P: ISSN NO.: 2394-0344 RNI No.UPBIL/2016/67980 VOL-5* ISSUE-8* November- 2020
E: ISSN NO.: 2455-0817 Remarking An Analisation

Morphometry of the Caudal Gills of *Ceriagrion coromandelianum* (Febricius) of Zygopteran Larvae (Odonata -Zygoptera)

Paper Submission: 15/11/2020, Date of Acceptance: 26/11/2020, Date of Publication: 27/11/2020

Abstract

In present study, the measurement of caudal gills morphometry of *Ceriagrion coromandelianum* (Febricius) of Zygopteran larvae, family Coenagronidae. Today morphometrics is used for vast area of studies either for measurement of gross dimensional relationship of body weight, head size, width with respect to gill weight, gill length, gill width and body length. The respiratory system of damselfly larvae consists of tracheal gills which are having complex structures in configuration and as such required special method for measurement, "the weighted method for gill morphometrics".

Keywords: *Ceriagrion*, Caudal Gills, Morphometrics, Measurement, Body Weight, Dimension, Surface Area.

Md. Afsar Ahmad
Assistant Professor (Guest),
Dept. of Zoology
Murarka College, Sultanganj
T. M. Bhagalpur University,
Bhagalpur, Bihar, India

Introduction

The term "Morphometrics" means the measurement of dimension of any biological system. Today morphometrics is used for a vast area of studies either for measurement of gross dimensional relationship of body weight, head size, width, with respect to gill weight, gill length, gill width, body length or, for minute dimension or respiratory surface area, blood vascular area and volume diffusion thickness etc. But it is appropriate to use this term with morphological measurement of any structure along with statistical analysis to understand its functional relationship.

The methodology for morphometrics varies in accordance with the structure of the organs and system to be measured. If the organ is of definite geometrical shape, its measurement is simple but if the surface of the structure is complex and corrugated, the measurement involves complex principles. The respiratory system of damselfly larvae consists of tracheal gills which are having complex structures in configuration and as such require special method of measurement. According to Snodgrass (2004) the tracheal gills are hollow, thin-walled evagination of the integument containing finely branched tracheae and with an abundance of tracheoles. The three terminal gills of zygopterans larvae are borne by the epiproct and the paraprocts. These are generally designated as caudal gills which may increase as larvae grow, presumably to maintain a favourable surface/ volume ratio for respiratory exchange. The caudal gills of some damselfly larvae exhibit protrusive growth in which the distal zone which a thinner cuticle than the proximal zone, increases in length as the larvae matures (Keister, 1948: MacNeill, 1960). Thus, there is distinct morphological and physiological differentiation in the caudal gills with regard to their structure, arrangement of trachea, tracheoles as well as capacity of DO_2 uptake. Therefore, the shape, size, length, width, weight etc. of the caudal gills of damselfly larvae may be the "indicator" of the prevalence of dissolved O_2 content in the habitat. It is imperative to know the dimension of the surface area of the entire caudal gills of the damselfly larvae.

The gills are highly characteristic features of aquatic animals which serves a multitude of vital functions, viz., gas exchange, ionic exchange, circulation of hormones, and detoxification (Chapman, 1969, 1998; Hughes, 1984; Munshi and Hughes, 1992; Olson, 1991). Their functional efficiency depends on their architectural plan, dimensions, nature of diffusion pathway, and also the ventilation and perfusion of the respiratory surface. Most authors considered a single secondary lamella and measured its area using a camera lucida or projection microscope (Gray, 1954; Byezkowskar, 1957; Hughes, 1966; Munshi, 1980).

This method is based on the principle that of simple represent portions of the total system that differ in significantly from one another in the average calculation more right should be given to these simplex which represent a lower part in the whole. In fact weighting of average is done and the method termed the "weighted method for gill morphometrics".

Morphometry of Gill Surfaces in relation to body Size

In relation to both their respiratory and osmo-regulatory function, it is of the barrier separating the gaseous exchange surface area and morphological thickness of the barrier separating the blood and water. Relatively few detailed studies have been made among animals but the studies of Dr. J. E. Grey (1954, 1957) of Durham, North Carolina are notable in this context. Among a series of American Crabs (Gray, 1957) established that largely due to an increase in lamellar area the total surface increased during the growth of individual species. He concluded that the surfaces for gaseous exchange areas of the active crab are greater than those of sluggish species.

The basic architectural plan of the gill lamellae of all damselfly larvae are the same, but the experimental species of gill lamellae show a degree of modification according to breathing habits. In damselfly larvae the gill lamellae look heterogeneous in different instars and also in different species and approximately different in dimension.

Damselfly larvae gills are complex and are suited for gaseous and ionic exchange in extreme conditions of their habitat. The limnological characteristics of the habitat are responsible for various modifications in functional organization of damselfly larvae gills; the respiratory efficacy of gills is directly proportional to their effective respiratory area. In recent years various sampling procedures have been attempted for estimating the gill area of fishes inhabiting different ecological niches (Hughes, 1984; Biswas, et. al., 1981).

There is practically no information available on the gill morphology of the damselfly larvae. Therefore, the objective of present study is to measure the gill surface of the damselfly larvae in order to know the dissolved O_2 uptake efficiency.

Review of literature

Odonates are amphibiotic insects closely associated with both lentic and lotic waters, where these are seen laying or perching on vegetations in its vicinity with immature stages are aquatic and adults being aerial. Ecologically and economically these insects are quite significant, being predator of noxious insects and bioindicator of quality and productivity of inland waters.

Odonates are usually the most conspicuous insect group near any body of inland water and commonly called as "devil's darning needle", "snake feeder", "snake doctor" and "horse stinger". The common name "mosquito hawk" refers to their value in destroying mosquitos' larvae and other pests, (Smith and Pritchard, 1956). The nymphal Odonates are predaceous like the adults and spending their entire larval period in the inland water.

In Odonata special respiratory organs in the form of tracheal gills are present in the nymphs of all dragonflies and on the other hand caudal gills present in larvae of all damselflies. In Zygoptera (damselfly) they take the form of caudal gills, which form an elaborate and beautiful apparatus known as caudal gills.

Caudal gills

In Zygoptera, however, the epiproct and paraproct have become specialized to form foliaceous lamellae. The function of these lamellae has been a subject of much controversy for sometimes, but there is no doubt that the lamellae have evolved as a supplement to other means of respiration in larvae (MacNeill, 1960, 1967; Corbet, 1962). Furthermore, the shape and size of the lamellae can be said to be the generally inverse proportional to the availability of oxygen in normal habitats. The lamellae of Zygopterous species which are found in slow-running streams and ponds are foliaceous, mostly duplex type and show protrusive growth and have well developed tracheation, thus, being able to breathe maximum amount of oxygen.

Practically no information is available on the morphometry of caudal gills of damselfly larvae variables of a single species i.e. literature pertaining to autecology of damselfly nymphs in very meagre. The perusal of literature indicates that no work has been done on the morphology of caudal gills of damselfly larvae (Odonata: Zygoptera). Therefore, the objective of present study is to measure the gill surface off the damselfly larvae in order to know the dissolved O_2 uptake efficiency and also need to more work on gill morphometry.

Materials and Methods

The four species of the Zygopteran (damselfly) larvae: *Ceriagrion coromandelianum* (Fabricius) was collected from local ponds viz. Bhairwa pond in the west of Marwari college, Bhagalpur another ponds lie behind the Life Science Department of T.N.B.College, Bhagalpur and in Post-Graduate Department of Zoology, Bhagalpur, Bihar called "Hathkatora pond" with the help of aquatic insect net on the littoral zones of ponds where plant vegetations grow up with sandy and muddy soil bottom. Collection of damselfly larvae was made by hauling method by sweeping the net from the side of the pond. Collected materials were kept in bucket. They were brought to the laboratory. The collected materials were kept in tray for sorting of Zygopteran (damselfly) larvae were sorted out, identified properly and kept in a glass aquarium with some vegetations and natural food such as mosquitoes, midges, fish spawn, tadpoles were provided. For morphometric measurement the materials taken up from jar and kept in petri disc, were 2 to 3 times washed, the body weight of the larvae have been taken ranging from 1st to 5th instars body weight.

The average area of the gill lamellae are representative of the lamellae of that larvae. The average area of lamellae is then double to ascertain the bilateral surface area. The morphometric measurement of the caudal gills of these larvae were done following the method of Roy, (1984)

Results

The functional efficiency of the tracheal gills depends on their architectural plan, dimension, ventilation and perfusion of the respiratory surface. The basic architectural plan of the caudal gills of all experimental species is the same, but the gill lamellae of these species show a degree of modification according to the dissolved O_2 content of the habitat. The shape and size of lamellae also show a great degree of heterogeneity. The lamellae differ from tip to base of lamellae in shape and size. The thick cuticle barrier act as an oxygen conserving device in these experimental zygopteran larvae when the surrounding water has low oxygen tension and concomitantly prevent collapse of the lamellae when the larvae is out of water.

Gill area is showing significant difference among the total gill area values of the 1^{st} to 5^{th} instar larvae. The 5^{th} instar larvae showed the largest gill area and the 1^{st} instar larvae, the lowest. The gill area and length is greatly reduced, in all zygopteran larvae when the body weight and body size is reduced from 5^{th} to 1^{st} instar larvae. Some variations in the gill lamellar area have been observed in all the five instars of zygopteran larvae. In all the five instars the gill lamellar area is greatest in the middle region as compared to their structure. Gill lamellar area, length and body weight are an important parameters as it makes a positive contribution to the dimension of the effective gill area. It also determines the architectural plan and compactness of the gill lamellae.

The simple graphs (Plate I; Fig. 1) showed that the body weight, body length, gill length and total gill areas indicate heterogeneity in their relative area, length and body weight of the zygopteran larvae of all five instars. It is interesting to note that the gill area gradually increased in relation to the weight, body length and gill length.

The morphometric data of *Ceriagrion coromandelianum* (Fabricius) has been shown in Plate-I. The gill morphometric data of species of damselfly larvae has been described below:

***Ceriagrion Coromandelianum* (Fabricius)**

The (Plate I, Fig. 1) depicts the data on the morphometry of 1^{st} to 5^{th} instar larvae of *Ceriagrion coromandelianum* (Fabricius). The body weight of the larvae varied from 0.280gms to 0.477 gms and body length and the gill length of the larvae was taken with the help of engineering divider and mm scale. The data were varied from 13.55 mm to 16.04 mm for body length and 9.13 mm to 12.04 mm for total gill length. The gill lamellae and measurement of the total gill area of the 1^{st} to 5^{th} instar larvae were done with the help of camera lucida, which were varied from 18.46410 mm^2 to 26.92130 mm^2 respectively.

The (Plate I, Fig. 1) showed that the largest gill area (26.92130 mm^2) in 5^{th} instar larvae and the lowest gill area (18.46410 mm^2) in 1^{st} instar larvae. This values showed that the 5^{th} instar larvae needs more oxygen for survival as compared to other instars. The gill area is directly proportional to the efficiency of the gill lamellae and shows the adaptive features for an aquatic mode of life.

Plate I

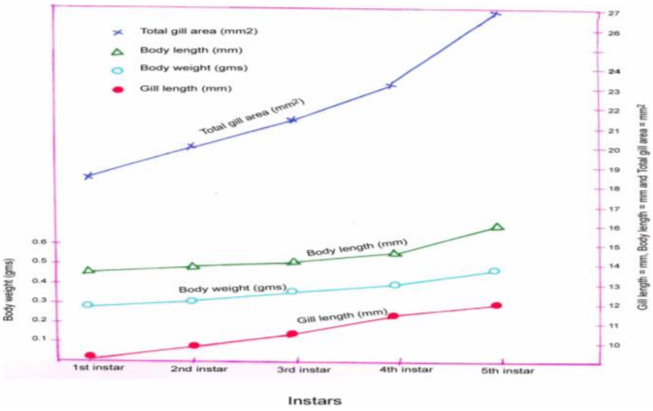

Fig. 1: Graph showing the relationship between body weight and (i-v) instars of *Ceriagrion coromandelianum* (Fabricius)

Conclusion

Morphometric studies contribute much to our understanding of respiratory organ functions with respect to growth, development, habit and habitat of zygopteran larvae. The structural complexity of caudal gills of zygopteran larvae necessitiates the application of stereological techniques. The morphometrics of some zygopteran larvae was analysed after grouping them into 1^{st} to 5^{th} instar larvae, great variation in the surface area of all five instar groups of zygopteran larvae was observed. The total gill area of 5^{th} instar zygopteran larvae is largest as compared to other instars.

In the zygopteran larvae, the body weight, body length, total gill length and total gill area increased between 1^{st} to 5^{th} instars showing the relationship between body weight and gill areas in each and every instars. In the larvae of Ceriagrion cormandelianum (Fabricius) the difference between 1^{st} and 2^{nd} instar larvae is 0.025gms in body weight, 0.27 mm body length, 0.59 mm total gill length and 1.5164 mm^2 total gills areas. The difference between 2^{nd} and 3^{rd} instar larvae was observed in 0.050 gms body weight, 0.23 mm body length, 0.74 mm total gill length and 1.3113 mm^2 total gill areas. In 3^{rd} and 4^{th} instar larvae the difference in 0.041gms body weight, 0.50 mm body length, 0.99 mm total gill length and 1.9311 mm^2 total gill area and finally the differences between 4^{th} and 5^{th} instar larvae in 0.081 gms body weight, 1.49 mm body length, 0.59 mm total gill length and 3.699 mm^2 total gill area respectively.

On the basis of this data it may be postulated that the larvae consumed more oxygen in between 4^{th} and 5^{th} instar and finally 5^{th} instar larvae consumed more oxygen as compared to other instars.

On the basis of above plate-I it is concluded that of all five instars of zygopteran larvae the total gill area increased in relation to the body weight and total gill length in accordance with the Dyar's rule.

The gill area and other parameters such as respiratory area have been measured for different weight groups of zygopteran larvae. The values of these parameters are carried out in order to study the effect of life stages by dividing the data of morphometrics of zygopteran larvae ranging from 1st to 5th instars.

The two significant conditions: the surface area and morphological thickness of the diffusing membrane play an important role in the gaseous exchange. Thus, the morphometrics data of damselfly larvae it in *Ceriagrion coromandelianum* (Fabricius) which has a total gill area comprising two paraprocts and one epiproct as calculated in 26. 92130 mm^2, it is shows that the respiratory surface varies from proximal to apical region and much greater in middle region.

References

1. *Biswas, N; Ojha, J. and Munshi, D.J.S. (1981) : Morphometrics of the respiratory organs of an estuarine fish, Boleophthalamus boddaerti, Japan J. Ichthy 27: 316 - 326.*
2. *Byezkowska, S.W. (1957): The respiratory surface of the gills in teleosts, Part I. Respiratory surface of the gills in flounder, Pleuronectes platessa and perch, Perca fluviatilis. Zool. Polonl. 8: 91 - 111,*
3. *Chapman, R.F. (1998): The insects: structure and function, 4th ed, Cambridge Univ. Press. PP. 54-56.*
4. *Chapman, R.F., (1969): The insect's structure and function. The Cambridge Uni. Press, New York: American Elsevier, 819 PP.*
5. *Corbet, P.S. (1962): Biology of Dragonflies. H.F. and G. Withhereby, London, 247 PP.*
6. *Dodds, G.S. and Hisaw, F. L. (1924):" Ecological studies of aquatic insects. II. Size of respiratory organs in relation to environmental conditions." Ecology, 5: 262 - 271.*
7. *Gray, I.E. (1954): Comparative study of the gill area of marine fishes. Biol., Bull., 107 219 - 225.*
8. *Gray, I.E. (1957): Comparative study of the gill area of marine fishes. Biological Bulletin of the Marine Biological Laboratory Woods Hole, 112: 34 - 42.*
9. *Hughes, G.M. (1984): Scaling of respiratory areas in relation to oxygen consumption of vertebrates. Experientia, 40: 519 - 524.*
10. *Hughes, G.M., (1966): The dimension of fish gills in relation to their function. J. Exp. Biol., 45: 177 - 195.*
11. *Keister, M.L. (1948): The morphogenesis of the tracheal system of Sciara, F. Morph., 83: 373 - 423.*
12. *MacNeill (1967): Had studied the developed caudal gills of Agrionid dragonfly larvae.*
13. *MacNeill, N. (1960): A study of the caudal gills of the damselfly larvae of the Suborder Zygoptera. Proc. R. Irish Acad., 61: 115 – 140.*
14. *MacNeill, N. (1960): A study of the caudal gills of the damselfly larvae of the Suborder Zygoptera. Proc. R. Irish Acad., 61: 115 – 140.*
15. *Munshi, J.S.D. (1980): The structure and function of the respiratory organs of air-breathing fishes in India. PP. 32-70. Presidential Address Section of Zoology, Entomology and Fisheries. 67th Session. Indian Science Congress Association, Kolkata.*
16. *Munshi, J.S.D. and Hughes, G.M. (1992): Air-breathing fishes: Their structure, function and life-history. Oxford and IBH Pub. Co., New Delhi.*
17. *Olson, K.R. (1991): Morphology and vascular anatomy of the gills of a primitive air-breathing fish, the bowfin, Amia calva. Cell Tiss. Res., 218: 499 - 517.*
18. *Roy, S. P. (1984): Studies on gut content analysis of odonate nymphs in a freshwater fish pond at Bhagalpur (Bihar). Entomon. 1984. Vol. 9, No. 1, PP. 25 - 29.*
19. *Smith, R.F. and Pritchard, A.E. (1956): Chapter 4, Odonata. In; R.L. Usinger (ed). Aquatic insects of California with keys to North America Genera & California species, PP. 106-153. University of California Press, Berkeley and Los Angeles.*
20. *Snodgrass, R.E. (2004): Priciples of Insect Morphology. Reprint 2004. CBS Publishers and Distributors, New Delhi/Banglore 10: PP. 1-647.*