MORPHOMETRY, FOOD, FEEDING AND REPRODUCTIVE BIOLOGY OF *Hemiramphus gaimardi* (PISCES, HEMIRAMPIDAE) FROM SOME RESERVOIRS IN SRI LANKA

N. Ramasinghe and H. H. Costa

Department of Zoology, University of Kelaniya, Kelaniya,
Sri Lanka

Introduction

Hemiramphus gaimardi is a relatively small species growing upto a length of about 15.0 cm. It is a common species of fish in Cormandal coast of India and in certain parts of Burma. This fish has now invaded the freshwaters of Sri Lanka and is now common in certain reservoirs in Anuradhapura, Polonnaruwa and Hambantota Districts.

It is yellowish green in colour with a narrow brilliant silvery band bordered above by a black line. Dorsal, anal and the extremity of the caudals are sometimes blackish. No scales on dorsal and anal fins. There are five rows of cycloid scales between the base of the dorsal and lateral line. The caudal is lobed, the lower being larger. Anal originates opposite dorsal. Pectoral reaches forward to the front edge of the eyes. Minute teeth in many rows in both jaws and tricuspidate. Upper jaw broader than long. The lower jaw is developed into a long beak. The full description of morphometric factors given by Day (1878) is as follows:

D. 13–14, P. 10, V.6, A. 13–15, C. 14, L. 50–51

Materials and Methods

Collection of fish:

Collections of *Hemiramphus gaimardi* were made from Mahawilachchiya Wewa at Anuradhapura, and Badagiriya Wewa at Hambantota. All the fish were caught using an encircling net of 1.2 cm stretched mesh. The fish were immediately preserved in 4% formalin and brought to the laboratory for detailed analysis. Observations were made with respect to the habitat, general activity and other behavioural patterns of the fish.

Growth and morphometry:

Standard, opercular and mandibular lengths, preventral and pre-pectoral distances, and the body height were measured to the nearest mm. Total, standard, opercular and

mandibular lengths are defined as the length from the tip of the beak to the largest caudal fin ray, to the end of the caudal peduncle, to the end of the operculum and to the end of the lower jaw respectively. The body height was measured as the depth of the body through pectoral fin base and the least height as the depth at caudal peduncle. The body height and iris diameter were measured to the nearest 0.5 mm (Lowe-McConnel, 1968).

In addition, the first and the last gill arches of the left side of five individuals were removed and the number of gill rakers were determined and their nature was studied. Also the distance between the gill rakers of the same arch was measured.

Alimentary tract morphology:

In the study of the alimentary tract morphology, fish below 8 cm in total length and above 8 cm were treated separately. Each fish was dissected and the alimentary canal was removed in its entirety and the lengths of stomach and gut were determined. The gut length was taken as from posterior part of the stomach to the anal pore and the stomach length was taken as from the posterior end of the oesophagus to the end of the large part of the gut. The guts were preserved in 10% formalin for further analysis. Teeth and other features of mouth were also examineed.

Food analysis:

For the studies of food and feeding habits, the stomach contents were analysed quantitatively and qualitatively. The stomach contents of each individual were analysed under a binocular microscope and the species composition of the diet was determined. The stomach contents of individuals belonging to the two size groups, i.e., below 8 cm and above 8 cm were treated separately. The total volume of gut contents was determined by the displacement method. The types of food items occurring in each stomach were identified up to generic level and their numbers were counted and percentage occurrence was estimated.

Reproduction:

The fish were cut open, the sex and gonadal condition were detrmined and the gonads were weighed to the nearest 0.001 g. When mature females were found, the ovaries were preserved in Gilson's fluid for egg diameter measurements and fecundity studies. In reproductive biology studies, the stages of the gonads were determined according to the Hjort's maturity scale (Hjort, 1910) with slight modifications. This scale is shown in Table I.

Table 1: Maturity scale for *H. gaimardi*

Stage	Testis	Ovary
Stage I (Virgin)	Minute, thread like, translucent and almost colourless. Sometimes examination is almost impossible.	Very small, narrow, colourless and translucent. Oocytes invisible to the naked eye.
Stage II (Developing Virgin)	Short, thread like, translucent and white.	Ovaries increase in size, short. Ovary wall is thick and opaque, creamy white in colour. Oocytes slightly visible to the naked eye.
Stage III (Developing)	Shorter than half of the body cavity. Thread like, opaque and creamy white.	Elongated ovary. Ovary wall is becoming thinner and translucent. Oocytes of various sizes are visible. Eggs small and spherical. Ovary is yellowish white.
Stage IV (Mature)	Occupy more than half of the body cavity. Yellowish white and opaque. Strap like.	Occupy more than half of the body cavity. Yellow in colour. Oocytes yellowish brown in colour. Mature eggs large and spherical.
Stage V. (Ripe)	Milt could be extruded easily by slight pressure on the abdominal wall.	Slight pressure on the abdominal wall extrude the eggs.
Stage VI. (Spent)	Testis baggy, blood-shot.	The sexual products have been discharged. Ovaries usually contain a few, left over eggs. Reddish in colour. Blood-shot and flat.
Stage VII. (Spent recover)	Reddish-brown colour. Empty	Very loosely packed oocytes. Ovary reddish orange in colour. Small oocytes visible to the naked eye.

Results

External features:

Figures IA and IB show the external appearance of *H. gaimardi*. Body is slender and elongate. Lower jaw is much elongated. Upper jaw is a triangular expansion. Eyes have a dorso–ventral position on the head. The eyes are relatively large in size. Gills are covered by an operculum and have long gill rakers. The origin of the dorsal fin is opposite to that of the anal fin. Pectoral and ventral fins are present. Gonadal fin is lobed. The colour of the body surface is yellowish green (Munro, 1955).

Morphometrics :

The weights of the fish varied from 3.0 g to 8.2 g. The relationships between log total length and log body weight are given in Table II. The relationships of total length with standard length, body height, mandibular length, opercular length, Pre-pectoral distance and pre-ventral distance are also given in Table II. The results expressed are for about fifty fish chosen randomly.

There is not much of a difference between the length weight relationships for males and females. Therefore they were pooled together. Table II gives the statistical relationships obtained for different parameters.

Table II: The statistical relationships of total length (T.L.) to different parameters and other relevant data for *H. gaimardi*. (Correlation co-efficient is given in brackets)

Maximum length recorded	15.0 cm (Day 1878)
Length range in sample	8.0 cm – 14.5 cm

Relationship of total length (x) to:

(a) Body weight (W)	$\text{Log } W = -1.7635 + 2.46 \log$	(0.85)
(b) Stnadard length (SL)	$SL = 0.94 \times -0.36$	(0.97)
(c) Body height (H)	$H = 0.13 \times -0.32$	(0.72)
(d) Mandibular length (ML)	$ML = 0.15 \times +0.18$	(0.58)
(e) Opercular length (OL)	$OL = 0.16 \times -0.07$	(0.86)
(f) Pre-pectoral distance (PPD)	$PPD = 0.35 \times -0.27$	(0.76)
(g) Pre-ventral distance (PVD)	$PVD = 0.59 \times -0.18$	(0.97)

No. of gill Rakers:

(1) Mean	25.0
(2) Range	22-28

Length of gill Rakers:

(1) Mean	0.88 mm
(2) Range	0.81 - 0.95 mm.

Iris Diameters:

(1) Perpendicular	0.2 cm
(2) Longitudinal	0.2 cm

Morphology of the alimentary tract:

The alimentary tract is almost a linear, undifferentiated tube and rather short. But the anterior 1/3 of the gut is stretchable to accomodate a large food mass. This portion of the intestine was designated as stomach. Both the alimentary system and reproductive system open out through the common vent.

Food and feeding habits :

One hundred and eighty fish were examined for food, out of which 168 had food items in their gut. The number of fish with empty stomachs was relatively low. The feeding intensity is maximum in the evening.

Composition of the diet:

Analysis of intestinal contents of *H. gaimardi* showed that small fish (< 8 cm) consumed primarily zooplankton while large fish (> 8 cm) consumed large quantities of zooplankton copepods, decaying fragments of higher plants, detritus and small quantities of insects. The dominant prey of small fish (juveniles) was copepods both in numbers and biomass. The algae seen in the gut appears to be accidently taken in by fish along with other food. The composition of diet of *H. Gaimardi* is given in Table III.

Organisms found in stomach were grouped into the following categories: --

(1) Decaying fragments of higher plants and detritus (Unidentified digested materials)

(2) Zooplankton (Copepods - Mainly *Phyllodiaptomus annae* and small quantities of nauplii)

(3) Small insects (Chironomid larvae. This category also consisted of dipteran adults)

(4) Ostracods

(5) Algae Filamentous green algae, mainly *Spirogyra sp.* (Probably ingested accidently with other food materials)

Table III- Composition of the diet of *H. gaimardi*

Food type	V%	O%
Copepods	35.7	88.0
Decaying fragments of higher plants and detritus	28.5	100.0
Small insects	24.3	59.0
Ostracods	11.3	3.0
Algae	0.2	0.3

V% – percentage volume.   O% – percentage occurrence.

Zooplankton showed a relatively higher percentage in the guts as compared to the other food items. The fragments of aquatic plants were also commonly seen. Decaying organic matter and unidentified food items were of consistent occurrence in the guts and remains of small insects were most frequent.

Spirogyra was the commonest alga found in the food.

Nematode parasites (larval stages) were seen both in the alimentary tract and in the reproductive system.

There is no difference between the diets of fish collected from the two regions and also between the diets of two sexes.

Relationship between mean gut length to body length :

The mean gut length was seen to have no significant relationship with the total length.

Gill rakers:

A study of gill rakers (Table II) indicates that they are rather well developed and the number of gill rakers on the upper limb of the arch is about 18. The mean distance between gill rakers was 0.5 mm.

Sex ratio and sexual dimorphism:

Out of the total number of 180 fish examined, 102 were females and 78 were males. The ratio of males to females was about 1:1 approximately. The maximum sizes of the examined fish were 12.3 cm and 14.5 cm for males and females respectively.

The two sexes can be identified externally by the swelling of the vent region near the anal fin in females. This swelling varies with the maturity stage of the female. In male, there is no swelling at the vent region. Except for this character, the males and females were very similar in external features. The sexes identified on the basis of external characters were confirmed by an internal examination. The females grow larger than the males.

Size of fish at 1st maturity:

The length at 1st maturity is the length at which 50% of the population are mature.

The length at 1st maturity were estimated to be as follows:—

> Female: 12.30 cm
> Male: 10.45 cm

Cycle of maturation and depletion of gonads :

The maturity scale of both sexes during the study period is shown in Table I. This classification, although very accurate for females, is not reliable for Stage II (developing virgin) and Stage III (developing) of males. In males, the testes at these two stages are very fine and thread like, making the identification of these stages difficult. However, if Stages II and III (developing virgin and developing) are grouped as one category (developing) this difficulty can be overcome. Female fish at Stage VI and above were not obtained. The females of Stage V were used for fecundity studies.

H. gaimardi is a serial spawner. It is evident from the figure that there are a number of modes in the frequency distribution of the egg diameters.

Fecundity:

The fecundity of fish is defined as the number of ripe eggs in the female just prior to the next spawning. The fecundity range for *H. gaimardi* is 40 to 237. The total length of the fish selected for fecundity studies ranged from 10.2 cm to 13.7 cm and their weights ranged from 4.5 g to 7.1 g.

The statistical relationships between fecundity and body weight, total length and gonad weight, which are significant at 5% level are as follows :—

Fecundity(F) with body weight(W):

$$F = 17.09 \ W + 27.23 \ (r = 0.49)$$

Fecundity(F) with total length(L):

$$F = 24.50 \ L - 166.68 \ (r = 0.51)$$

Fecundity(F) with gonad weight(GW):

$$F = 34.78 \ GW + 49.30 \ (r = 0.54)$$

Summary of the data on the reproductive biology of *H. gaimardi* is given in Table IV.

Table IV: Summary of reproductive biology of *H. gaimardi*.

No. of fish examined	180
% Females	57
Size at 1st maturity of females	12.3 cm
Maximum size	14 cm
Size at 1st maturity as a % of maximum size	85.0
Fecundity	40 – 237 eggs

Table V shows the average values for fecundity, relative fecundity and weights of ovary of various length ranges.

Table V: The length range and mean values for total length and weight of fish used for fecundity studies and the average values for weight of ovary, fecundity, relative fecundity and number of or a per unit weight of ovary.

Length range (cm)	Average length (cm)	Average weight (gm)	Average weight of ovary (g)	Average Fecundity	No. of ova/g weight of body	No. of ova/g weight of ovary
10.0 – 10.4	10.2	3.3	0.11	60.0	18.1	544.4
10.5 – 10.9	10.7	3.9	0.13	82.3	21.1	633.3
11.0 – 11.4	11.2	4.3	0.14	128.0	30.0	914.0
11.5 – 11.9	11.7	4.6	0.15	110.0	24.0	733.3
12.0 – 12.4	12.2	5.8	0.18	153.0	26.4	850.0
12.5 – 12.9	12.7	6.5	0.25	108.0	16.6	432.0
13.0 – 13.4	13.2	6.8	0.21	175.0	26.0	833.3

122

Discussion

Observations in the field have shown that these fish generally inhabit shallow waters where there is aquatic vegetation. They appear to be usually accompanied by their fry. Feeding appears to take place in the evening.

Although these fish were collected from two reservoirs at Hambantota and Anuradhapura, observations indicate that they are now spreading very fast into most of the larger man made reservoirs in the dry zone and have been collected from water bodies upto about 150 m above sea level where the water temperature vary from 26°C to 33°C.

In the present study, the maximum length recorded was 14.5 cm. This tallies approximately with the recorded maximum length for *H. gaimardi* (Day, 1878).

The relationship between total length and body weight showed a curvilinear relationship. Statistical analysis shows that the relationship of total length with standard length, opercular length, body length, mandibular length are significant at 5% level.

The maximum sizes of examined fish were 11.4 cm and 14.5 cm for males and females respectively. Females may have a higher growth rate than males.

The major food items of all fish are copepods, decaying higher plant materials, detritus and small insects. Higher plant materials may come from aquatic weeds. The algae seen in the gut seem to be accidently taken in by the fish along with other food.

The alimentary tract of *H. gaimardi* is short. The intestine is so short that it occupies less than 2/3 of the gut length. The rather well developed gill rakers may indicate that the filter feeding habitat is important in these fish.

Results indicate that the size of the fish at first maturity are 10.45 cm and 12.30 cm for males and females respectively. This shows that the two sexes mature at different lengths. Females appear to mature later than the males. This may be for the laying of more eggs.

The sex ratio of this species is 1:1 approximately. Nikolsky (1965) showed that this sort of sex ratio is due to a lack of difference in the longevity of the sexes. *H. gaimardi* does not show a sexual dimorphism in colour.

H. gaimardi was found to be a serial spawner. Mature fish and fry were present in all the samples collected indicating that these populations of fish spawn continuously throughout the year.

The fecundity ranges from 40 to 237 eggs. The accompanying length and weight ranges are 10.2 – 13.7 cm and 4.5 – 7.1 g respectively. This shows that their fecundity is relatively low compared with other species. This may be the reason for the scarcity and

low population density of the species. Fecundity shows a linear relationship with both weight and length indicating that fecundity increases with both weight and length. Davis (1977) recorded similar instances for plaice, *Pleuronectus platessa* and fresh-water cat fish, *Tandanus tandanus*. The results also showed that the egg size increased with the body weight and length.

References

Davis, T.L.O. 1977. Reproductive biology of the freshwater cat-fish *Tandanus tandanus*. *Aus. J. Mar. Freshwater Res.* 28: 159-169.

Day, F.L.S. 1878. *Fishes of India; A Natural History of the Fishes Known to Inhabit the Seas and Freshwaters of India, Burma and Ceylon*. London., 2 volumes, 778 p.

Hjort, J. 1910. Report on herring investigations. *Scot. Fish. Bull.*, 12: 111-131.

Lowe McConnel, L.H. 1968. Identification of freshwater fishes. In W.E. Ricker (Ed). *Methods of Assessment of Fish Production in Freshwaters*. IBP Handbook No. 3. Blackwell Scientific Publications, Oxford.

Nikolsky, G.V. 1965. *Theory of Fish Population Dynamics for Rational Exploitation and Management of Fishery Resources*. Oliver and Boyd Edinburg, 323p.

Munro, I.S.E. 1955. *The Marine and Freshwater Fishes of Ceylon*. Dept. Ext. affairs, Canberra, p. 350.