ring is already formed at the end of the first year, this ring obviously cannot be a spawning ring. It could perhaps be argued that the sexual excitation of the spawning fish is somehow communicated to the younger fishes. However, the immature fishes form distinct schools which do not mingle with spawning schools. Also, when a young fish can be found near or in a spawning school, it is abnormally advanced, and already able to join in spawning activities.

Other hypotheses brought forward to explain the occurrence of annual rings can be refuted in similar fashion such that only negative evidence can be presented here with regard to this problem. However, even if the [occurrence] of annual growth rings in tropical fishes cannot be explained scientifically, it will still be useful to know that the available methods to investigate fish in our temperate waters can be applied in the tropics, especially in view of the fact that there seems to be an interest in developing fisheries in [Northern] Australia and [Indonesia].

An Account of Fisheries Development in the Republic of Djibouti with Notes on the Growth and Mortality of Three Species of Groupers[a]

A. DARAR

Abstract

A brief description of fisheries development in Djibouti is given, with emphasis on the major constraints that have to date limited the increase of fishing effort. Estimates of L_∞ obtained through Wetherall plots are presented for three important demersal species caught off northern Somalia and landed in Djibouti: the groupers *Cephalopholis sonnerati*, *Epinephelus chlorostigma* and *E. areolatus* (Fam. Serranidae). These are combined with estimates of the growth performance index ϕ' to calculate K values, subsequently used for the construction of length-converted catch curves. The estimate of mortality thus obtained suggests that these stocks are lightly fished.

Introduction: the Fisheries of Djibouti

The Republic of Djibouti, with coastlines bordering on the Red Sea and the highly productive Gulf of Aden (Fig. 1), appears to have a considerable fisheries potential.

The shelf, along the coastline of about 350 km, covers an area of nearly 2,500 km^2, and consists of both softbottom and corraline areas, with the former predominating (Bouhlel 1988). A potential yield of 1,200 t·year^{-1} has been estimated for softbottom demersal fishes, and of 2,000 t·year^{-1} for small pelagics (clupeoids, mackerels) to which may be added 70 t·year^{-1} of sharks and 150 t·year^{-1} for miscellaneous marine groups (coral reef fishes, cephalopods, crustaceans).

This potential is not realized. Indeed, in Djibouti, fishing is a marginal activity: most Djiboutians have pastoralism as cultural background, and beef is much more preferred than fish. Thus, commercial fishing activities have difficulties establishing themselves, and what little fishing is done is for subsistence and/or is highly seasonal, and aimed at spawning aggregations.

In view of these constraints, the Government of Djibouti established a plan for the development of small-scale fisheries three years after its independence (from France), which occurred in 1977. This led to a number of development programs funded by external agencies (United Nations Development Programme, Food and Agriculture Organization, International Fund for Agricultural Development and the US Agency for International Development), through the Djiboutian Directorate for Livestock and Fisheries. These various programs led to some permanent and some temporary results, notably:

- the organization of fishers through a cooperative (Association Cooperative de Pêche Maritime), contributing about 80% of the total catch;
- the establishment of a fisheries training school (Centre de Formation de Pêcheurs Professionels);
- the rebuilding and expansion of the (small-scale) coastal fishing fleet, meant to exploit areas in the north and south of the Gulf of Tadjourah, the fishing grounds north of Obock, as well as the fishing grounds from Djibouti City to the Somalian border (Fig. 1);

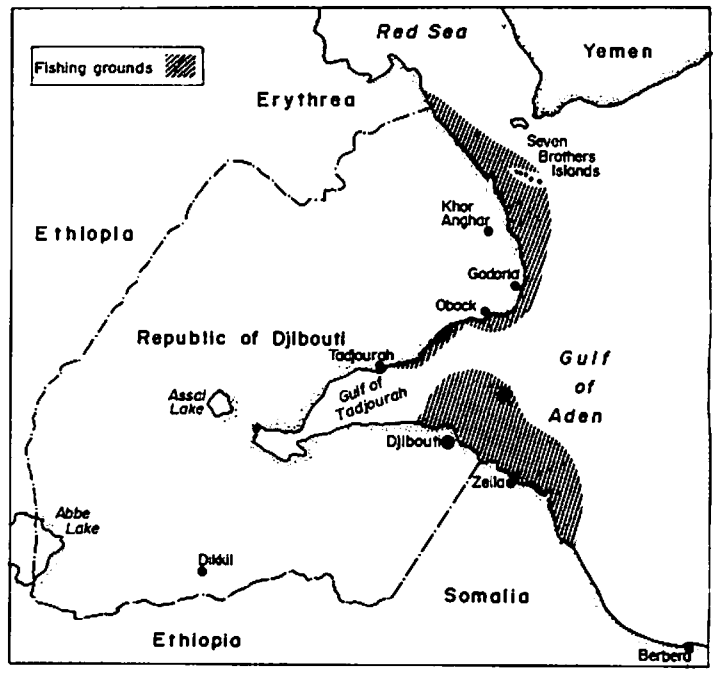

Fig. 1. *Map of Djibouti and northern Somalia, showing locations mentioned in text.*

[a]Written during a study stage at ICLARM headquarters from 19 March to 21 April 1993.

- a book on the fish of Djibouti, enabling field identifications (Bouhlel 1988);
- an increase in catches from 170 t in 1980 to 600 t in 1986, and an increase in the number of landed species, now including jacks (*Caranx sexfasciatus, Carangoides bajad*), groupers (see below), snappers (*Lutjanus sanguineus, Pristipomoides typus*), emperor (*Lethrinus mashena*) mullets (e.g., *Valamugil seheli*), barracuda (*Sphyraena jello*) and king mackerels (*Scomberomorus commerson*); and
- the establishment of a "cold chain" and of marketing channels, which for a while even included the air freighting of quality fish to Réunion.

Yet in spite of these measures, severe constraints to fisheries development persist, notably:

(i) lack of knowledge on the population dynamics and on the spatial and temporal distribution of most resources species (see Kedidi and Bouhlel 1985 for one of the few available accounts);
(ii) lack of trained Djiboutian personnel to undertake the research required in (i);
(iii) absence of port facilities supportive of further fisheries development; and, most importantly
(iv) lack of a market demand for fish, the Djiboutian population being familiar with only a limited number of species (notably *Scomberomorus commerson, Lethrinus mashena* and *Caranx sexfasciatus*).

Constraint (iii) may be soon alleviated through a grant from the African Development Bank, devoted to port development.

To address constraint (i) and as far as possible constraint (ii) as well, the Government of Djibouti and the German Development Agency (Deutsche Gesellschaft für Technische Zusammenarbeit, GTZ) have initiated in January 1992 a joint project which will conduct trawl (demersal and pelagic) and acoustic surveys of Djiboutian waters.

Growth and Mortality of Three Demersal Species

The growth and mortality of three species of groupers (*Cephalopholis sonnerati, Epinephelus chlorostigma* and *E. aerolatus*, Fam. Serranidae) were studied, based on length-frequency data of fish landed in Djibouti, from November 1992 to January 1993, and handlined on Somalian fishing ground off Zeila and further down toward Berbera (Fig. 1, Table 1). The methods used to analyze these data were standard ones, i.e.;

a) estimation of L_∞ from a cumulative L/F sample using a Wetherall plot;

Table 1. Length-frequency data of three species of groupers caught off Zeila and other fishing grounds off northern Somalia (Fig. 1) and landed in Djibouti on 22 November 1992 (A), 22 December 1992 (B) and 23 January 1993 (C).[a]

Midlength (TL, cm)	*Cephalopholis sonnerati*			*Epinephelus chlorostigma*			*Epinephelus areolatus*		
	A	B	C	A	B	C	A	B	C
21				8	1	2			
23				4	1	1	0	2	1
25	2	0	3	28	13	6	6	1	3
27	4	3	3	67	44	35	21	17	9
29	16	17	12	129	86	61	46	25	19
31	52	22	18	285	161	93	100	51	35
33	62	22	22	340	247	144	108	62	55
35	83	20	21	324	225	152	110	64	68
37	70	26	23	291	180	197	95	34	73
39	62	19	14	252	159	156	29	8	42
41	43	10	15	245	135	186	6	4	13
43	22	2	10	269	161	174	1	0	0
45	22	3	4	293	159	192	1	0	0
47	9	0	0	211	163	180			
49				228	168	190			
51				206	161	194			
53				164	130	167			
55				131	83	160			
57				118	89	142			
59				121	80	98			
61				103	49	51			
63				46	9	24			
65				15	3	4			
67				1	0	1			
71				0	0	1			
73				0	0	1			
75				0	0	1			
Sum	447	144	145	3,879	2,507	2,613	523	268	318

[a] The vertical lines on the left and right sides of the samples identify the length ranges included in the Wetherall plots and the catch curves, respectively.

b) computation of ϕ' ($= \log_{10}K + 2\log_{10}L_\infty$) from previous estimates of growth parameters in other populations of the same species (two cases), or related species (one case);
c) estimation of K from the ϕ' and L_∞ values; and
d) construction of length-converted catch curves, from which total mortality (Z) and ancillary statistics are estimated.

This methodology, building on Pauly (1980, 1987), is fully documented in Venema et al. (1988), and was implemented using a beta version of the FiSAT software package (Pauly and Sparre 1991).

This led to the results summarized in Table 2 from which the following can be seen:

- estimated mean sizes at first capture are rather large, ranging from 32 cm in *C. sonnerati* to 42 cm in *E. chlorostigma*;
- the mean of the three estimates of fishing mortality in Table 1 ($F = 0.26$ year^{-1}) is rather low compared with the mean of the estimates of natural mortality ($M = 0.35$ year^{-1})

These results suggest, albeit very tentatively, that the stocks from which the samples in Table 1 originated were lightly fished.

Table 2. Summary of statistics estimated from the length-frequency data in Table 1.

Statistic (Unit)	*Cephalopholis sonnerati*	*Epinephelus areolatus*	*Epinephelus chlorostigma*
TL_∞(cm)	50.2	49.4	69.1
ϕ'	2.315[a]	2.644[b]	2.191[b]
K (year^{-1})	0.082	0.18	0.17
Z (year^{-1})	0.21	1.19	0.44
M (year^{-1})[c]	0.25	0.43	0.38
F (year^{-1})	(-0.04)[d]	0.76	0.06

[a] Mean ϕ' for related grouper species.
[b] From growth parameters for the same species in Kuwait (Mathews and Samuel 1987).
[c] Based on an annual mean habitat (bottom water) temperature of 20°C (from Bouhlel 1988).
[d] Not a possible value, but indicating low F, and thus used to compute mean of three species.

Acknowledgements

Messrs. A.H. Bilil, M.M. Dacud and H.A. Houmed collected the bulk of the data in Table 1, and their input is gratefully acknowledged. Also, I thank Dr. W. Künzel (GTZ) for making possible the study stage during which the (French language) draft of this contribution was written; Dr. D. Pauly at ICLARM for sharing his knowledge in a language I understand better than English, and for translating and editing the draft of this paper. Finally, I thank Mr. Felimon Gayanilo, Jr., for patiently teaching me how to operate computer software, particularly the FiSAT package.

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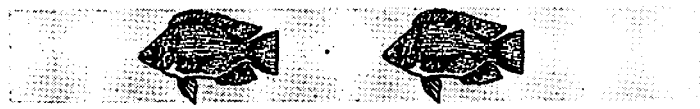
A. DARAR *is with the Project on "Les Resources Halieutiques et les Quantités Pêchable des Eaux Djiboutiennes", executed jointly by the Direction de l'Elevage et des Pêches, Republique de Djibouti, and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH.*



Comparative Growth Performance of Jack Mackerels of the Genus *Trachurus*, with Emphasis on *T. symmetricus murphyi* in Chile

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HUGO F. ARANCIBIA

Abstract

This contribution presents von Bertalanffy growth parameter estimates for species/stocks of jack mackerels of the genus *Trachurus* from around the world, and compares these with growth parameters for *T. symmetricus murphyi* caught off central-southern Chile (33°S-39°S). It is found that *Trachurus* stocks inhabiting upwelling areas such as the Humboldt and Benguela current systems grow better than their ecological equivalents in temperate waters, such as the North Sea. The von Bertalanffy growth parameters estimated for Chilean horse mackerel are: $FL_\infty = 65.2$ cm ($TL_\infty = 71.6$ cm) and $K = 0.138$ year^{-1}.