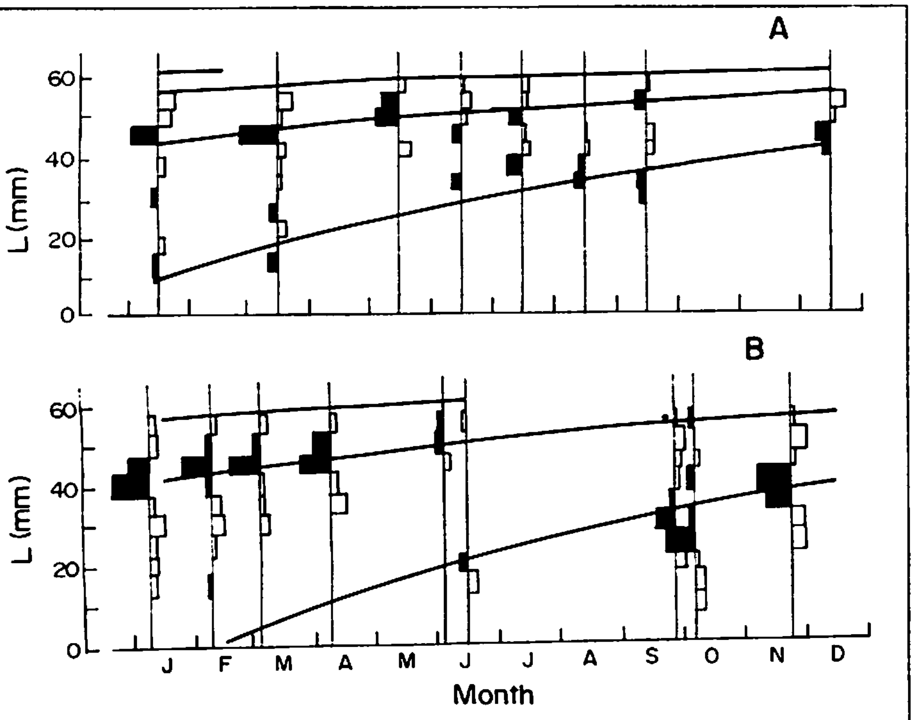

Fig. 1. *Length-frequency distributions (standard length) of two Rastrineobola argentea populations from Lake Victoria. A. Beach seine catches from Buvuma Channel, Uganda (Dec. 1987-Sept. 1988). B. Nightly surface trawl catches from Mwanza Gulf, Tanzania (Jan.-Nov. 1988). ELEFAN I has been used to restructure the distributions from Tables 1 and 2 to the form presented here, and to perform the curve fitting. The growth parameters are summarized in Table 3.*

fitted the curves (Fig. 1) from which the growth parameters, as presented in Table 3, were determined. To compare the two populations, we have calculated a growth performance index ϕ' using the formula of Pauly and Munro (1984):

$$\phi' = 2 \log_{10} L_\infty + \log_{10} K \qquad \text{...1)}$$

where L_∞ is the asymptotic length in cm and K is a growth constant, per year. The values of ϕ' amounted to 1.62 for Buvuma Channel and 1.66 for the Mwanza Gulf, a difference of only 2.5%.

Mortality

Natural mortality (M) was estimated from the equation of Pauly (1980):

$$\log(M) = -0.0066 - 0.279 \log(L_\infty) + 0.6543 \log_{10}(K) + 0.4634 \log_{10}(T) \qquad \text{...2)}$$

where T is water temperature in °C. The value T = 23 was entered for both populations. This resulted in an estimated M of 2.5 $year^{-1}$ for Buvuma Channel and 2.6 $year^{-1}$ for the Mwanza Gulf.

Total mortality (Z) was estimated from a length-converted catch curve. Before this curve was drawn, the ELEFAN I program was used to determine the selectivity characteristics of the gear. The results of this analysis are summarized in Table 4. The difference in mesh size between the beach seine used in Uganda and the trawl net operated in Tanzania is reflected in the length at which *dagaa* enters the corresponding fishery (L-50). The catch curves are presented in Fig. 2. Total mortality amounted to 3.9 $year^{-1}$ in Uganda and to 4.4 $year^{-1}$ in Tanzania.

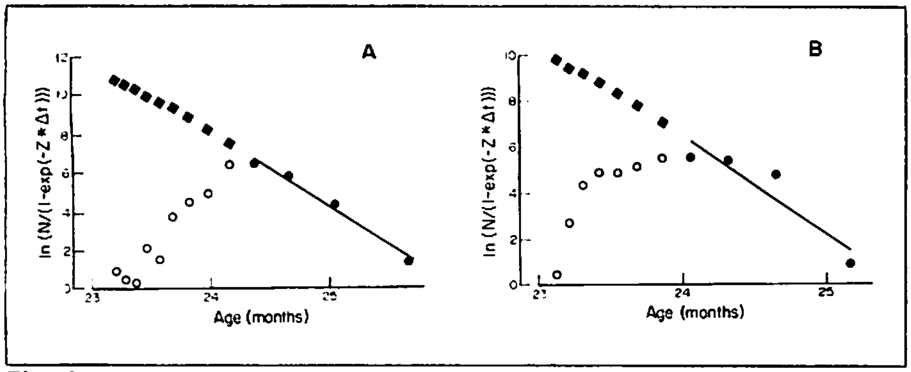

Fig. 2. *Catch curves for dagaa populations from the Ugandan (A) and the Tanzanian (B) part of Lake Victoria. Sampling done by beach seine in Uganda and by surface trawl in Tanzania. Gear selectivity is presented in Table 4. The estimated mortality is given in the text.*

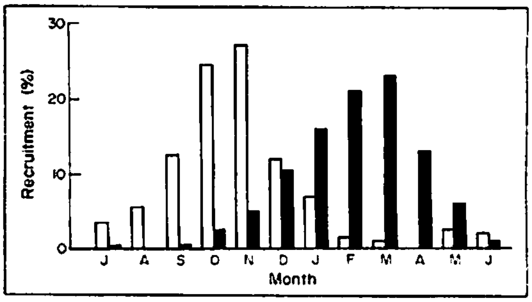

Fig. 3. *Yearly recruitment of dagaa in Uganda (white bars) and Tanzania (black bars).*

Table 3. Growth parameters of *Rastrineobola argentea* as determined by the ELEFAN I program in fitting the curves presented in Fig. 1.

Location	L_∞ (mm)	K (year^{-1})	Starting length	Starting sample	Rn
Buvuma Channel	65	0.99	44	1	0.418
Mwanza Gulf	65	1.08	37.5	9	0.785

Table 4. Selectivity of the gears. Sizes at which 25, 50 and 75% of the encountered fishes were retained are indicated.

Location	L-25	L-50	L-75
Buvuma Channel	49.0	52.8	56.6
Mwanza Gulf	39.7	44.4	49.1

Table 5. Growth performance of some East African small pelagic freshwater fishes. Relationships between standard, fork and total length of *dagaa* (Wanink 1988b) have been used to recalculate the size of all species to standard length. Symbols are explained in the text.

Species	L_∞ (cm)	K(year^{-1})	ϕ	Reference
E. sardella	11.0	2.58	2.49	Rufli and van Lissa (1982)
E. sardella	11.0	2.89	2.54	Rufli and van Lissa (1982)
S. tanganicae	8.5	2.53	2.44	Proude and Stoneman (1973)
R. argentea	6.5	1.04	1.65	This study

Recruitment

The annual recruitment patterns for the two populations have been combined in Fig. 3. In both areas only one major breeding period per year was found. In Ugandan waters the breeding peak occurred during October/ November, while in Tanzania the highest values were found four months later.

Discussion

Growth

Since the growth parameters of the two studied populations were almost identical, the mean values for L_∞ (65 mm standard length) and K (1.04 year^{-1}) will be used to describe the growth curve of *dagaa* in Lake Victoria. The growth rate of *dagaa* is low compared to some other small pelagic fishes from East Africa. Values of K = 2.58 to 2.89 year^{-1} (for L_∞ = 138 mm total length) have been established for the clupeid *Stolothrissa tanganicae* (Roest 1977).

Unfortunately, the early work on the growth of *Rastrineobola argentea* in the Ugandan part of Lake Victoria (Proude and Stoneman 1973) has never been published. However, Rufli and van Lissa (1982) have cited a maximum fork length of 105 mm from this manuscript. The growth rate of *dagaa* was said to resemble the values found by Rufli and van Lissa (1982) for *Engraulicypris sardella*. Therefore, we have assumed a K value of 2.74 year^{-1} (the mean of two values given for *E. sardella*) for the *dagaa* population studied by Proude and Stoneman (1973). L_{max} (105 mm fork length) observed by Proude and Stoneman was transformed to standard length (95 mm) using Wanink's (1988b) relationship between the two parameters. Subsequently L_∞ could be estimated (100 mm SL) from L_{max}/0.95 L (Taylor 1958). The recalculated values for L_∞ and K were then used to compute the growth performance index of the *dagaa* population described by Proude and Stoneman (Table 5). Also the growth performance of *Engraulicypris sardella, Stolothrissa tanganicae* and the average value of the *dagaa* populations described in this paper have been calculated (Table 5). Our value appeared to be the lowest by far.

Apparently the growth rate and the maximum length of *dagaa* in Lake Victoria has decreased significantly over the last 15 years. Dwarfing has been reported for the Mwanza Gulf, where the modal length of adult *dagaa* decreased by 18% between 1982 and 1987 (Wanink 1988a; Wanink and Goudswaard 1989). The same phenomenon has been observed in *dagaa* populations from Lake Kyoga (Uganda) and the northern part of Lake Victoria (Wandera, in press).

Mortality

The estimated total mortality for *dagaa* (Z = 3.9 - 4.4 year^{-1}) is high, compared to the value published for the Nile perch population of the Mwanza Gulf (Z = 1.1 - 1.2 $year^{-1}$) (Ligtvoet 1988). However, a high mortality rate is a normal phenomenon in small pelagic species. Turner (1982) gave values ranging from 2.2 to 5.0 for *Engraulicypris sardella* in Lake Malaŵi. For *Stolothrissa tanganicae* from Lake Tanganyika, a total mortality of 5.5 $year^{-1}$ has been reported by Roest (1977).

Recruitment

The single recruitment peak per year found both in Uganda and Tanzania resembles the reproduction pattern of the small zooplanktivorous haplochromine cichlids from the Mwanza Gulf (Witte 1981). On the other hand, both *Engraulicypris sardella* (Rufli and van Lissa 1982) and *Stolothrissa tanganicae* (Roest 1977) have more than one spawning peak during a year. To date we do not know the underlying factors determining the reproductive cycle of *dagaa*. The main recruitment seasons determined by ELEFAN II are in agreement with the period in which high numbers of ripe and running animals were found in Uganda (Wandera, in press) as well as in Tanzania (Wanink 1988b).

Size Selective Sampling

Due to the sampling design, the analyses for both populations were performed on the larger size classes only. The mesh size of the beach seine was too large for catching juveniles. The surface trawl net could have caught small *dagaa* when operated by day, since in the Mwanza Gulf size related daily vertical migration of *dagaa* has been reported (Wanink, in press; Wanink and Berger, in prep.). At night only the adult cohort is found near the surface, while during the day mainly juveniles and cestode infected adults occupy the top layer (Wanink, in press). In this first attempt to assess the growth parameters of *dagaa* in Lake Victoria we have selected night catches only, in order to achieve the best cohort separation.

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