Bulgarian Journal of Agricultural Science, 14 (No 2) 2008, 221-226
National Centre for Agrarian Sciences

INVESTIGATION OF DUCKS INFLUENCE UPON NUTRIENTS IN CARP PONDS BY MEANS OF RDA (REDUNDANCY ANALYSIS)

D. TERZIYSKI[1], L. NIKOLOVA[1], L. HADJINIKOLOVA[1], A. STOEVA[1] and R. KALCHEV[2]
[1]*Institute of Fisheries and Aquaculture, BG-4003 Plovdiv, Bulgaria*
[2]*Institute of Zoology, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria*

Abstract

TERZIYSKI, D., L. NIKOLOVA, L. HADJINIKOLOVA, A. STOEVA and R. KALCHEV, 2008. Investigation of ducks influence upon nutrients in carp ponds by means of RDA (redundancy analysis). *Bulg. J. Agric. Sci*., 14: 221-226

Integrated breeding of fish and ducks in fish ponds during the course of three years has been investigated (2000-2002). The polyculture applied has included carp (*Cyprinus carpio*, Linn), bighead carp (*Aristichthys nobilis* Rich.) and grass carp (*Ctenopharingodon idella* Val.). The grass carp has been absent from the composition of the polyculture used in 2001. Some of the ponds has been used as control, while in the remaining, a definite number of ducks have been grown (140-350 numbers per ha), by one, two or three runs (series) per year, for a period of 15-52 days each, within the interval May-September. The final result of ducks‘ and of the other variable influence upon the nutrient concentrations of the aquatic environment by using the RDA (redundancy analysis) at different degrees has been determined in this paper. The overgrowing of ponds with macrophytes and the redundancy with ducks have been the most significant factors, which have influenced upon the nutrients. The differences among nutrient concentrations in the control ponds (Duck0) and those with 1, 2 and 3 levels of loading (P=0.01 for the 1 level and 0.005 for the second and third), as well as those with the 1 and 3 (P=0.005) levels, have been significant. The differences between the ponds with the 1 and 2 levels, as well as those with 2 and 3 levels have been not significant (P=0.06 and P=0.08).

Key words: fish-cum-duck farming, multivariate analysis, fish ponds, phosphate, ammonium and nitrate concentration

Introduction

The analysis from the many years‘ experience gained concerning the integrated breeding of fish and ducks (Cherfas and Zernishko, 1946; Goflin and Suhoverhov, 1955; Shoshkov, 1977) has shown that the investigations in this field are still going on, in the developing countries mostly (Ali et al., 1992; Chand et al., 2006), some of them only just have started their application (for instance, Egypt, Soliman et al., 2000). Our country has gained much experience in this field, as well (Grozev et al., 2001; Nikolova, 2003).

From environmental protection point of view, the increased intensity of breeding in ponds with fish and ducks has been accompanied by increasing of aquaculture intensity and has lead to quicker recycling of

E-mail: doichint@abv.bg

nutrients in the water column and at the bottom of the ponds. This has created prerequisites for eutrophication of the latter, to “blooming” of water, accompanied by oxygen deficiency (insufficiency) situations (anoxia).

Concerning the keeping of environmental equilibrium in every pond, the possibility discussed has been undesirable and has submitted the problem for optimization of environmental protection in the ponds depending on the overcrowding of ducks and fish-stocking of ponds, as well.

For countries, among which stands Bulgaria, as well, in which all prerequisites for this kind of activity have been available, the influence of the main factors group should be cleared up – the nutrients, which have been an important component of ecological equilibrium in fish-breeding ponds, inhabited by fish and ducks. This necessity, as well as the circumstance that similar complex investigations upon carp-breeding ponds have not been done in our country, has set the purpose of this study – to establish the interconnections between the basic ecological factors in carp-breeding ponds, at different technologies of fishery in polyculture.

Materials and Methods

Experiments in 20 fish-breeding ponds for integrated growing of fish and ducks have been done in the course of three years (2000-2002), during the vegetation period (May-September). The average pond depths have varied within 0.7-0.8 m, and their area - 0.13-0.41 ha. Polyculture, including carp (*Cyprinus carpio*, L.), bighead carp (*Aristichthys nobilis* Rich.) and grass carp (*Ctenopharingodon idella* Val.) has been applied in the fish-stocking of the ponds. The grass carp has been absent from the composition of the polyculture used in 2001.

One part of the ponds has been used as control, while in the remaining part, a definite number of small ducks have been grown (140-350 numbers per ha), once, twice or thrice, for a period of 15 to 52 days, within the interval May-September. The following values have been registered at every 2 weeks interval:

1. Water temperature.
2. Secchi depth transparency.
3. Estimation by sight of the ponds overgrowing percentage, with (*Trapa natans* L.) mostly, in % to the pond area.
4. Estimation of pond theoretical residence time according to the surface water flow discharge.
5. pH – electrochemically, in the surface layer of the water and in the slime.
6. Dissolved oxygen concentration, electrochemically, by using oxymeter, OXI 96 type.
7. NH_4-N and NO_3-N colorimetrically, by using Nessler‘ reagent, according to the Bulgarian State Standard (BSS) 3587-79 and 3758-85 in the surface layer of the water.
8. The total nitrogen in the slime by using distillation in Parnasse-Wagner apparatus.
9. PO_4-P colorimetrically, by using molybdenum reagent according to BSS 7210-838 in the surface layer of the water and in the slime.
10. Permanganate oxidability according to BSS 3413-77.
11. Biochemical oxyden demand for five days according to BSS 17.1.4.07-78.

The presented in the above-manner values have been divided into two groups: the first one – “the nutrients” (NH_4-N and NO_3-N, PO_4-P, lgN/P, Nitrogen in the slime (Azot tin)); the second one – “Oxygen contents”, “Permanganate oxidability”, “BOD_5”, “Chlorophyll a”, “Secchi depth transparency”, “pH in the surface layer of the water and in the slime”. These two groups dated 2000, 2001, and 2002 have been subjected to RDA (redundancy analysis). The time components (by months and years) and the space components (by ponds) of variability in the data obtained have been analyzed separately by RDA. The first group of ecological variables has been investigated in this paper, and the effect of the influence at different extent of the duck breeding and the other variables upon the nutrient concentrations of the aquatic environment has been determined.

In their quality of independent (explanatory) variables the following have been used: macrophytes overgrowing percentage, theoretical residence time , water temperature, ponds area, chlorophyll a, pH in the surface layer of the water and in the slime, “dissolved oxygen concentration” and redundancy with ducks, as it has been presented below, in the respective figures.

By using the rate of ponds redundancy with ducks (coefficient of pond loading with ducklings) calculated by Nikolova (2003; 2006), the frequency distribution has outlined 4 groups of ponds. The following values have been accepted: ponds without ducks (Duck0); for 1 (Duck1) from 0.5-0.99; for 2 (Duck2) from 1-1.59; for 3 (Duck3) over 1.6. The ponds were grouped on the basis of their technological characteristics: surface area, depth and water flow discharge for the period of the experiment.

Results and Discussion

Variations by separate ponds

By ponds, the share of the total nutrient variability, explained by means of the independent variables, like: the overgrowing with macrophytes, the area of the ponds and the degree of (duck loading) redundancy, has amounted to 10.1%, by taking into consideration that the first main axis, as well as the total variation at level P=0.005 explained, have been significant. The influence of ducks upon variation of nutrients by ponds (Figure 1) has been 5.2% of the total variation. The area of the ponds and their overgrowing can explain about 3.7% (also significant for P=0.005), and the total variability, which has been explained by the two groups of factors at the same time, has been 1.2% of the total variation of nutrient data. There is a tendency for phosphate phosphorus variation in the water at a higher extent than that of nitrate nitrogen, while ammonium nitrogen has varied within a similar extent. The ratio N/P has been influenced negatively and mostly by the phosphate phosphorus, while nitrate and ammonium nitrogen almost cannot correlate with it.

In the ponds with a smaller number of ducks, the conditions of the aquatic environment have been not so productive, mostly as regards the ratio N/P, which has increased and has been an indication of phosphorus limitation increase. It, however, could also be the

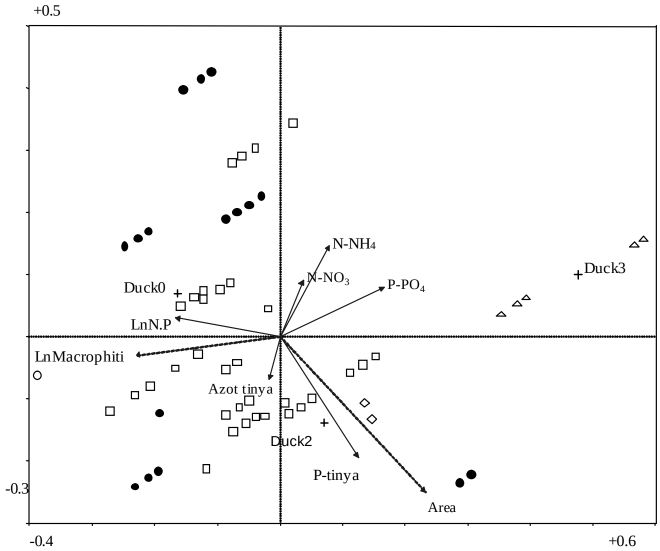

Fig. 1. Results of partial RDA analysis explaining variations between ponds of the response variables total nitrogen in the mud (Azot tinya), phosphate phosphorus in the mud (P-tinya), phosphate phosphorus in the pelagial ($P\text{-}PO_4$), natural logarithmic values of the ratio between inorganic soluble nitrogen and phosphorus compounds in the pelagial (LnN.P), nitrate nitrogen ($N\text{-}NO_3$) and ammonium nitrogen ($N\text{-}NH_4$, with vector almost coinciding with that of P-tinya) by the explanatory variables natural logarithmic values of the percent coverage with macrophytes (lnMacrophiti), area of ponds and duck load, presented by 4 levels (Duck 0-3). Black c ircle means sample originating from ponds of 0 level duck loading, and then square - first level, diamond - second level and triangle – third level of duck loading

result of the increased overgrowing with macrophytes, which are also consumers of phosphate phosphorus. In our previous investigations, we have also established the same tendency (Grozev et al., 2001). The percentage increase of macrophytes overgrowing in the separate ponds, has not accidentally coincided with the decreased influence of ducks, which suppress their growth by troubling the water or by direct consumption.

The nutrients in the slime have not been influenced directly by the redundancy with ducks (loading). The phosphorus content in the slime has varied to a greater extent than that of nitrogen. As regards nitrogen forms in the water column, a greater variation of ammonium nitrogen has been observed, as compared to nitrate nitrogen. In the larger ponds, the phosphorus quantity at the bottom has been higher than that in the smaller ponds and that has been probably due to the better sedimentation conditions in the latter.

Variations by redundancy with ducks

The differences in the biogenic elements between control ponds (Duck0) and those having the 1, 2 and 3 degree of redundancy (P=0.01 for the 1 degree and P=0.005 for the second and third degree of (loading) redundancy), as well as those between ponds having the 1 and 3 degrees (P=0.005) have been significant. The differences between ponds having the 1 and 2 degrees, as well as between those with the 2 and 3 degrees have been not significant (P=0.06 and P=0.08).

Variations by months

The total, explained by the analysis variability of the values analyzed concerning nutrients by months (Figure 2) has been about 6%. The first main axis has not been significant for P<0.05 and along its prolongation there has not been a clear group division of the separate measurements by months, i.e. the monthly variations of biogenic elements have been poor.

The total variation explained by the variables, which describe the redundancy with ducks, the oxygen content and pH of the slime, however, has been significant (P=0.005). The share of ducks' influence upon monthly variability of nutrients has been 4.2% of the total variability and has not been significant. The oxygen water content and the slime pH have influenced upon them significantly (P=0.005), although it can explain only 2.5% of the total variability explained.

Variations by years

The factors, deduced by means of the analysis, which have exerted an influence upon the annual variations of nutrients (Figure 3) are the degree of redundancy of ponds with ducks. They can explain 15.2%

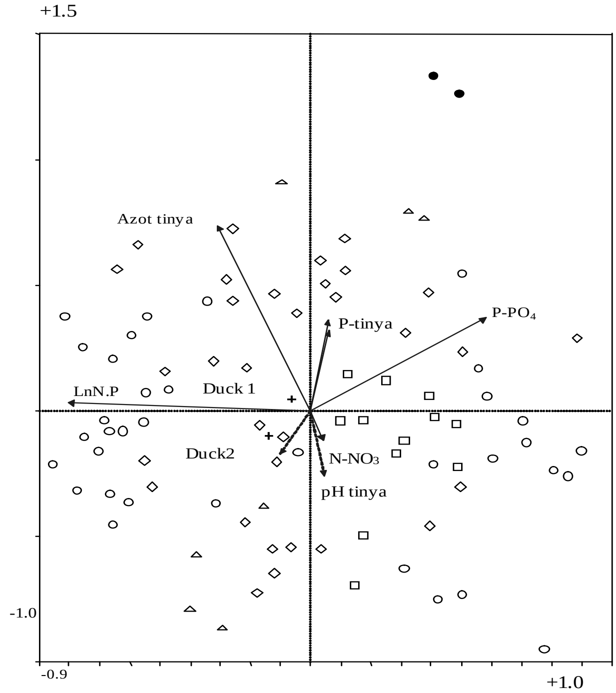

Fig. 2. Results of partial RDA analysis explaining month variations of response variables total nitrogen in the mud (Azot tinya), phosphate phosphorus in the mud (P-tinya), phosphate phosphorus in the pelagial (P-PO_4), natural logarithmic values of the ratio between inorganic soluble nitrogen and phosphorus compounds in the pelagial (LnN/P), nitrate nitrogen (N-NO_3) and ammonium nitrogen (N-NH_4, with vector almost coinciding with that of P-tinya) by the explanatory variables pH in the mud (pH-tinya), oxygen concentration (dotted vector close to that of pH-tinya) and duck load, presented by 4 levels (Duck 0-3). Black circle means sample originating from ponds of 0 level duck loading, and then square first level, diamond second level and triangle – third level of duck loading

of the variability of biogenic elements among the separate years of experimenting and have been significant as along the first, so as along all main axis, in total (P=0.005).

In the control ponds (Duck0), there has been a tendency for increase of nitrate nitrogen and phosphate nitrogen, while as regards ponds having the first

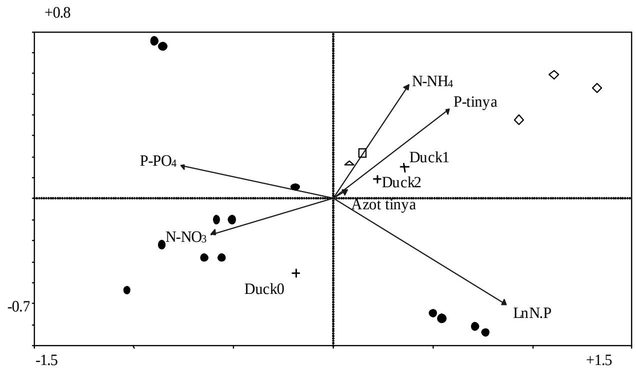

Fig. 3. Results of partial RDA analysis explaining variations between years of the response variables total nitrogen in the mud (Azot tinya), phosphate phosphorus in the mud (P-tinya), phosphate phosphorus in the pelagial ($P\text{-}PO_4$), natural logarithmic values of the ratio between inorganic soluble nitrogen and phosphorus compounds in the pelagial (LnN.P), nitrate nitrogen ($N\text{-}NO_3$) and ammonium nitrogen ($N\text{-}NH_4$) by the explanatory variables implying the duck load, presented by 4 levels (Duck 0-3). Circle means sample originating from ponds of 0 level duck loading, and then square - first level, diamond - second level and triangle – third level of duck loading

and second degree of redundancy, this tendency has been towards increase of ammonium nitrogen and phosphorus in the slime. 2002 and 2001 have been marked as years richer in nitrate nitrogen and phosphate phosphorus, while 2000 has been characterized by its higher ratio of N/P and more ammonium nitrogen.

Conclusions

The part of total nutrient variability explained by three explanatory variables (percentage of area covered with macrophyties, pond area and degrees of duck load) is 10.1%, which is statistically significant for both the first canonical axis and in total for probability level of P=0.005. The influence of the ducks on the nutrient changes between ponds accounted for 5.2% of the total variation and the pond area and macrophyties coverage together explain approximately 3.7% (both significant for P=0.005). The common variability explained by both groups of factors amounted to 1.2% from the explained total data variation of nutrients.

The variability of analyzed values of nutrients between months explained by the analysis is about 6%. The first canonical axis is not statistically significant for Ð<0.05 and there is not a clear separation of measurements along it. The month variations of the nutrients seem to be relatively weak. However the 6% explained by variables describing the duck load, the oxygen content and pH of the slime are statistically significant (P=0.05).

Statistically significant are the nutrient differences between control ponds (Duck0) and the 1, 2 and 3 levels of loading (Ð=0.01 between the 0 and first level and Ð=0.005 between the 0 and second and third levels), as well as those between 1 and 3 levels (Ð=0.005). The differences between ponds with 1 and 2 levels, as well as with 2 and 3 levels of duck loading are insignificant.

The only factors having influence on the annual changes of nutrients, derived by the statistical analysis are the levels of duck loading. They explain 15.3% of the variability of the nutrients between the different experimental years and are statistically significant correspondingly by the first canonical axis and as a whole (P=0.005).

References

Chand, B., K. Goswami, P. Biswas , P. Biswas and B. Patra, 2006. Effects of stocking levels of ducks on production of Indian Major Carps in village ponds under duck-fish integrated system in West Bengal state of India, *Livestock Research for Rural Development*, **18** (1).

Cherfas, B. and G. Zernjishko, 1946. Ducks breeding in carp-breeding farms, *Pishchepromizdat*, Moscow, pp. 6-11 (Ru).

Chernomashentzev, A. and V. Miljshtin, 1983**.** Fishery, *Light and Food Industry*, Moscow, pp. 204-206 (Ru).

Goflin, M. and F. Suhoverhov, 1955. Combined fish and ducks breeding farm “Gzhelka”, *State Publishing House of Agricultural Literature*, Moscow pp. 25 (Ru).

Grozev, Gr., L. Hadjinikolova, Z. Kostova, L. Nikolova, Dj. Grozev, R. Atanasova and D. Terziyski, 2001. Integrated farming of fish and waterfowl in carp ponds. I. Research on major points of the technology and their impact on productivity and on some water parameters. *Journal of Animal Science*, **(5)**: 15-21 (Bg).

Hossain, A. and M. Islam, 1992., Polyculture of carps in integrated duck-cum-fish farming ponds (in Bangladesh). *Bangladesh Journal of Training and Development,* **5** (2): 25-32.

Nikolova, L., 2003. Investigation of some technological elements of ecological and bio-Friendly technology for integrated growing of fish and ducks in fish-breeding ponds. PhD Thesis, 198 pp. (Bg).

Nikolova, L., 2006. Application of the assessment method for loading the fish ponds with ducks under the conditions of complete integration. *Bulgarian Journal of Agricultural Science*, **12** (2): 236-246.

Shoshkov, D., 1977**.** Fish diseases and fundamentals of fishery. *Zemizdat*, Sofia, 17 pp. (Bg).

Soliman, A., A. El-Horbeety, M. Essa, M. Kosba and I. Kariony, 2000. Effects of introducing ducks into fish ponds on water quality, natural productivity and fish production together with the economic evaluation of the integrated and non-integrated systems. *Aquaculture International,* **8**: 315–326.

Received February, 20, 2008; accepted for printing March, 15, 2008.