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ARTIFICIAL BREEDING OF TWO GEOGRAPHICALLY SEPARATED WILD STOCKS OF ENDANGERED SARPUNTI, *PUNTIUS SARANA* (HAMILTON)

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Abstract: Artificial breeding of *Puntius sarana* (Hamilton) between and within two different wild stocks, namely Sukhair haor of Sunamgonj districts and Kangsha River of Netrokona district were conducted. Three breeding lines SS (Sukhair x Sukhair), SK (Sukhair × Kangsha) and KK (Kangsha × Kangsha) having three replications of each were tested after breed with pituitary gland extract (6.5mg/kg body weight for female and 2.0mg/kg body weight for male). The highest ovulation (100%), fertilization (84%) and hatching rate (81%) were found in SS followed by SK and KK. The highest length gain (56mm), weight gain (275 mg), SGR (16%) and health condition (4.88 mg/mm) were observed in SK population followed by SS and KK population. The highest survival rate (85%) was also found in SK population and lowest (70%) in KK population.

mvi-ms‡¶ct wecbcvq †`kxq mic‡U *Puntius sarana* Gi eab I ev¯Pvi nvi e‡× wbY‡qi Rb¨ mbvgMÄ †Rjvi ÒmLvBi nv‡iÓ I †bÎ‡Kvbv †Rjvi ÒKskÓ bvgK `B‡U cvK‡ZK Dr‡mi gv‡Qi g‡a¨ Aš: I Avš:K‡Îgc Rbb m¤úb Kiv n‡q‡Qj| c‡Z¨K cRbb †¶‡Î wZb‡U †ic‡j‡Kkbmn †gvU wZb‡U cRbb jvBb †hgbt jvBb-1 (mLvBi♀ × mLvBi♂), jvBb-2 (mLvBi♀ × Ksk♂) Ges jvBb-3 (Ksk♀ x Ksk♂) wcUBUvix M‡Ši wbhv‡mi (¯x gvQ‡K Zv‡`i c‡Z †K‡R †`n IR‡b 6.5 wg‡jMvg I c‡Z¨K ci"I gvQ‡K c‡Z †K‡R †`n IR‡b 2.0 wg‡jMvg nv‡i) mvnv‡h¨ c‡Yw`Z K‡Îg cRbb m¤úb Kiv n‡q‡Qj Ges cRbbxq ˆe‡ków ch‡e¶Y Kiv n‡q‡Qj | wZb‡U cRbb jvB‡b Drcb †iY †cvbvi eab I ev¯Pvi nvi Kv‡Pi GK‡iqv‡g 35 w`b chš ch‡e¶Y Kiv n‡q‡Qj| cRbb jvBb-1 G m‡ev"P If‡jkb (100%), d‡UjvB‡Rkb (84%) I n¨v‡Ps †iU (81%) cvIqv v‡M‡q‡Qj Ges jvBb-2 I jvBb-3 Gi †¶‡Î If‡jkb, d‡UjvB‡Rkb I n¨v‡Ps †iU Kg cvIqv v‡M‡q‡Qj| m‡ev"P ‰`N e‡× (56 wg.wg.), IRb e‡× (275 wg‡jMvg), SGR (16%), ¯v¯¨MZ Ae¯v (4.8 wg‡jMvg/wg.wg.) I ev¯Pvi nvi (85%) jvBb-2 G Drcb †iY ‡cvbvi (SK) †¶‡Î cvIqv v‡M‡q‡Qj|

Key words: Breeding, *Puntius sarana*, wild stock, growth and survival

INTRODUCTION

Sarpunti, *Puntius sarana* is a critically endangered indigenous barb fishes of Bangladesh (IUCN 2000). This species is also found in India, (Menon 1999), Nepal (Shrestha1994), Sri Lanka (Pethiyagoda 1991), Myanmar (Doi 1997) Thailand (Sidthimunka 1970), Afghanistan and Bhutan (Talwar and Jhingran 1991). This species was available in rivers, haors, baors, beels and natural depression of Bangladesh (Gupta 1908). Unfortunately availability of this species has greatly reduced and has become endangered due to combination of over exploitation, environmental degradation and anthropogenic activities. The fish are endemic mainly in Kangsha river of Mymensingh district and haor region of Sunamganj, Sylhet and Kishorgonj districts (Parvez *et al.* 2005) of Bangladesh.

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By considering its threatened situation and culture potential some sorts of research activities were done in Bangladesh. The research activities so far conducted with this species include distribution of this species (Parvez *et al.* 2005), artificial breeding (Chakrabortey *et al.* 2002, Akhteruzzaman *et al.* 1992), embryonic and larval development (Chakrabortey *et al.* 2002), larval rearing (Parvez *et al.* 2006, Chakrabortey *et al.* 2003) and also the culture potential of this species under semi-intensive culture system (Chakraborty *et al.* 2005). All these activities play significant role for the protection of this species from being extinction. However, research on growth and survival performances of *P. sarana* in farmer's pond is scanty. The farmers are losing their interest to culture this species due to slow growth and higher susceptibility to disease. The hatcheries which are engaged in *P. sarana* seed production are collecting their broods from single sources (Parvez *et al.* 2005). The essentiality for maintaining a sufficient amount of genetic variation for the long term survival and adaptability of a species can improve the growth and survival of produced spawns Leberg (1991).

OBJECTIVES

The objectives of the present study are to assess the growth and survival of F_1 generation through artificial breeding of two different wild stocks of *P.sarana.*

MATERIAL AND METHODS

Induction of artificial breeding

Sources of brood: P. sarana broods were collected from two geographically distinct regions: the Sukhair haor of Sunamgonj district and the Kangsha river of Netrokona district. Twenty broods from the Sukhair haor and 70 broods from the Kangsha River were collected from November 2004 to February 2005. During the collection of brood fishes the number of female and male was maintained at 2:1 ratio. The broods were reared in the previously prepared separate rectangular size ponds (18x14x1.3) m^3, situated at the Fisheries Field Complex of Bangladesh Agricultural University, Mymensingh.

Brood rearing: Special diet was initiated in early March and continued till August 2005. A special diet enriched with protein and vitamin E, was formulated and provided to the broods twice daily at 0800 hours and 1600 hours at 4% of their body weight per day. The feed was formulated with 18.33% fish meal, 18.33% rice bran, 18.43% wheat bran, 18.33% soyabean meal, 11.06% mustard oil cake, 11.06% sesame oil cake, 4% wheat flour, 0.45% vitamin-mineral-premix and 0.01% vitamin E. Regular manuring with cow dung (5kg/decimal) and fertilization with Urea and Triple super phosphate

(200g/decimal and 100g/decimal respectively) was done at 15 days interval. Liming (1kg/decimal) was performed whenever necessary.

Breeding plan: The breeding plan was designed with three treatments, namely Line-1: SS (Sukhair × Sukhair) Line-2: SK (Sukhair × Kangsha) and Line-3: KK (Kangsha × Kangsha). In each treatment three trials were performed and in each trial four males and six females were used. In Line-1 both male and female broods were taken from Sukhair stock, in Line-2 female from Sukhair stock, and male from Knagsha stock and in Line-3 both female and male brood taken from Kangsha stock.

Administration of carp pituitary gland extract: According to Chakraborty *et al.* (2002) locally available dehydrated carp pituitary glands (PG) were used as an inducing agent. The PG solution was injected intramuscularly at an angle of 45° to the body surface at the dorsal side behind pectoral fin. The female and male broods were injected @ of 6.5mg/kg and 2.0mg/kg body weight of fish, respectively.

Ovulation, fertilization, incubation and hatching: Eggs from ovulated females were stripped into fertilization trays (29 cm x 19 cm x 4 cm). Following the deposition of a good number of eggs on the tray, milt was quickly stripped from the males onto the tray. Fertilization was done by mixing the eggs and milt, and allowing the eggs to stand for 3 to 5 minutes. After fertilization, the eggs were immediately transported to the wet laboratory and spread on steel trays (101.6 cm x 40.6 cm x 12.7 cm) for incubation and continuous water flow (water exchange rate: 3 l·min-1·tray-1) was maintained on the trays. The eggs were examined after 10-15 min of injection under the microscope to see whether the blastodisc had formed as an indication of successful fertilization. Two hours after mixing the eggs and milt, the unfertilized eggs turned whitish while the fertilized eggs remained translucent. The fertilization rate was determined by counting the percentage of fertilized eggs out of the total number of eggs in several egg samples.

The incubation trays were kept under room temperature ranging between 26 and 30°C. When hatching started, the hatchlings were collected in another tray that was set in such a manner that the water from the hatching tray containing eggs could smoothly flow into another tray. In this way most of the active and strong hatchlings were collected in the second tray. Continuous water flow (water exchange rate: 3 l·min-1·tray-1) was maintained to the trays in which the larvae were collected. The hatching rate was determined by counting the percentage of hatchlings from the total number of fertilized eggs.

Stocking and Feeding of larvae: The experiment was conducted in the wet laboratory of Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. Three days old spawn of *P. sarana* (8.25 ± 0.6 mm and 4.5 ± 0.5 g) were stocked in glass aquaria (45 × 25 × 24 cm^3) containing 17 liters of water in each. The experiment was designed with three treatments, namely T_1, T_2 and T_3 having three replications (R_1, R_2 and R_3) of each. Sixty larvae of SS, SK and KK were used in T_1, T_2 and T_3, respectively at a stocking density of 3.5 spawns/L of the volume of water and were reared for 35 days. The same feeding and water quality parameters were maintained during the experimentation. For this experiment the food was provided according to Parvez and Khan (2005) where approximately 5000 plankton/L of water was given twice in a day.

Analytical method: Twenty fishes were randomly collected from each glass aquarium at the start of the experiment and at every seven days interval. A transparent calibrated ruler was used to measure the total length of the fish up to the nearest 0.1 mm and an electronic balance (College B204S, Switzerland) for the body weight up to the nearest mg. Samplings were usually done before the application of feed to avoid the biasness of weight due to the presence of excessive feed. The length gain (in mg) and weight gain (in mg) were determined by subtracting the average initial length and weight from the average final length and weight, respectively.

The SGR or percentage of body weight increase per day was calculated according to Ricker (1979): $SGR= (\ln W_2-\ln W_1)/ (T_2-T_1) \times 100$ Where, W_2=final live body weight at time T_2 and W_1= Initial live body weight at time T_1.

The experiment was terminated on 35th day and the fish were harvested from the ponds, and the final growth and survival of fish were estimated. The survival rate was estimated by the subtraction of initial stocking larvae from the harvested fish.To determine the health condition of fish, the weight (mg) of the larvae in different treatments was divided by total length (mm) to find out weight per millimeter.

The physico-chemical parameters, such as temperature, dissolved oxygen (DO) and pH of water in each aquarium under each treatment were recorded on sampling dates. Temperature was recorded by using a Celsius thermometer, DO by a digital DO meter (Multi 340i/set, Germany) and pH by a portable digital pH meter (MICRO-TEMP, pH 500). The plankton that was providing to the T_1 and T_2 was grown in a nursery pond and was collected using 50 µm mesh sized plankton net. The collected plankton populations were count numerically with the help of sedgwick-Rafter counting cell under a compound microscope (Olympus, BH2).

Statistical analysis: The breeding parameter; ovulation rate, fertilization rate and hatching rate and growth parameter; the length gain (mm), weight gain (mg), specific growth rate, health condition and survival rate of larvae were tested using one way analysis of variance (ANOVA). Significant results (p<0.05) were further tested using Duncan's New Multiple Range Test (DMRT) to identify significant differences among means. These statistical analyses were performed with the aid of the computer software MSTATC program.

RESULTS AND DISCUSSION

Brood fish: After successful completion of broodstock management the fish attained maturity within early May 2005. Trials of artificial breeding were started with Line-1 and followed by Line-2 and Line-3 and two trials were completed within May. One trial for all the Lines was conducted on 8th June 2005 for the purpose to obtain the same aged spawn to use them in growth and survival performance study. During the experimental period temperature, DO, pH of water were recorded between 27.3 and 30.2°C, 5.1 and 6.5 ppm and 6.6 and 7.4, respectively. Sobhan and Nair (1974) also reported a prolonged breeding season of *P. sarana* extending from May to November. The maturation of brood in the early May may be the positive effect of using of vitamin mineral premixes in the feed.

Breeding parameters: Summery of results on artificial breeding of *P. sarana* are shown in Table 1. The treated female spontaneously started to release eggs after 6.5-7 hrs of injection at 26-30 ºC temperature. Before releasing eggs the injected females showed speedy movement as sign of ovulation. The female broods of Sukhair haor used in Line-1 and Line-2 showed 100% ovulation rate and the broods of Kangsha River used in Line-3 showed 83.33% ovulation rate. The ovulation rate of Sukhair haor was significantly higher (p < 0.05) than the broods of Kangsha River. The fertilization rate was higher in Line-1 (84.05 ± 2.82) and followed by Line-2 and Line-3 (78.79 ± 3.80 and 72.43±3.80 respectively). After incubation of the fertilized eggs, the hatchlings were required 18-22 hours to come out at 26-30°C. The highest hatching rate was in Line-1 (81.18 ± 4.72) % followed by Line-3 and Line-2 (80.58 ± 8.67 and 75.58 ± 5.78, respectively). Chakraborty *et al.* (2002) reported fertilization and hatching rates (90% and 80%, respectively) of *P. sarana* brood from Kangsha River by using PG @ 6.5 mgk^{-1} body weight of fish. The fertilization and hatching rate of *P. sarana* broods used from Kangsha river were lower (72.23 ± 3.21 and 75.58 ± 5.78 respectively) than Sukhair broods (84.05 ± 2.82 and 81.18 ± 4.72, respectively) (Table 1) and also lower than the findings of Chakraborty *et al.* (2002). This might be due to the declining of the availability of *P. sarana* stocks in Kangsha

River. Chakraborty (2002) assumed if such situation continued for another two or three years, the species would disappear from Kangsha river. As the availability of the species in Kangasha river declined the effective breeding number (*Ne*) also declined thus the occurrence of inbreeding is very common. The detrimental effects of inbreeding are well documented and resulted in decrease of 30% or greater in growth production, survival and reproduction (Kincaid 1976a, b, 1983a and Dunham 1996b). But the broods of Sukhair haor ovulation showed the highest ovulation, fertilization and hatching rate which indicated that the quality of *P. sarana* brood remained better. During the rainy season the Sukhair haor becomes interconnected with adjacent haor of Sylhet and Kishorganj districts and the fish get the chance of movement from one place to another which allows the brood to mate with a wide range of population and helping to avoid inbreeding.

Table 1. Summery of results on the induced breeding trials of *P. sarana* in Bangladesh

Treatments	Ovulation period (hrs)	Ovulation rate (%) M±SD	Incubation period (hrs)	Incubation temperature (°C)	Fertilization rate (%) M ± SD	Hatching rate (%) M ± SD
1		100.00			84.05±2.82	81.18±4.72
2	6.5-7	100.00	18-22	26-30	78.79±3.80	80.58±8.67
3		83.33			72.43±3.80	75.58±5.78

Values of the parameter in each column with different superscripts (a, b) differs significantly ($p < 0.05$).

Rearing of larvae: The growth performances in terms of length and weight during the experimentation are presented in Table 2. The specific growth rate and survival rate of *P. sarana* during the experimental period are also presented in Table 3. The highest length and weight gain (56.44±1.23 mm and 275.33±1.53 mg, respectively) were observed in T_2 and the lowest (36.35±0.69 mm and 167.33±3.05, respectively) were observed in T_3. The highest SGR value (16.10±0.02) was observed in T_2 and the lowest SGR value (14.71±0.06) was found in T_3. All the growth parameters of T_2 were significantly different ($p<0.05$) from T_1 and T_3. The survival rate was also highest (85%) in T_2 followed by T_1 and T_3 (72 and 70%, respectively).

The plankton as feed for larval rearing (Parvez and Khan 2005) of *P. sarana* is suitable for obtained highest growth. The p^H and DO level of the present experiment was 7.4-7.8 and 5.6-6.1, respectively, and temperature ranged from 27-30 °C which were suitable range of for larval rearing (Rahman *et al.* 1982). Aeration was provided to the entire experimental unit equally which reduces the level of ammoniacal nitrogen. Singh *et al.* (1980) suggested that aeration reduces the level of ammoniacal nitrogen and helps in mineralization of fish metabolites.

Chen (1988) also suggested that the ammoniacal nitrogen below 1% is suitable for fish production. The presence of ammoniacal nitrogen in all the aquaria was (0.25-0.35 ppm) which was suitable for larval rearing.

Table 2. Growth and survival rate of the larvae of *P. sarana* during 35 days experiment

Treatment	Length gain (mm)	Weight gain (mg)	SGR (% day)	Health condition mg/mm	Survival rate (%)
T_1	45.98±0.93^b	210.00±2.64^b	15.34±0.04^b	4.57± 0.06^a	72.00± 6.55^a
T_2	56.44±1.23^a	275.33±1.53^a	16.10±0.02^a	4.88±0.08^b	85.33±4.61^b
T_3	36.35±0.69^c	167.33±3.05^c	14.71±0.06^c	4.60±0.08^a	70.00±8.66^a

(Mean ± SD), Values of the parameter in each column with different superscripts (a, b) differs significantly (p<0.05).

Feeding and water quality parameters in all the treatment were the same and in suitable range of aquaculture. But, the growth parameters and survival rate of *P. sarana* in T_2 was significantly different from T_1 and T_3. The highest larval growth and survival rate were obtained in T_1 where the larvae (SK) are from cross breeding of Sukhair (♀) and Kangsha (♂). Cross breeding between two different wild stocks may contributed to introduction of more gene in F_1 (SK) generation than the parental generation. Using of crossing in selection to avoid closely related breeding as well as to ensure the preservation of the heterogeneity of pedigreed groups centered on many of the German studies for German carps described (Schaperclaus 1961). Such type of study for the domestication, selective breeding and the potential for genetic improvement of striped bass for aquaculture were conducted and observed variation of growth rate within and among geographic stocks and families (Hallerman *et al.* 1998). The genetic diversity and selective breeding particularly crossbreeding of red common carps have also been applied successfully to red common carps in China (Li and Wang 2003). By conducting selective breeding up to 5-6 or more generation genetically improved *P. sarana* could be developed which will fulfill the quality seed in terms of growth and survival rate and as well as the conservation of the species in nature.

CONCLUSION

According to IUCN Bangladesh (2000), about 54 fresh water fish species are in threats of different level of extinction due to anthropogenic activities and environmental degradation. Thus it is essential to protect these threatened fish species from the being extinction. The first step to protect fish species from their extinction is essential to produce larvae of the species having higher growth and survival rates. It was a preliminary study to revive *P. sarana* from their

endangered situation. The result of artificial breeding showed that this fish respond frequently in induced breeding and in general, the fertilization and hatching rate are satisfactory for a species for its commercial propagation. The offspring of line-2, i.e. where broods from two different sources were used showed higher growth and survival rate; if immediate attempts in large context are taken it would be possible to make them available in farmers' pond as well as in nature. In this way other threatened fish species may also conserve in nature as well as could also revive our lost tradition as "Mache Bhatee Bangali".

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LITERATURE CITED

AKHTERUZZAMAN, M., KOHINOOR, A.H.M. and SHAH, M.S. 1992. Observations on the induced breeding of *Puntius sarana* (Ham). *Bangladesh J. Zool.* **20**(2): 291-295.

CHAKRABORTY, B.K., M.I. MIAH, M.A.B. HABIB, and M.J.A. MIRZA. 2003. Embryonic and larval development of indigenous sarpunti, *Puntius sarana* (Hamilton). *Bangladesh J. Fish.* **25**(1-2): 135-147.

CHAKRABORTY, B.K., MIAH, M.I. and HABIB, M.A.B. 2002. Induction of Spawning in local sarpunti (*Puntius sarana*). *Bangladesh J. Train. Dev.* **15**(1&2): 239-243

CHAKRABORTY, B.K., MIAH, M.I., MIRZA, M.J.A. and HABIB, M.A.B. 2003. Rearing and nursing of local sarpunti, *Puntius sarana* (Hamilton) at different stocking densities. *Pakistan J. Biol. Sci.* **6** (9): 797-800.

CHAKRABORTY, B.K., MIAH, M.I., MIRZA, M.J.A. and HABIB, M.A.B. 2005. Growth, Yield and Returns to *Puntius sarana* (Hamilton) Sarpunti, in Bangladesh under Semi intensive Aquaculture. *Asian Fishereis Science* **18**: 307-322.

CHEN, L.C. 1988. *Aquaculture in Taiwan.* Fishing New Books, London. 273 pp.

DOI, A., 1997. A review of taxonomic studies of cypriniform fishes in Southeast Asia. *Jap. J. Ichthyol.* **44**(1): 1-33.

DUNHAM, R.A. 1996b. Results of early pond based studies of risk assessment regarding aquatic GMOs. 126th Annual Meeting of the American Fisheries Society, Dearborn, MI, August 26-29. Abstract No.381.

GUPTA, K.G. 1908. *Report on the result of injury into the Fisheries of Bengal*, Kolkata. India.'

HALLERMAN, E., WOODS, L.C., LINDELL, S. and HARRELL, R. 1998. Domestication, selective breeding, and the potential for genetic improvement of striped bass for aquaculture. Aquaculture-'-98-Book-of-Abstracts143, JM-Parker-Coliseum-Louisiana State-University-Baton-Rouge-LA-70803-USAWorld-Aquaculture-Society : 223 p.

IUCN. 2000. Red Book of Threatened Fishes of Bangladesh, IUCN-Bangladesh. 35p.

KINCAID, H.L. 1976a. Effects of inbreeding on rainbow trout populations. *Trans. Am. Fish. Soc.* **105**: 273-280.

KINCAID, H.L. 1976b. Inbreeding in rainbow trout (*Salmo gairdneri*). *J. Fish. Res. Board Can.* **33**: 2420-2426.

KINCAID, H.L. 1983a. Inbreeding in fish populations used for aquaculture. *Aquaculture* **33**: 215-227.

LEBERG, P. L. 1990. Influence of genetic variability on population growth: Implication for conservation. *J. Fish. Biol.* **37**: 193-195

LI, S.F and WANG, C.H. 2003. Genetic diversity and selective breeding of red common carps in China. *Naga* **25**(3-4): 56-61

MENON, A.G.K. 1999. Check list - fresh water fishes of India. Rec. Zool. Surv. India, Misc. Publ., Occas. Pap. No. 175, 366 p.

PARVEZ I. and KHAN, M.M.R. 2005. Effect of feed on larval rearing of endangered local sarpunti (*Puntius sarana,* Hamilton*)* in laboratory condition. *Bangladesh J. Fish* **29**(1&2): 63-68.

PARVEZ I., KHAN, M.M.R., RAHMAN, S.M.Z. and ALAM, M.A. 2006. Present status and future potential of the gene pool of local sarpunti, *Puntius sarana* (Hamilton). *J Bangladesh Agril. Univ.* **4**(2): 319-324.

PETHIYAGODA, R. 1991. Freshwater fishes of Sri Lanka. The Wildlife Heritage Trust of Sri Lanka, Colombo. 362 p.

RAHMAN, M.S., CHOWDHURY, M.Y., HAQUE, A.K.M.A. and HAQ, M.S. 1982. Limnological studies of four ponds. *Bangladesh J. Fish.* **2-5**(1-2): 25-35.

RICKER, W.E. 1979. Growth rates and models. In: *Fish Physiology* (Hoar, W.S. & Brett, P.J. eds) **8**: 677–743. Academic press, New York.

SCHAPERCLAUS, W. 1961. *Lehrbuch der Teichwirtschaft*. 2nd edition. Berlin.

SHRESTHA, J. 1994. *Fishes, fishing implements and methods of Nepal*. Smt. M.D. Gupta, Lalitpur Colony, Lashkar (Gwalior), India. 150 p.

SIDTHIMUNKA, A. 1970. *A report on the fisheries survey of the Mekong River in the vicinity of the Pa Mong Dam site*. Inland Fisheries Division, Department of Fisheries, Bangkok, Thailand. 75 p.

SINGH, S.B., GHOSH, S.R., REDDY, R.V.G.K., DEY, R.K. and MISHRA, B.K. 1980. Effects of aeration on feed utilization by common carp fingerlings. *J. Inland Fish. Soc. India* **12**(1): 64-69pp.

TALWAR, P.K. and JHINGRAN, A.G. 1991. *Inland fishes of India and adjacent countries*. Vol **1**. A.A. Balkema, Rotterdam. 541 p.

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