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The most significant activities and advances outlined in this progress report include: 1) The intensive culture of the male Tilapia hybrid (T. hornorum x T. nilotica) was proved to be technically and economically feasible. 2) A simple but comprehensive fish culture manual was published to promote fish culture and teach methods. 3) Twenty-five ponds of the Waldemar de Franca fish hatchery were placed in Tilapia hybrid fingerling production. 4) During 1974-1975, farms involved in intensive culture of Tilapia hybrids increased from 1 to 13. Although reservoir fish production still is not meeting consumer demand, knowledge from the new fish culture research program may help to alleviate such food shortages in the future. A fish culture system has been adapted to conditions of Northeast Brazil, and numbers of fish farmers have increased as word of success has spread.

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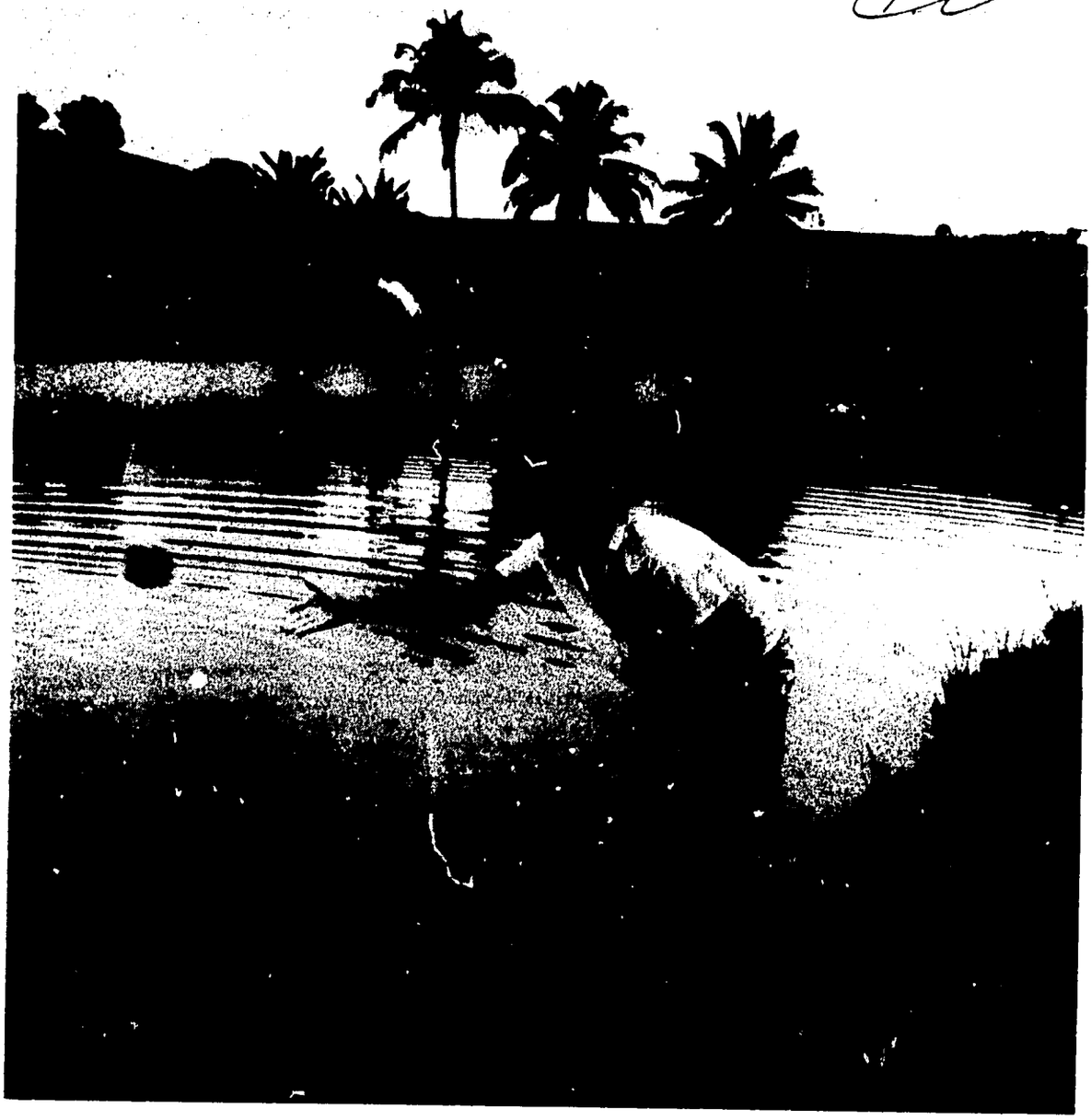

Progress Report on Fisheries Development in Northeast Brazil

INTERNATIONAL CENTER FOR AQUACULTURE
AGRICULTURAL EXPERIMENT STATION, AUBURN UNIVERSITY
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Auburn, Alabama

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Progress in development of a fish culture extension program is evident in these scenes: TOP—Fish culture extensionists discuss construction details for a new fish pond being constructed by a local farmer. CENTER—Local farmers look on as DNOCS personnel sample Tilapia hybrids during a fish culture demonstration program at a private fish pond. BOTTOM—Both fresh and saltwater fish are sold in Fortaleza's markets. Tilapia hybrids (foreground) were marketed during a market test carried out by DNOCS. The study indicated large demand for Tilapia which sold for Cr$5.00 per kilogram (U.S. $0.26 per pound).

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COVER PHOTO. Moist balls of wheat bran were fed to Tilapia hybrids in this 8,000-square-meter pond on a daily basis at selected feeding stations.

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Progress Report on Fisheries Development in Northeast Brazil

JOHN W. JENSEN*

INTRODUCTION

THE BRAZILIAN GOVERNMENT'S National Department of Works Against the Drought (DNOCS)[1] has received technical assistance in intensive fish culture extension since 1972 through an Auburn University International Center for Aquaculture USAID contract. Task Order No. 8, contract AID/csd-2270, provided technical assistance funds from May 1972 through June 1974. The last year, from July 1974 through June 1975, was funded under Task Order No. 2 AID TA-BOA-1152.

In 1966, Auburn University personnel surveyed the DNOCS fisheries program to establish guidelines for improving freshwater fisheries management practices in Brazil's Northeast region. At that time, intensive fish culture was recommended as "the most feasible solution to increase fish production in this drought-stricken area." In the relatively short period since that recommendation was made, an intensive fish culture research facility was built that has become South America's largest. Its work in tropical aquacultural systems has already brought international recognition to this facility. Intensive fish culture techniques, applicable to the physical and economic conditions of Northeast Brazil, have been developed using the Tilapia hybrid (*Tilapia hornorum* (male) x *Tilapia nilotica* (female).[2] Through DNOCS, an extension program has been established to carry these techniques to the producers. In addition, training of fellow Brazilian and foreign fishery biologists has been initiated using expertise of DNOCS fishery personnel.

The author's contract participation dealt with assistance in fish culture extension. Therefore, this report will be limited to discussion of progress made in that field from May 1972 through June 1975, with emphasis on the period 1974-75. Additional information for the period 1972-74 can be found in "Progress Report on Fisheries Development in Brazil."[3]

Progress was made during the 3 years that the DNOCS Center for Ichthyological Research was provided with assistance in aquaculture extension. The following items highlight the most significant activities and advances related to the development of the fish culture extension program:

1. A counterpart extension worker was assigned by DNOCS, thereby initiating the first fish culture extension program in Northeast Brazil.

2. The former Division of Fisheries and Fish Culture under the Directorate of Irrigation was established as an autonomous directorate[4] under the administration of the General Director of DNOCS, providing new organization and vitality to the program.

3. Intensive culture of the all male Tilapia hybrid (*T. hornorum* x *T. nilotica*) was proved to be technically and economically feasible. With this culture fish, DNOCS began an extension program aimed at helping regional farmers.

4. A simple but comprehensive fish culture manual (*Cartilha do Criador de Peixe*) that could be easily understood by farmers of the Northeast was published by DNOCS to promote fish culture and teach methods.

5. Twenty-five ponds of the Waldemar de França fish hatchery were placed in Tilapia hybrid fingerling production. These ponds had been used for raising fingerlings used in reservoir stocking programs. This action increased hybrid fingerling production, but most importantly it directly involved DNOCS fish hatcheries with the intensive fish culture program.

6 During 1974-75, farms involved in intensive culture of Tilapia hybrids increased from 1 to 13, giving momentum to the rapidly developing program.

7. DNOCS fisheries extension workers participated in training Brazilian and foreign biologists. The International Training Program in Fish Culture sponsored by DNOCS during March-April 1975 included on its agenda training in aquaculture extension.

When the Auburn University fishery investigative team surveyed the DNOCS fishery program in 1966, reservoir fish production was not meeting consumer demand. Hunger and malnutrition were commonplace among the Northeast's poor. Although the region is still plagued by these problems almost 10 years later, knowledge from the new fish culture research program may help alleviate such food shortages in the future. A fish culture system has been adapted to conditions of Northeast Brazil and numbers of fish farmers have increased as word of success has spread. A real impact on food production in Northeast Brazil can be made by fish culture now that resources are available. To do this, larger efforts in extension and fingerling production will be necessary.

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[1] Departmento Nacional de Obras Contra as Secas.

[2] LOVSHIN, DA SILVA, AND FERNANDES. 1974. The Intensive Culture of the All Male Hybrid of *Tilapia hornorum* (male) x *Tilapia nilotica* (female) in Northeast Brazil. FAO/CARPAS Symposium on Aquaculture in Latin America, Montivideo, Uruguay. (In print.)

[3] JENSEN, J. W. 1974. Progress Report on Fisheries Development in Brazil. Project AID-2270 Task Order 8, International Center for Aquaculture, Auburn University, Auburn, Alabama.

[4] Directorate of Fisheries and Fishculture (Directoria de Pesca e Piscicultura).

PRESENT STATUS

Personnel

Two full-time extension workers headquartered in Fortaleza are presently charged with the duties of promoting fish culture and providing technical assistance to farmers. Two part-time workers, who are primarily hatchery biologists, operate from two DNOCS fish hatcheries within the state of Ceará.

The Center for Ichthyological Research has been closely associated with USAID technical assistance programs since 1966. Although administered directly by the Directorate of Fisheries and Fishculture, this research center is not properly structured to administer an extension program. However, DNOCS regional directorates have a structure capable of managing an extension program. Under these directorates are included the four fish hatcheries in the Northeast. In June 1975, the extension division was added to the regional directorates' responsibility.

Extension workers headquartered in Fortaleza were placed under the Second Regional Directorate. This directorate is responsible for Ceará, the state where almost all fish ponds are located. For intensive fish culture to have a larger impact on the Northeast, however, other regional directorates must have at their disposal trained extension personnel to carry on this work in other Northeast states.

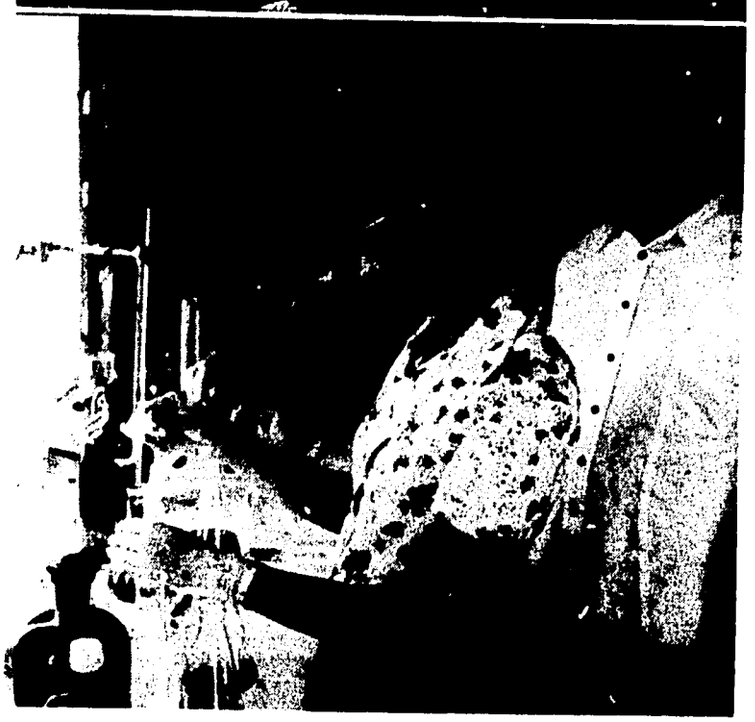
Extension personnel working in Ceará are able to respond to requests for assistance from local farmers. Promotional work to increase the number of farm ponds in the region is limited, however, due to the lack of a constant supply of hybrid fingerlings and a shortage of extension workers.

Initiation of extension efforts throughout the Northeast will require an intensive personnel training program. To begin, at least two extension workers should be trained and assigned to each DNOCS fish hatchery. This would require six more workers plus a coordinator. To train these additional people will require outside assistance, most likely through USAID. Training would include instruction in practical fish culture, extension methods and theory, and economics. Additional fish culture extension staff would be trained as the need arises.

The Pentecoste Aquaculture Station has become an internationally recognized training center for intensive fish culture and other fishery-related fields. DNOCS fisheries personnel are committing themselves to a program aimed at training fishery biologists from other Latin American countries. Fish culture extension is included in the curriculum offered in DNOCS-sponsored programs, which will require extension specialists with advanced training as instructors.

Among Latin American countries, only Brazil and El Salvador have intensive fish culture extension programs. Many countries have aquaculture research programs and good results are being obtained, but a lack of extension workers prevents communication of research results to producers or prospective producers. In many cases, research is done for research's sake with no practical objective. However, the

Dr. John Plumb, of Auburn University's International Center for Aquaculture, demonstrates techniques of fish parasite and disease diagnosis to international trainees.



TOP—International students attending a 1-month training program conducted by DNOCS observe Dr. Leonard Lovshin examining fish for spawning condition. BOTTOM—Laboratory exercise in water quality being carried out by an international trainee under direction of DNOCS water chemist Helio de Melo during the tropical aquaculture training program.

Brazil project has practical research in progress that can be immediately utilized as dependable results are obtained. DNOCS administrators and biologists recognize the importance of extension for implementing new methods that will be used to benefit producers and consumers alike. Their support in training more extension workers can be assured.

Fingerlings

Tilapia hybrid fingerlings are produced exclusively by DNOCS at its two Ceará hatcheries and at the Aquaculture Research Station in Pentecoste, Ceará. Fingerling production has barely kept pace with demand to date, and demand is expected to outstrip supply in the near future. The fish hatcheries were not built for the special requirements of Tilapia hybrid production. The Pentecoste station, which produces the majority of fingerlings used for stocking private farms, has research as its primary function and should not be responsible for fingerling production.

At the time of this report, money from the Ministry of Planning was being appropriated for constructing facilities specifically for hybrid fingerling production at DNOCS hatcheries. With these facilities in operation, the extension effort will be well supported. If plans do not materialize, DNOCS can opt for introducing fingerling production to private farmers. With assistance from DNOCS biologists, commercial fingerling producers can be trained to the point that they will be able to meet the demands of commercial growers.

Fish Farming Activities

Fish raised in family or community ponds could provide the necessary dietary supplement to increase protein consumption in Northeast Brazil. But small farmers seldom have this opportunity because of the land holdings and watershed controls of large private farmers in the Northeast.

Three problems exists:

1. Poor subsistence farmers do not as a rule own land, but are tenants or sharecroppers of large landowners.
2. When small farmers do own land, it generally does not contain water, either from lowland sources or reservoirs. They are therefore dependent on rainfall to grow crops.
3. Financing for subsistence level projects is not available. Funds are obtainable only for projects that promise to stimulate economic flow.

All fish culture projects initiated to date, with one exception, are owned and managed by larger farmers. These own land appropriate for fish culture, have adequate water supplies, and are financially stable. Thus, the three problems are overcome.

Fish raised commercially generally reach the lower economic class through the local markets. Some larger farmers allow their tenants to consume fish grown in farm ponds, but this is an exception. Most producers prefer to sell at regular market prices. Fish at the market place is always less expensive than red meat and is consumed by all classes. The poorest people are seldom able to buy any type of high protein food, either fish or red meat, but they more commonly eat fish than higher priced meat. In summary, cultured fish reach the poor consumer only through regular market channels at high prices.

Large private farmers presently are benefiting more than others by intensive fish culture activities. Soon, however,

some low-income families will be helped through aquaculture because of an agrarian reform program that has been in progress for 5 years. DNOCS is developing and improving land downstream from reservoirs built by that agency, and is leasing this land and houses to low-income, rural families. Soils are improved and irrigation systems are provided. Cooperatives organized at each site handle marketing and provide for tractor rentals, an agricultural extension service, and financing of agricultural supplies.

Shortly, DNOCS, acting as principal advisor to the cooperatives, will introduce intensive fish culture to a few projects in a move to diversify crops raised on irrigated lands. Fish cultured by families will be consumed directly by producing families, bought and consumed by other settlers, or marketed by the cooperative through regular channels. This activity will make a source of inexpensive animal protein available to low-income groups.

The DNOCS Center for Ichthyological Research and the Second Regional Directorate are now developing a similar project based on fish farming, in which agriculture is programmed as a secondary activity. Some lowlands below large reservoirs are composed of soils unsuitable for terrestrial crops or the reservoir water is too alkaline to support irrigated crops. Fish can be raised despite these conditions, making it possible to put formerly unproductive land into food production. Plans are now being developed for settling low-income families on these lands. Also, the perimeters of the reservoir will be developed by rationally placing a controlled number of fishermen so that maximum sustained yields can be obtained by managing natural fish stocks. Such a project will benefit the low-income families directly while increasing the amount of protein sources available at regional market places. Due to its high short-term impact potential, this project should be implemented without delay.

Private Fish Culture Projects

Thirteen private fish culture projects were initiated during 1973-75, the majority after December 1974. Interest is rapidly spreading. At report time, 16 ponds were in production using mainly the Tilapia hybrid. The surface area of ponds involved totals 4.3 hectares averaging 0.27 hectare each. Samples taken monthly show that fish reach approximately 275 grams in 6 months. Stocked at nearly 8,000 fish per hectare, this growth represents a total potential production of 18.8 metric tons for 1975.

The profit margin of Cr$3.47[5] per kilogram shown by one farmer is an indication of the economic feasibility of the Tilapia hybrid culture. Current sampling and estimates demonstrate that other farmers now initiating cultures will experience similar profits. Abnormally high profit margins should disappear, however, as more farmers begin production and larger supplies lower market prices. The following example illustrates the high profits obtainable at present and shows that a relatively large drop in the market price can be tolerated by producers.

An 8,000-square-meter pond was constructed on the "Fazenda Passagem Franca," a dairy farm, immediately below a medium-size reservoir. Total investment cost was Cr$3,700. Tilapia hybrids were stocked at 10,250 per hectare. Fish were fed wheat bran at 3 percent of body weight, 7 days a week. The pond was fertilized with 10,000 kilograms (wet weight) of cattle manure before fish were stocked and with 125 kilograms per hectare of triple superphosphate at stocking. Thereafter, 188 kilograms per hectare per week of quail manure were used to maintain pond fertility. Pig manure was also added at various times during the period. After 207 days, 50 of which were used for harvesting, the total production reached 1,975 kilograms, or 4,233 kilograms per hectare per year. Survival was 90.5 percent and fish averaged 266 grams each.

The following is a brief economic analysis of this enterprise based on a pond of 0.8 hectare in size and a culture period of 207 days.

Fixed costs	
Total pond construction cost	Cr$3,700
Cost of net	200
Maintenance (pond and equipment)	350
Variable costs	
Feed (3,605 kg wheat bran)	1,279
Chemical fertilizer (100 kg)	400
Transportation of organic fertilizer from farmer's private sources	200
Guard service	600
TOTAL COSTS (fixed and variable)	6,729
Gross profit (fish harvested by buyer @ Cr$5,000 kg)	9,875
NET PROFIT	Cr$3,146*

* The annual net profit for this operation on a hectare basis would be equivalent to Cr$6,934.

Harvest operations at the Passagem Franca Farm resulted in a production of 1,975 kilograms of Tilapia in an 8,000-square-meter pond during a 7-month growing period, which is equivalent to 4,233 kilograms of fish per hectare per year.

[5] Cruzeiro (Cr) = U.S. $0.143.

Large fish of uniform size typifies Tilapia hybrid culture. Also the fact that Tilapia live several hours out of water makes it an excellent fish for marketing in tropical areas where refrigeration may be limited.

After one harvest, the farmer's total initial investment was recovered. As a result, subsequent annual profits will reach Cr$15,089 per hectare. This means that to produce 1 kilogram of fish will cost Cr$1.53 in future years, far below the present wholesale market price of Cr$5.00 per kilogram.

RECOMMENDATIONS

Training

Intensive fish culture in the Northeast is presently limited to Ceará State, but DNOCS is obligated to expand to all regions under its jurisdiction. To reach these regions and to ultimately make a significant impact on local fish supplies, more fish culture extension workers must be trained, preferably through USAID assistance. A fish culture extension advisor is needed not only for assisting in training of more fish culture extension specialists, but also for assisting in DNOCS-sponsored international and regional training programs. As training will be continuous, assistance provided by USAID will be necessary for at least 3 years.

DNOCS Colonization-Settlement Project

Experience of DNOCS in the last 5 years has shown that previously under-utilized and under-productive land could feasibly be put to crop production through rational planning and proper management of stored water resources. These "colonization" projects with terrestrial crops and livestock have been successful.

Aquaculture is a viable option for land that is not suitable for cultivation. Fish culture colonization projects similar to agricultural projects now functioning are in the preliminary planning stages. Such projects deserve priority attention due to their short-term impact possibilities. Not only would such a project bring direct financial benefits to low-income farmers, but large fish supplies could be produced and, through a cooperative, marketed in a rational manner that would benefit the maximum number of consumers at the lowest cost. DNOCS is urged to expedite development of this project so that fish protein reaches consumers in significant quantities.

Model Farm Demonstrations

The most important extension tool is the practical demonstration. This teaching tool is being used in Northeast Brazil, with private farm ponds serving as demonstration units. Demonstrations directed by public institutions can often provide farmers with a better concept of fish culture methods because Brazilian farmers are generally not interested in demonstrating techniques to potential competition.

To promote intensive fish culture and teach production methods, it is recommended that DNOCS create public, intensive fish culture demonstrations throughout the Northeast's more suitable regions. Possible locations include DNOCS's experimental farms and state agricultural model farms. All such demonstration-type projects should apply sound methods developed through research to demonstrate techniques of pond construction, fish stocking, fertilization, feeding, harvesting, processing, and marketing to farmers and other interested persons.

Fingerling Production

The future of fish farming in Northeast Brazil is now dependent on sufficient fingerling production to satisfy farmer demand. Without a continuous adequate supply, fish culture will not progress to a point that it can make a significant impact in Brazil's Northeast region.

Fingerlings can be supplied through one of two methods. First, DNOCS can increase fingerling production through its own initiative. For example, existing facilities can be expanded by construction of more production ponds and related holding facilities. Such expansion would require employment and training of more personnel. Second, fingerling production could be increased by the government relinquishing control and allowing capable persons in the private sector to produce fingerlings on a commercial scale.

Either of these methods should help attain the goal of producing an adequate supply of fingerlings so that returns on investments in commercial fish production facilities can be maximized.

ACKNOWLEDGMENT

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