Age-Growth, Length-Weight and Condition Factor of a Hill Stream Fish, *Garra Lamta* (Hamilton-Buchanan) of Kumaun Himalaya.

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Abstract: The age and growth of a hill stream fish, *Garra lamta* was determined by scales in the present study. One to four years classes of the fish were obtained from Petsal and Sironia garh, tributaries of Suyal river of Kumaun Himalaya. The average radius of one year scale 962.36microns, two year scale 1412.20microns, three year scale 18.38.82microns and four year scale 2767.43microns were enumerated. The first year fish has attained 5.1cm, second year 6.5cm, three year 9.1cm and 12.5cm.. Straight line relationship between total length and body weight (W = 2.5154L - 13.092 where r = 0.9213) of the fish has been established. The condition factor fluctuates month wise and season wise among both the sexes and different age groups.
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Key word: Garra lamta, Age and growth, length weight, condition factor, hill stream fish.

Introduction:

As of great biological interest, many methods of age determination in fresh water fishes are known (Das, 1959). Interpretations of annulus formation laid down on hard parts such as scales of the fish have been obtained in the study. The analyses were dependent on changes in the rate of growth or metabolism during certain periods of the year as evidenced in the hard parts (Nikolsky, 1964). Accuracy in determining the age is dependent upon the ability to intercept these layers correctly. Clarity of the layers laid down on hard parts of the fishes vary with species and structure (Rounsefell and Everhart, 1953). Accurate age determination is important in life history studies and modelling of fish populations and many provide length-at-age and age structure information that is fundamental to the management of fish population. A remarkable study on age and growth of other cold water fish was contributed by Pathani and Joshi, 2006, Joshi, 2005 and Pathani and Rautela, 2003, Uniyal *et al.*, 2003, Thapliyal *et al.*, 2002 and Pathani, 1979, 1981 and 1987 in Kumaun and Garhwal Himalaya. The great importance of the determination of the age of fishes in the solution of biological problems of fisheries has led to the accumulation of a large amount of information and there are many recent investigations on age and length-weight relationship (condition factor) as an aspect of fishery biology (Shendge, 2008, Annappaswamy *et al.,* 2007, Chakrawarti, 2006, Mohan, 2006, LaBay and Lauer, 2006, Kumar *et al.,* 2006 and Thapliyal *et al.,* 2002. But there is no information on the age and growth of *Garra lamta*.

Materials and Methods:

Fish specimens were collected from the field as regular monthly task during the period October 2006 to September 2008 from the Petsal garh (elevation 1230msl), and Sironiya garh (elevation 1170msl), tributaries of Suyal river. The freshly living fish specimens were carried to the zoological laboratory of Kumaun University, Soban Singh Jeena Campus, Almora for recoding the different data. Age determination of fish in the present study was made by scale for the said period of two years.

Scale method:

The scales were collected from and area between the dorsal fin and the lateral line. Freshly pulled scales (key scales) from the fish body were washed in water two to three times and rubbed between thumb and fore finger to remove the mucus and chromatophores and then dried till required. Clean scales were then placed in 10% formalin for ten minutes and then dried till required for examination. These scales were preserved in a separate envelop for each fish bearing the data such as total length, weight of fish, sex, month of collection etc. required for further examination and preparation of data of the fish concerned. Usually 10-15 scales were soaked in water for five to ten minutes and place the scales between glass slides for examination through a binocular microscope (Nikon SMZ-U Zoom 100 and Nikon Eclipse 80i). Then the best scale were studied for annuli, circuli, radius and false rings. The actual age of the fish was determined by identifying annuli according to Das, 1959) and Pathani, 1987 and 1981.

Back calculation

The back calculation of the fish length by scale was determined by applying the Lea's formula:

$$l_n = \left(\frac{S_n}{S}\right) X (l)$$

Where,

l_n= Length of the fish when annulus 'n' was formed; l = Length of fish when scale sample was obtained; S_n= Radius of annulus 'n' (at fish length l_n); S= Total scale radius.

Relationship between fish length, scale radius were also studies by using the regression formula:

$$L = a + b X S$$

Where,

L = Total length of the fish; S = Radius of scale and operculum from center in (microns); 'a' and 'b' are the constants.

Length-weight relationship

The relationship between fish length and body weight was obtained by plotting a graph between two variables and the relationship was estimated with the help of least square method as follows:

$$W = a + bL$$

Where

W= weight of fish in grams; L = fish length in centimeter; 'a' and 'b' are the constants.

Condition factor

Monthyl condition factor (K-factor) was calculated by standard formula applied by Le cren, 1951.

$$K = \frac{W \times 10^5}{L^3}$$

Where,

K= Condition factor; W= Weight of fish in gm; L= Total length of fish in cm.

Result:

In the present investigation only one to four years classes of *Garra lamta* were obtained from the Petsal and Sironia garh, tributaries of Suyal river of Kumaun Himalaya (higher age groups were hardly available). The pattern of different age of hill stream fish by scale is studied as follows:

One Year: The scales were clearly showed the circulli around the centre (nucleus). The circulli were most prominent in the anterior region of the scales. Therefore, the main observations for annuli were made in the area. The posterior region of the scale also showed some annuli which were used to avoid errors in age assessment. A wider band of circulli constitutes the summer ring in the scale. These winter and summer rings together form one year's growth of the scales. The average radius of one-year scale was 962.36microns. The total length of various fishes ranged from 4.7cm to 5.6cm in total length and the scale has one annulus with many circular rings (Table 2), therefore, the age is 1 to 1++ year. The average total length of fish was 5.1cm (Fig.1.1).

Two Years: The average scale radius was 1412.20microns. The total length of various fishes ranges from 5.8cm to 7.4cm and the scale has two annulus with many circular rings therefore the age is 2 to 2++ years (Fig. 1.2). The average total length of the fish was 6.5cm in the study. In the second year scale the end of the first year's growth appeared as a clear streak in antero-lateral part of the scale. This may be due to cessation of food intake in the last rings due to feeding fluctuations by the fish (Fig. 1.2). The false rings may be avoided after continuous observations on a number of scales from the same fish (Table 2).

Three Years: The annuli are seen as three marks with some streaks or crossing over of circulli. False streaks are also present due to wintering in the last ring because fish matures only after 3years of age. False rings unlike the seasonal feeding fluctuation streaks (Fig. 1.3). In the three year fish the average scale radius was 1838.82microns. The total length of various fishes ranges from 7.7cm to 11.2cm and the scale has three annulus with many circular rings therefore the age is 3 to 3++ years. The average total length of fish was 9.1cm (Table 2).

Four Years: Here also four dark narrow winter rings followed by wide summer rings marking each year were observed in the scale of *Garra lamta* (Fig.1.4). False rings or streaks and cutting over of circulli due to feeding fluctuations were also seen. There are four annuli and thus the fish is four years old. The average scale radius was 2767.43microns. The total length of various fishes ranges from12.0cm to 13.0cm and the scale has four annulus with many circular rings therefore, the age is 4 to 4++ years of *Garra lamta*. The average total length of the fish was 12.5cm (Table 2).

Back calculation: Back calculation by using only scale annuli or scale radius from nucleus to the tip of the anterior margin has been used for back calculation in the present study. By establishing a formula for relationship between scale radii and fish length, the older fish scale, it can be used to determine the length at any year class from the scale alone. Back calculations were also done by standard formula y= 0.0031x + 2.852, (where y= Total length of the fish and x is the radii of scales at particular age group). The calculated length for each year class was found to be almost similar except in lower length group of scales this could be fast growth of the fish

and due to vary small size of scales with the observed length (Table 2 and Fig. 2).

Relationship between fish length and scale radius: The total length of the fish of *Garra lamta* has been ranged from 4.7 to 13.0cm and having scale radius from 699.51microns to 3284.92microns. The length of the fish (y) is plotted against the scale radii (x) in Fig. 2 and Table 2. It shows that the total length of fish is directly correlated with the scale radii, as the length of the fish increase with the increase of scale radii also in the study. This shows a linear relationship between these two variables and the relationship can be expressed as:

$y = 0.0031x + 2.852$,

$r = 0.9413819$

The coefficient of correlation ($r = 0.9413819$) shows a strong positive correlation between total fish length and scale radius. The observed and calculated fish length are also obtained in the study (Fig. 3).

Length-weight relationship: Some 240 specimens of *Garra lamta* (sex are not significant) ranging from 4.7cm to 13.0cm and weight varied from 1.9gm to 23.6gm have been made in the study. A straight line relationship has been observed between fish length and weight of *Garra lamta* in the study as follows:

$W = 2.5154L - 13.092$

$R^2 = 0.8488$; $r = 0.9213$

Where, $a = -13.092$, $b = 2.5154$ are constants.

The value of correlation coefficient $r = 0.9213$ shows a strong correlation between fish length and fish weight and vice-versa, respectively (Fig. 4). The formula is suitable to calculate length and weight of fish when either length or weight of fish is known in the study.

Monthly condition factor (K-value): The monthly variations of K -values in male and female of *Garra lamta* during October 2006 to September 2008 have been obtained (Table 3 and Fig. 5). The fluctuation showed almost similar trends in both the sexes of *Garra lamta* in the study. In female K fluctuated between 0.99 (March, 2008) to 1.71 (November 2006) as the minimum and the maximum value and in male it was 0.96 (March 2007) to 1.52 (December 2006). The minimum K value has been recorded in February (1.03) and maximum in November (1.71) in female and it was found to be minimum in male in March (0.96) and maximum in December (1.52) during first year (Table 3 and Fig. 5). Second year data reveals that there are slight fluctuations (Table 3 and Fig. 5). It was minimum in March (0.99) and maximum in November (1.64) in female and in male there was no sharp fall and peak yet it was minimum in August (1.13) and maximum in September (1.36). The monthly average value of condition factor was high during prespawning (winter) then fall considerably during summer and again rise during postspawning in both the sexes during both the years (Fig. 5).

Condition factor in different size group: The condition factor of different size groups have been plotted separately for male and female fish and have shown in Fig. 6. It showed that K remain almost high in female and stable in male size group 4.6 – 5.0 cm and 7.1 -7.5cm and it was similar in male except some range in which no records are available. The condition factor was high in small fish and decrease with increasing fish size of *Garra lamta* in the study during 2006-08. It indicate that the high growth in younger fish than the old/adult fish in the study (Table 4).

Table 1. Age determination of *Garra lamta* by scale

Total length range (cm)	Average length (cm)	Age in Years (by scale)
4.7-5.6	5.1	$1\text{-}1^{++}$
5.8-7.4	6.5	$2\text{-}2^{++}$
7.7-11.2	9.08	$3\text{-}3^{++}$
12.0-13.0	12.53	$4\text{-}4^{++}$

Table 2. Back calculation by scale in *Garra lamta.*

Age of fish (years)	Observed total length of the fish (cm)		Calculated total length of the fish (cm)	
	Range	Average	Range	Average
$1\text{-}1^{++}$	4.7-5.6	5.1	5.02-6.07	5.61
$2\text{-}2^{++}$	5.8-7.4	6.5	6.13-7.98	7.00
$3\text{-}3^{++}$	7.7-11.2	9.1	7.46-12.02	8.95
$4\text{-}4^{++}$	12.0-13.0	12.5	12.80-13.03	12.92

Table 3. Month wise variation in condition factor of *Garra lamta* during October 2006- September 08.

S. N.	Month \Sex	2006-07		2007-08.	
		Female	Male	Female	Male
1	Oct	1.29	1.28	1.39	1.17
2	Nov	1.71	1.45	1.64	1.28
3	Dec	1.25	1.52	1.35	1.17
4	Jan	1.43	1.40	1.15	1.25
5	Feb	1.03	1.06	1.06	1.20
6	Mar	1.05	0.96	0.99	1.24
7	Apr	1.33	1.01	1.30	1.27
8	May	1.36	1.34	1.22	1.26
9	Jun	1.17	1.13	1.21	1.17
10	Jul	1.26	1.18	1.13	1.23
11	Aug	1.16	1.06	1.22	1.13
12	Sep	1.37	1.35	1.22	1.35
Mean/average		**1.28**	**1.23**	**1.24**	**1.23**

Table 4. Condition factor 'K' values in different size group of *Garra lamta* for two years 2006-08.

Length group (cm)	Mean value of 'K' factor	
	Female	Male
4.6-5.0	2.204094	1.542021
5.1-5.5	-	1.062706
5.6-6.0	1.363333	1.310091
6.1-6.5	1.127615	1.192852
6.6-7.0	1.193753	1.153588
7.1-7.5	1.925827	1.127169
7.6-8.0	1.194111	1.215689
8.1-8.5	1.213334	1.285405
8.6-9.0	1.214795	1.287134
9.1-9.5	1.311206	1.208136
9.6-10.0	1.148739	1.172906
10.1-10.5	1.212267	1.244508
10.6-11.0	1.197648	-
11.1-11.5	1.342955	1.103259
11.6-12.0	1.365741	-
12.1-12.6	1.124789	-
12.6-13.0	1.028675	-

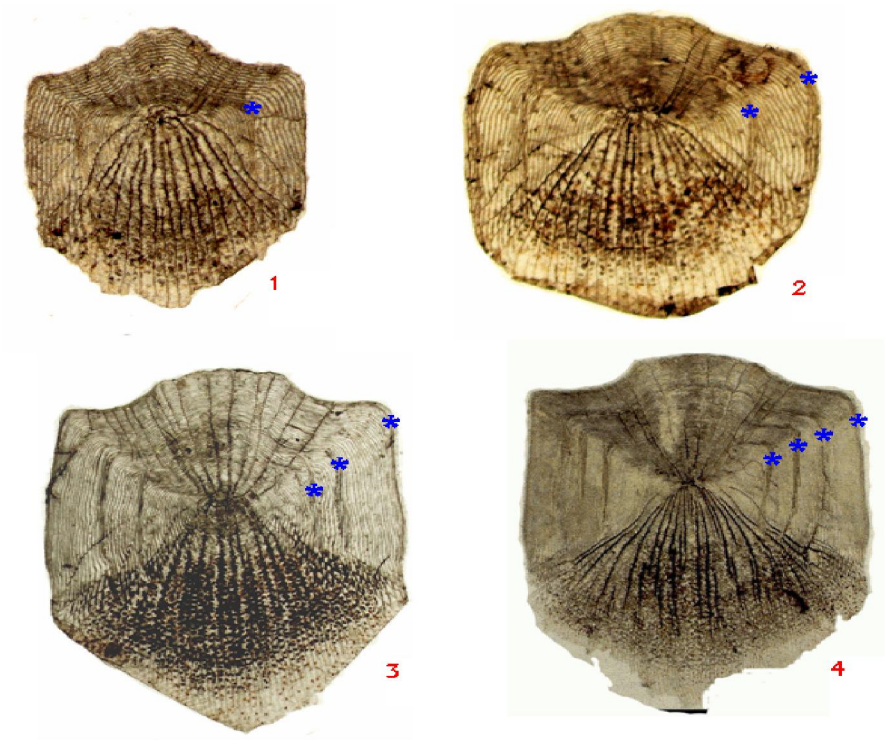

Figure 1. Different year of fish scale viz. 1.1 one year, 1.2 two year, 1.3 three year and 1.4 four years

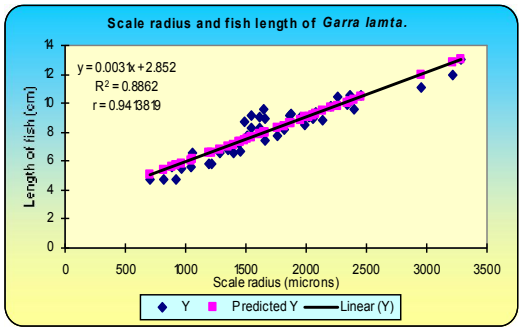

Figure 2. Relationship between scale radius and fish length and calculated fish length.

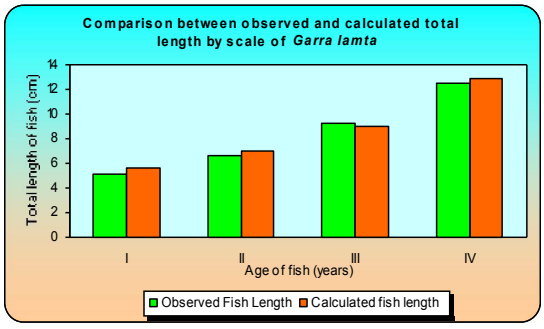

Figure 3. Comparison between observed and calculated total length by scale.

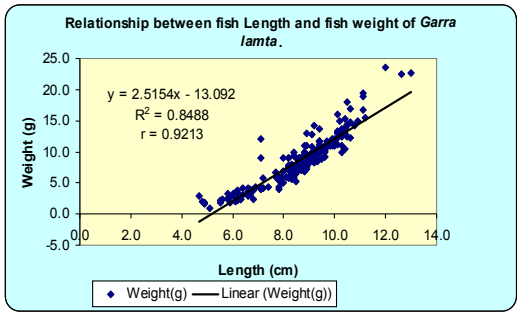

Figure 4 Relationship between fish length and fish weight of *Garra lamta.*

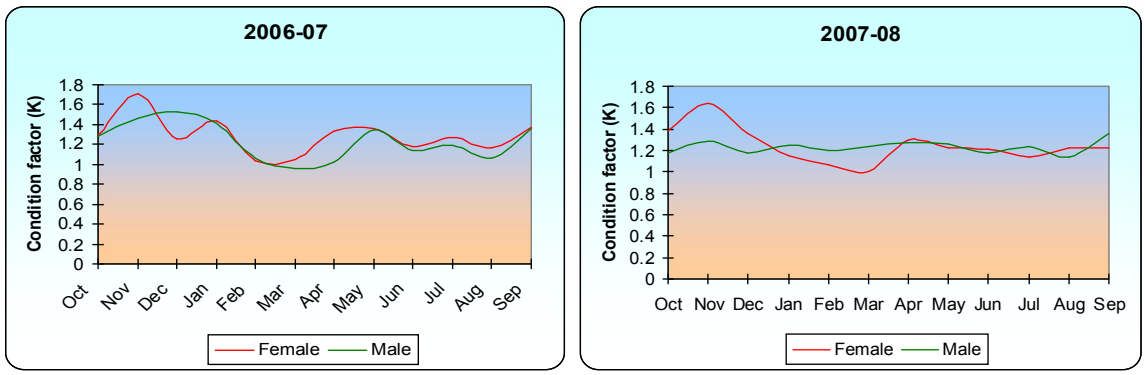

Figure 5. Monthly variations in condition factor of female and male *Garra lamta* during 2006-08.

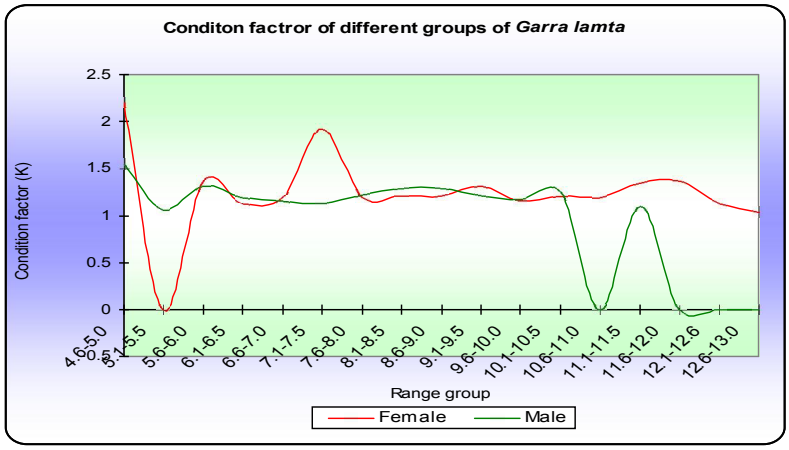

Figure 6. Fluctuations in condition factor of different size group of *Garra lamta* during 2006-08.

Discussion:

The formation of annual checks in the scale has been attributed to various factors such as seasonal temperature, wet and dry seasons, feeding and reproductive cycles (Beckman and Wilson, 1995). A careful examination of scales of *Garra lamta* revealed alternating transparent and opaque growth zone. One opaque and transparent zone together was taken to indicate one year's growth. Deviation in age patterns may results from false annuli on the scale. These annuli tend to be discontinuous, weak and inconsistent with general growth pattern of true ones in the scale of *Garra lamta*. They mostly occur at younger ages in the fish due to feeding fluctuations. Van Oosten, 1929 confirmed that there is a correlation between age and annuli in the scales which increases as the fish grows older. This relationship of annulus of scale and fish length has been applied to *Garra lamta* in the present study. Das, 1959 was the first to demonstrate the feasibility of age determination by scales in tropical and temperate fishes of India. Similarly age determination by scale has been made successfully in the present study.

The annuli are formed mostly in the summer season (April to June) in the study, which is the spawning season of hill stream teleost, *Garra lamta*. Low feeding has been observed during the period. A streak or crossing over of circulli formation takes place which is evidenced in the scale of *Garra lamta* collected during the season i.e. April to June. False rings were also observed in some mature fishes during early winter when also the feeding intensity is low and fish were observe to be low active in the water it may be attributed to sudden environmental changes, fluctuation in temperature, scarcity of food in the season and some metabolic change after spawning as also reported by Pathani and Joshi, 2006, Pathani and Rautela, 2003 and Pathani, 1981 and 1987). Pathani, 1979, 1981 in *Tor tor* and *Tor putitora* attributed annual marks in the scales to low feeding and low temperature. Similarly Malik *et al.,* 2003 observed single annuals in Golden mahaseer of Ganga river with

false spawning rings in the scale due to low feeding rate in spawning and winter months similar to present fish, *Garra lamta*.

The present study indicated the presence of fish in four age groups in the population namely 1, 2, 3 and 4 years groups based on annuli laid down in the scales of the fish. The mean length for the age groups 1^+, 2^+, 3^+ and 4^+ years was 5.1, 6.5, 9.1 and 12.5cm, in total length respectively. Joshi, 2005 reported the mean length of hill stream fish, *Botia almorhae* as 104.30, 122.20, 143.10 and 159.20mm at one to four year groups, respectively. Shamsan, 2008 reported one to four years aged fish, *Sillago sihama* as 88, 130.9, 168.3 and 199.8 mm, respectively. Pathani, 1981 reported mean length of *Tor putitora* from one to five years aged groups as 126, 237.4, 338.5, 422 and 499mm in total length in Kumaun waters. However, present study suggests the longevity of *Garra lamta* upto four years old with certain length in Petsal and Sironia garh of Suyal river of Kumaun Himalaya.

The relationship between fish length and scale radius was also studied in the present study. It exhibits a straight line relationship in *Garra lamta* with high degree of correlation factor (r = 0.9413819). Recently similar relationship also reported by Joshi, 2005 and Pathani, 1981. The length and weight relationship of the *Garra lamta* shows a straight line relationship (r = 0.9213) in the present study. The relationship indicates that increase in one character leads directly increase in the other. Similar observation also reported by Pathani *et al*., 2008. The present study has shown that the fish attains maturity at 8.2cm in total length (Fig. 4). Gaur and Pathani, 2003 and Joshi, 2005 recorded significant correlation between length-weight and the derived regression coefficient was obtained as b= 2.5154 which indicates no isometric growth in *Garra lamta* in the study (b = 3). The value of regression coefficient was approximately 3 in *Puntius sophore* reported by Shendge, 2008 and others by Chakrawarti, 2006 and Kumar *et al.,* 2006. But Thapliyal *et al*., 2002 has recorded very high value of b in *Pseudecheneis sulcatus* of Garhwal Himalaya.

In *Garra lamta* the values of condition factor were observed to decrease with increase in fish length. The increase and decrease in K-values with the increasing length is attributed to metabolic strain of spawning of the fish. Similar report have also been made by Pathani and Rautela, 2003, Gaur and Pathani, 2003 and Uniyal *et al.,* 2003. The fish *Garra lamta* of Kumaun lotic waters is observed to be mature after attaining 8.2cm in total length. Condition factor is therefore, observed to vary with the size of the fishes in the present study (Table 3, 4 and Fig. 5, 6). Monthly and seasonal fluctuations in condition factor of *Garra lamta* have been obtained as also reported by others cited above. Recently Shendge, 2008 reported reasons for the fluctuation in condition factor could be attributed to both the spawning and feeding intensity in *Puntius sophore;* Annappaswamy *et al.,* 2007, Mohan, 2006 and Thapliyal *et al.,* 2002 obtained high 'K' value. The monthly fluctuation in condition factor has also been obtained with relation to gastro and gonado-somatic index when the gastro and gomado-somatic index was low in the fish the condition factor found to be high. The condition factor varies not only monthly and seasonally but also sex-wise manner in the fish *Garra lamta* as also reported by others (Joshi, 2005).

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