Indian J. Fish., 60(2) : 99-102, 2013

Estimation of loss due to argulosis in carp culture ponds in India

P. K. SAHOO[1], J. MOHANTY[1], S. K. GARNAYAK[1], B. R. MOHANTY[1], BANYA KAR[1], HEMA PRASANTH[2] AND J. K. JENA[3]

Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar - 751 002, Odisha, India
[2]Regional Research Centre, Central Institute of Freshwater Aquaculture, Bengaluru - 560 089, Karnataka, India
[3]National Bureau of Fish Genetic Resources, Lucknow - 226 002, Uttar Pradesh, India
e-mail: pksahoo1@hotmail.com

ABSTRACT

Argulosis caused by crustacean ectoparasites of the genus *Argulus* is one of the parasitic diseases that pose a major threat to freshwater aquaculture industry around the globe. The actual loss incurred due to this disease has gone mostly unnoticed. In the present study, economic burden imposed by *Argulus* sp. in carp culture ponds in India was estimated based on the data obtained from the survey conducted in major aquaculture zones in the country. The loss was estimated by taking into account the mortality occurred, loss in growth by reduction in weight and expenditure towards drugs/chemicals applied for treatment or prevention of this disease. The total loss due to argulosis has been estimated to the magnitude of ₹ 29524.40 (US$ 615) ha^{-1} year^{-1}. Hence, management of this disease should be given top priority to save the aquaculture industry from this huge loss.

Keywords: Argulosis, *Argulus* sp., Carp farming, Freshwater aquaculture, Prasaite

Introduction

Parasitic diseases pose serious problems to the aquaculture industry. Argulosis caused by crustacean ectoparasites of the genus *Argulus* (freshwater fish lice) is one of the important parasitic diseases of freshwater aquaculture that causes heavy economic losses to the industry. Acute infestation of *Argulus* spp. results in fish loss due to direct effects such as dermal ulceration, osmotic imbalance, physiological stress and immunosuppression (Walker *et al*., 2004). Besides, indirect effects of infestation such as reduced fish growth, reduced feed conversion ratio, secondary infections and fish mortality as well as farmers perception about safe aquaculture, too contribute substantially to the loss incurred. Argulosis in the wild is very low in intensity and are less of a threat than to those in aquaculture conditions (Walker *et al*., 2004). In recent years, occurrence of argulosis appear to be more frequent due to intensive aquaculture activities. Fish farmers mostly use organophosphates for treatment of this disease, which have deleterious effect on the environment (Jones *et al*., 1992). Therefore the damage includes the impact on the fish as well as on the environment and public perception of aquaculture (Costello *et al*., 2001). Hence, development of alternate control strategies through management practices as well as other biological methods assumes high significance.

Carp culture is the mainstay of Indian freshwater aquaculture and argulosis is the most important parasitic disease associated with cultured carp species. The loss incurred due to *Argulus* spp. infestation is yet to be estimated for carp culture in India except for the study by Sahoo *et al*. (2012). However, a good number of publications on loss estimates have been reported for sea lice infestations causing heavy damage to salmonid industry in Europe and the Americas (Pike and Wadsworth, 1999; Mustafa *et al*., 2001; Rae, 2002; Costello, 2009). Here we report the estimates of the economic burden imposed by *Argulus* spp. in carp culture ponds in India. The current estimate may help researchers, aquatic animal health specialists and policy makers to approximate the economic costs of infestation to the carp industry and work towards developing long-standing control measures.

Materials and methods

Survey of aquaculture zones

Argulosis outbreak and prevalence were surveyed in major aquaculture zones of India (Fig. 1) during 2008-10 covering 1067.22 ha of water area in 8 states of India comprising 87 fish farmers. During this period, an interview-based study was conducted using a standardised questionnaire based on aquaculture practices. Relevant information regarding management and outbreak status of argulosis was collected either by quarterly visits to the individual farm or by personal telephonic interview.

Estimation of loss due to argulosis

The loss due to argulosis was estimated by taking into account the mortality occurred, expected loss in growth of

West Bengal
1. Naihati 2. Nowbhaga
3. Khorda 4. Nilaganj
5. Barasat

Orissa
1. Khurda 2. Balasore
3. Jajpur 4. Jagatsinghpur
5. Bhanjanagar

Andhra Pradesh
1. West Godavari
2. East Godavari
3. Nellore 4. Elluru

Karnataka
1. Kustagi 2. Koppal
3. Dharward 4. Hospet
5. Bellary 6. Shimoga

Meghalaya – 1. Tura
Himachal Pradesh – 1. Mandi
Tamilnadu – 1. Trichurapalli
Uttarpradesh – 1. Lucknow

Fig. 1. Map of India showing areas surveyed for argulosis

fish in terms of the total biomass production and expenditure towards drugs/chemicals applied for prevention and control of this disease. The expenditure towards labour charges and reduction in feed conversion ratio were not included due to lack of sufficient authentic data.

The loss was estimated following the formula described below:

Total loss = {(Loss due to reduction in growth + Loss due to mortality) x Rate per kg} + Cost of treatment

where, loss due to reduction in growth (in kg) = average growth/day x number of fish affected x total period of infestation from all the outbreaks in a year (in days) and loss due to mortality (in kg) = average weight of fish x mortality (in number)

It was observed that due to *Argulus* spp. infestation, the growth of fishes almost ceases. Hence, the loss due to reduction in growth was calculated assuming that during infection there is no substantial growth increment in fish. It was observed that ~50% fish were affected during low degree (mild) of infection; ~70% in case of moderate and almost all the fishes were affected in high degree of *Argulus* spp. infestations in carp culture ponds. The average loss due to reduction in growth per day was calculated taking into consideration the stocking density and average production of the farm per hectare per year. The loss in growth increment per day during the infection was calculated as follows: 1, 2 and 3 g loss in growth per day at stocking densities ranging from 7000 and above, 4000-7000 and 4000 and less number per hectare of water body respectively. This was based on field survey data and also earlier studies conducted with regard to stocking density in carps and specific growth rate relationship there on (Jena *et al*., 2001; 2002; 2008). Stocking ratio and the species of fish affected were taken into consideration while calculating number of fish in the affected pond. The estimates on fish stocking, survival, number of incidences and medication details were deduced from discussions with farmers on the basis of their personal observations and experiences.

Results

Out of 87 fish farms surveyed, only data from 67 farms, which provided relevant data of loss due to argulosis on continuous basis necessary for calculation were included in the final calculation. A loss to the tune of ₹ 29524.40 (US$ 615) {29524.40 ± 2506.46 (mean ± SE)} per hectare of water area per year was incurred annually due to argulosis (Table 1). The range of total estimated loss among the farms was ₹ 8,100.00 – 91,125.00 ha^{-1} yr^{-1}. In reality however, the loss incurred by a farmer would have been much more than what was estimated, if we had included labour, cost for medication, reduction in food conversion ratio (FCR) and feed wastage.

It was observed that some farmers do not apply any drug for the control of argulosis, while some others used drugs in plenty for prevention and control of argulosis. The loss due to *Argulus* spp. infestation was estimated to be maximum at ₹ 91,125.00 ha^{-1} yr^{-1} in a farm in Andhra Pradesh. They were not using any drug against this disease. When the average total loss was calculated separately for farms that did not use any drug as compared to those using drugs; the results were as high as ₹ 37,926.85 {37,926.85 ± 6,328.73 (mean ± SE)} for the former when compared to ₹ 27,304.90 {27,304.90 ± 2,695.76 (mean ± SE)} for the latter (Table 2).

Taking into consideration the fact that average carp production of a farm is over 2.5 t ha^{-1} yr^{-1} (Jena and Das, 2011), the loss due to argulosis was estimated to be ₹ 11.81 per kg carp production. However, it was not possible to derive percentage loss in production cost due to argulosis, as there were great variations in production figures among the farmers.

Table 1. Calculation of loss due to argulosis in carp culture ponds

Factors taken for calculation of loss	Loss in weight (kg ha^{-1} yr^{-1})	Price of fish (₹ kg^{-1})	Cost of treatment (₹ ha^{-1} yr^{-1})	Loss in value (₹)
Mortality (average loss in biomass) ha^{-1} yr^{-1}	31.26	75.00	-	2344.50
Reduced growth (average loss in biomass) ha^{-1} yr^{-1}	324.29	75.00	-	24321.75
Drug applications	-	-	2858.15	2858.15
Total average loss due to argulosis (₹ ha^{-1} yr^{-1}				29524.40

Table 2. Comparison of loss due to argulosis in carp culture farms using drugs *vs*. farms not using any drug

Factors taken for calculation of loss	Loss due to argulosis per (₹ ha^{-1} yr^{-1})	
	Farms using drugs	Farms not using drugs
Mortality (Average loss in biomass)	2397.88	2142.85
Reduced growth (Average loss in biomass)	21293.89	35784.00
Drug applications	3613.13	-
Total average loss due to argulosis (₹ ha^{-1} yr^{-1})	27304.90	37926.85

Discussion

The economic loss associated with a problem is often used as the best measure for prioritisation of research and management of resources. The economic loss due to argulosis was estimated to be ₹ 67 102.00 (US$ 1428) ha^{-1} yr^{-1}, in a carp culture farm in Mandi, Himachal Pradesh, India taking into account factors like mortality, reduced growth rate, and costs associated with drug application (Sahoo *et al.,* 2012). Here we provide an economic cost to argulosis in carp culture on a national scale. This is the first report on estimation of loss due to *Argulus* spp. infestations on a national scale, although a number of estimates are available for sea lice infestations (Pike and Wadsworth, 1999; Mustafa *et al*., 2001; Rae, 2002; Costello, 2009). It is interesting to compare our findings on argulosis in carp culture with that of sea lice infestation, a similar disease in salmon industry. In the present estimate, the loss due to argulosis was found to be ₹ 29,524.40 ha^{-1} yr^{-1}. Further, the loss was estimated to be ₹ 9.84 (0.146) per kg carp production. Costello (2009) similarly reported that most of the loss estimates for sea lice infestations fall within the range of € 0.1-0.2 per kg fish produced annually.

Out of the total estimated loss, 82% was due to reduced growth rate (reduction in production of biomass than expected), 8% due to mortality (direct reduction in biomass) and 10% was in the form of cost of drugs used for control of *Argulus* spp. infestations (Fig. 2). It has been reported that ~17-30% of the total cost involved in sea lice control was towards purchase of parasiticides and purchase and maintenance of equipments (Mustafa *et al*., 2001; Rae, 2002). The greatest financial loss due to argulosis could be attributed to reduced growth rate, which was possibly due to poor food conversion ratio (FCR) in infected fish. Farmers also spent extra feed to regain better FCR and ultimately better growth. Similarly, Sinnott (1998) reported that sea lice infested fishes were 5-15% lesser in weight due to reduced fish growth and suggested that 5% more feed was required to compensate the reduced FCR. The extra cost incurred for feed was not included in this study because of lack of authentic data.

It was observed that the loss due to mortality did not vary much between treated and non-treated groups, however, slightly higher average loss in treated ponds as compared to non-treated ponds could be attributed to delayed treatment by the farmers after recording mortality in ponds as well as to susceptibility of fish in farms using higher stocking density, as observed in our survey. The loss due to reduction in growth was ~41% less in treated farms as compared to non-treated farms (Table 2). In the non-treated farms, the infestations persisted for a long time before self-cure took place, *i.e*., normally 2-3 months depending upon the pond environment. Persistent heavy parasite load keeps the fish off-feed, make them ulcerated and stressed leading to substantial growth reduction as noticed here.

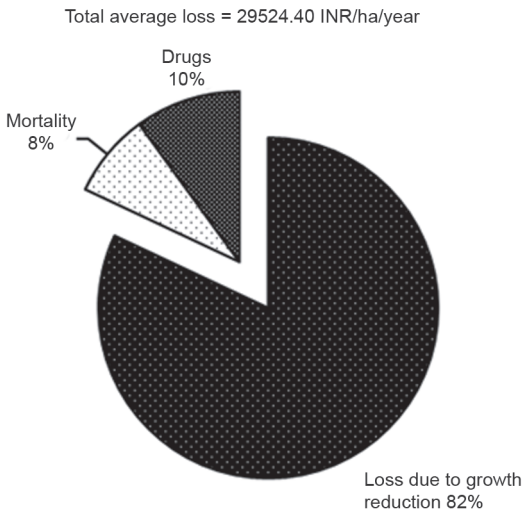

Fig. 2. Estimated loss due to argulosis in carp culture ponds

This is the first comprehensive report on economic loss due to a freshwater fish disease at a national level, through targeted active survey over a period of two years in major aquaculture farms. The estimated loss varied from farm to farm based on the intensity of infection and the management practices adopted by farmers. Many other factors like labour cost, operational cost *etc*. contribute indirectly to the loss, which were not included in the present study. Thus, the actual loss might be higher than the loss estimated here. Hence, management and control of this disease is essential to save the aquaculture industry from the great economic loss.

Acknowledgements

This work was supported by the National Fund for Basic Strategic and Frontier Application Research in Agricultural Sciences (NFBSFARA) of Indian Council of Agricultural Research, New Delhi. The authors wish to thank the Director, CIFA, Bhubaneswar for providing necessary facilities during this study. Thanks are due to Dr. P. Pradhan, NBFGR, Lucknow; Dr. K. Anbarasu, Bharathidasan University, Tiruchirappalli; Dr. P. P. Chakrabarty and Dr. A. Dutta, RRC of CIFA, Rahara, West Bengal; Dr. B. S. Giri and Dr. P. V. Rangacharylu, RRC of CIFA, Vijayawada; Dr. P. Venugopal, CIFE Centre, Kakinada and Dr. P. Haribabu, College of Fisheries, Nellore for their help during survey and sampling.

References

Costello, M. J. 2009. The global economic cost of sea lice to the salmonid farming industry. *J. Fish Dis*., 32: 115-116.

Costello, M. J., Grant A., Davies, I. M., Cecchini, S., Papoutsoglou, S., Quigley, D. and Saroglia, M. 2001. The control of chemicals used in aquaculture in Europe. *J. Applied Ichthyol.,* 17: 173–180.

Jena, J. K., Ayyappan, S., Aravindakshan, P. K. and Muduli, H. K. 2001. Comparative evaluation of growth, survival and production of carp species at different stocking densities under polyculture. *Indian J. Fish*., 48(1): 17-25.

Jena, J. K., Ayyappan, S., Aravindakshan, P. K., Dash, B., Singh, S. K. and Muduli, H. K. 2002. Evaluation of production performance in carp polyculture with different stocking densities and species combinations. *J. Appl. Icthyol.*, 18: 165-171.

Jena, J. K., Das, P. C., Kar, S. and Singh, T. K. 2008. Olive barb, *Puntius sarana* (Hamilton) is a potential candidate species for introduction into the grow-out carp polyculture system. *Aquaculture,* 280: 154-157.

Jena, J. K. and Das, P. C. 2011. Carp culture. In: Verma, S. A., Kumar, A. T. and Pradhan, S. (Eds.), *Handbook of fisheries and aquaculture*, 2nd edn. Directorate of Knowledge Management in Agriculture (DKMA), Indian Council of Agricultural Research, New Delhi, p. 380-400.

Jones, M. W., Sommerville, C. and Wooton, R. 1992. Reduced sensitivity of the salmon louse *Lepeophtheirus salmonis*, to the organophosphate dichlorvos. *J. Fish Dis.,*15: 197-202.

Mustafa, A., Rankaduwa, W. and Campbell, P. 2001. Estimating the cost of sea lice to salmon aquaculture in eastern Canada. *Can. Vet. J.*, 42: 54–56.

Pike, A.W. and Wadsworth, S. L. 1999. Sea lice on salmonids: their biology and control. *Advances in Parasitol.*, 44: 233–337.

Rae, G. H. 2002. Sea louse control in Scotland, past and present. *Pest Manag. Sci.*, 58: 515–520.

Sahoo, P. K., Hema Prasanth, Banya Kari, Garnayak, S. K. and Mohanthy, J. 2012. Mixed infection of *Argulus japonicas* and *Argulus siamensis* (Branchiura, Argulidae) in carps (Pisces, Cyprinidae): loss estimation and a comparative invasive pattern study. *Crustaceana,* 85 (12-13): 1449-1462.

Sinnott, R. 1998. Sea lice – watch out for the hidden costs. *Fish Farmer*, 21(3): 45–46.

Walker, P. D., Flik, G. and Wendelaar Bonga, S. E. 2004. The biology of parasites from the genus *Argulus* and a review of the interactions with its host. In: Wiegertjes, G. F. and Flik, G. (Eds.), *Host-parasite interactions* Garland/ Bios Scientific publishers, Abingdon UK, p. 107-129.

Date of Receipt : 28.04.2012
Date of Acceptance : 21.11.2012