STUDY OF THE LENGTH FREQUENCY DISTRIBUTION OF SUCKER HEAD, *Garra gotyla gotyla* (Gray, 1830) IN DIFFERENT RIVERS AND SEASONS IN NEPAL AND ITS APPLICATIONS

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ABSTRACT
Size structure data particularly that of length frequency distribution is very important fisheries management tool. This is also applied to assess the health, habitat and integrity of the rivers. Nepal is tremendously rich in both fisheries and water resource and thus, this analysis is very important. However, this kind of analysis is not common in fisheries studies and hence the size structure information of all the fish in Nepal is wanting. This study simply tries to open the door for such studies with the study of the sucker head *Garra gotyla gotyla*, a very common fish in Nepal. The field observation was done in nine rivers of the country in all the seasons of the 2003 by using electrofishing gear. The length frequency distribution of the river was found to vary both spatially and temporally among rivers and seasons respectively indicating different conditions in different rivers. The study suggested that the beginning of the breeding season should be immediately before monsoon. The rivers Aandhikhola and Tinau were found to possess some of the best distributions of length frequencies of this species and hence have a better habitat conditions and water quality.

Keywords: *Garra gotyla gotyla;* size structure; length frequency; electrofishing; habitat condition; Nepal.

INTRODUCTION
Length and weight data are useful and standard information of fish sampling programs (Morato *et al.* 2001). Such data are essential for a wide number of studies, for example estimating growth rates, age structure and other aspects of fish population dynamics. Study of the size structure (length frequency) in riverine fish reveals many ecological and life-history traits such as the river health, stock conditions and breeding period of the fish. The size structure of a fish population at any point in time can be considered a 'snapshot' that reflects the interactions of the dynamic rates of recruitment, growth and mortality (Neumann 2001).

From length frequency distributions of fish there are methods to determine the ages (Bagenal and Tesch 1978), which together with the weight and abundance (catch per unit effort, CPUE) give details of the different disturbance regime of the rivers, breeding ground and breeding seasons, the general health of the stock, density and the status of the species. Therefore, the size structure analysis is one of the most commonly used fisheries assessment tools.

Although size structure analysis is a standard and regular method to evaluate the conditions of both rivers and stocks in developed countries of North America and Europe, it has just started in the developing countries. Nepal, with a huge amount of water resource, has a

tremendous potential for fisheries development. A total of 182 species belonging to 93 genera under 31 families and 11 orders has been reported from Nepal (Shrestha 2001). Some information on ecological and population characteristics of the fish, such as region and altitude of occurrence, habitat preference, temperature range, maximum length, feeding habit, life history and a crude status of many of the fish species are available. However, the size structure analysis, which is so important in fisheries management is clearly lacking in the Nepalese fish species. This could be the first work of its kind in Nepal.

This paper presents and analyzes the length frequency distribution of sucker head *Garra gotyla gotyla* (Gray 1830), a widely distributed and important fish species of the region (picture1). This fish, commonly called as Buduna in Nepal, has been listed by Gray (1832), Day (1889), Prashad (1912), Hora (1921), Taft (1955), DeWitt (1960), Menon (1962), Ganguly and Dutta (1973), Shrestha (1978), Rajbanshi (1982), Rahman (1989), Shrestha (1990), Talwar and Jhingran (1991), Shrestha (1994) and Shrestha (2001) under the same name or different synonyms. It is reported from Afghanistan, Pakistan, India, Nepal, Bangladesh, Bhutan and Burma. In Nepal the species has been reported from up to 1560 masl (meter above sea level) with maximum size of 150 mm. It has been included as coldwater fish of Nepal by Shrestha (1999) and Swar (2001). It is not included in IUCN red list and reported as 'fairly common' in the country. The present work finds it in all the rivers studied except river Bagmati and is perhaps one of the most common species. It is a harmless fish feeding on algae, plants and detritus (fishbase.org).

The importance of the fish is commercially minor according to Talwar and Jhingran (1991). However, due to high value as a food fish as well as its distribution, this species has a potential to become important protein source to the poverty-ridden population of Nepal. But there is hardly any method developed to assess the population dynamic of neither the species nor any example of using it as an indicator for the impact of various disturbances. In Nepalese context, even a basic work regarding size structure description and distribution is of great value for reference as well as for comparison for future studies.

The main objectives of this work are (1) to describe the length frequency distribution of the species in the selected river, and to analyze if there are any spatial differences, (2) to describe the length frequency distribution of the species in 4 seasons, and to analyze if there are any temporal differences, and (3) to evaluate and interpret the river conditions, fish health and some life history traits based on length frequency distribution.

MATERIAL AND METHOD

STUDY AREA:

Altogether nine rivers from central and western region of Nepal were studied for a Ph.D. work and this paper is a side result of that work. The selection of site was done with main objective of including rivers and streams that are perfect representatives of the disturbances from dams and weirs, agriculture, industry and urbanization. However, there are other factors too, which were considered, such as, similarity in origin of the river, accessibility etc.

Accordingly the rivers selected were, Aandhikhola, Arungkhola, Bagmati, Jhikhukhola, Karrakhola, Narayani, East Rapti, Seti and Tinau. Except for Narayani and Seti rivers, which were included due to popular demand, all other rivers originate from midhills. The six rivers, Aandhikhola, Arungkhola, Karrakhola, Narayani, East Rapti and Seti are the members of Gandaki River system, Jhikhukhola is a tributary of Koshi River System, and Tinau and Bagmati are independent systems (Sharma 1977). Among these all the rivers except Narayani

are wadeable rivers at least in the seasons other than monsoon. There were 23 sampling sites covering those nine rivers. The table 1 highlights the characteristics of all the sampling sites.

Fish sampling was done using electro fishing gear and this could be the first application of electro fishing gear for fish sampling in Nepal, as there are no previous records. The method followed here was a simple but standard wading type with a person carrying a backpack electro-fishing unit. He was assisted by two persons each carrying a long dip nets to collect the shocked fish and a third person carrying a bucket to empty the nets. For the safety, a long wading boots insulated all the persons involved in fishing.

In each site, the fish sampling was done in two runs, 1 and 2 respectively. The stretch of the each sampling site was mostly between 50 to 100 meters. The time span for each run were taken separately as it is a important factor to calculate the catch per unit effort (CPUE) which in turn is important tool to see other population dynamics of the fish. The time for each run were tried to be fixed around 20 minutes and was never less than 30 minutes for the total of run 1 and 2 in any of the sample in all seasons. Consistent sampling design for each site in each season was applied to avoid biased results.

The first set of field sampling of this study in selected river sections of Nepal began on the third week of February 2003 on the onset of spring season. Prior to that selection of appropriate sampling sites and testing of some of the equipments were carried out since October 2002. After the first real sampling, replicate of it were taken corresponding to all major seasons, summer or premonsoon, autumn or postmonsoon and winter. Finally four sets of data representing each season, spring, summer/premonsoon, autumn/postmonsoon and winter were collected spanning until the beginning of 2004.

With 23 sites (table 1) and four replicate of these, there are altogether 92 samplings that constitute this work. The total lengths of all fishes were measured up to the last 5 mm with the help of a specially constructed simple mechanical devise. The measuring range of this tool was 0 – 1000 mm. Several weights were also measured for each length group with a portable device starting with the reading of minimum of 2 gm and with the interval of 1 gm thereafter. A portable GPS device also measured latitude, longitude and altitude of the sites.

RESULTS AND DISCUSSION

Out of nine river sampled in this study, the species *Garra gotyla gotyla* was recorded from all except Bagmati river at Sundarijal in Kathmandu. There were altogether 4567 numbers of the species captured from eight of the remaining rivers from all seasons. The total length of the species varied from minimum of 20 mm to the maximum of 180 mm, and there were all the length groups in between. The length of 180 mm of the species is perhaps the new record. The mean length of the fish species in each case is rounded to a whole number while describing. The result of the length frequency distribution in each river, that is the spatial variation of length frequency, is shown in the figures 1-8.

Aandhikhola: This river has one of the best length frequency distribution (figure 1). Altogether 711 number of the species were captured in all season in this river with minimum total length of 30 mm and the maximum of 180 mm. Looking at the length frequency distribution in this river, it can be said that it holds a very healthy population of the species. There were sizable numbers of the species with the length 50 mm and under, while the largest numbers were with the length category of 80 to 100 mm, the size already capable of breeding. There were also abundant of the species with length category 105 – 150 mm indicating the

favorable habitat condition for the mature adults. In addition, the presence of the species even longer than that and up to 180 mm just indicates the river provides the optimum suitable conditions for all the stages in the life cycle of the species. The mean length of the species in this river was found to be 85 mm, highest of the entire river studied.

Arungkhola: Total number of this species caught in Arungkhola was 458 with minimum total length of 20 mm to the maximum of 115 mm from all seasons (figure 2). The length frequency distribution of the species in this river showed a different picture than that of Aandhikhola. In this river too, there were abundant of number of the length category 20 – 50 mm, suggesting that it provides a good spawning ground for the species. However, the peak of the number was in the length category 55 – 80 mm, which is less than before. There were some number with the length category of 85 – 115 mm, but longer than that were absolutely missing. The mean length of the species was also clearly less than before at 58 mm.

Jhikhukhola**:** Total number of this species captured in Jhikhukhola was 214 with the minimum total length of 30 mm to the maximum of 120 mm (figure 3). There were few numbers of the fish with less than 50 mm of total length suggesting the decline of the breeding ground. However, there were large numbers of this fish in the length category of 50 – 90 mm suggesting a similar situation as in Arungkhola. There were some numbers of the fish of total length category 95 mm up to 120, which is also similar to Arungkhola. The large matured fishes were missing here too, though the mean total length of the species was little higher than before at 68 mm.

Karrakhola: The number of this species caught in Karrakhola was 172. Among the captured, the minimum total length was 20 mm and the maximum was 120 mm (figure 4). The highest numbers of fish in this river were of the length category 20 – 50 mm indicating the condition of breeding ground to be normal. There were slump of numbers of the length categories between 55 –100 mm. There were very few numbers of the length categories 105 –120 mm and after that all large adult fishes were missing. The mean total length of the species here was 53 mm.

Narayani: It is one of the biggest rivers of Nepal, but the total number of the sucker head captured in this river was moderate at 415 (figure 5). The total length of the species in this river varied from 40 mm minimum to the maximum of 175 mm. The distribution of length frequency of the species here gives a very different picture. The total length category, 50 mm or less of this species was almost missing in this river indicating that it is not suitable for spawning. However, there were abundant of length categories from 55 mm to 100 mm suggesting a suitable habitat for fresh adults. There were also many fishes of length group 105 mm – 150 mm and a few even up to 175 mm suggesting that the conditions are suitable for very large adults. The mean of the total length was also relatively higher at 81 mm.

East Rapti: The total number of this fish species caught here were 636. Among the captured, the minimum total length was 30 mm whereas the maximum was 140 mm (figure 6). Compare to Narayani,

There was more number of fish with length categories less than 50 mm indicating good conditions for the fries. However, the bulk of the number of this fish here was made up of the length categories between 50 mm to 95 mm. There were relatively few numbers of the fish higher than those length categories, but available length group was moderately longer up to 140 mm. The mean of the total length of the species in this river was 67 mm.

Seti: The lowest numbers of this species were caught from Seti River. Out of 84 number of sucker head captured from here, the minimum total length of the fish was 40 mm and the maximum was 130 mm (figure 7). There were very few numbers of lesser length categories and also many of these categories missing. It indicates that the conditions for spawning are not favorable. However, there were steady numbers of them in the categories from 55 mm to 100 mm suggesting that the conditions are not so bad for fresh adults. There were some fishes longer than those categories up to 130 mm, but some groups were missing indicating the population may not be healthy. Nevertheless, the mean total length of the species in this river stands at 74 mm.

Tinau: In terms of abundance as well as the distribution of length frequency, the population of sucker heads was the healthiest in this river. The total number of the fish accounted here were 1877 with a very unpleasant situation during premonsoon when a massive poisoning of the river was reported just a few days before the sampling. The total length of the species varied from minimum of 20 mm to the maximum of 145 mm (figure 8). There were a good number of the fish of the length categories 20 mm to 50 mm suggesting good conditions for spawning and initial growth. The majority of the population was composed of the length categories 55 mm to 100 mm indicating a right habitat conditions for the growth and maturation of the species. The numbers of fish more than 100 mm in total length were few but there were a presence of continuous length categories up to 145 mm. The mean of total length of the population of sucker heads in Tinau River was found to be 62 mm.

The length frequencies of the sucker head were also found to vary in temporal basis. There are different pictures and the mean total length of the species in the four seasons, when they were sampled. The temporal variation of the length frequency normally gives insight to the attributes such as the time of spawning, migration if any, and the growth status of the stock. Here are the findings of all year around divided into four seasons in a clockwise series.

Spring: The total number of sucker head captured in this season was 1326 with the total length varying from 30 mm to 180 mm (figure 9). The absence of the fish of 20 mm length categories indicates that this season might not be the spawning season. There were some fish of the length categories 30 mm to 45 mm and these could be the fish hatched in the last breeding season. There are large numbers of fish of length categories 50 mm – 100 mm. Though the numbers slump above this length categories, there abundance were consistent till length category 150 mm and there were some even longer than that up to 180 mm. Presence of all ranges of fish suggest that they are resident fish. Also the highest mean of the total lengths, 72 mm was due to the less number of fries indicating spring is not a breeding season.

Premonsoon: The total number of the fish caught in this season was remarkably low because of the poisoning of Tinau River just before the sampling as mentioned before. In addition no fish were recorded from Seti River as well. 608 sucker heads were captured in this season ranging from 20 mm to 140 mm (figure 10). Presence of some numbers of 20 mm category indicated that the season should be the starting point of spawning. There were many fishes up to 45 mm length group. The peak of the numbers however were of the length categories 50 mm to 90 mm. Above those length groups the numbers slumped till the 140 mm length groups and there were even some groups entirely missing. The mean total length of the assemblage was lowest at 61 mm. The absence of some higher length groups and large mature adults indicate there might be some migration after spawning.

Autumn: The numbers of fish captured in this season were the highest at 1371 with lot of juveniles, which indicate that it followed the breeding time (figure 11). Also important was the remarkable recovery of the numbers of sucker heads in Tinau River. The lengths of the captured fishes varied almost a full range from 20 mm to 175 mm indicating a good and healthy assemblage. There were many fishes of the length groups 20 mm to 35 mm indicating the time of breeding. However, the peaks of the numbers were of the length groups 40 mm to 95 mm. There was a gradual slump of numbers from 100 mm to 150 mm length categories, which is a characteristic of a normal healthy population. There were even some numbers of sucker heads above 150 mm up to 175 mm. The mean of the total length in this season was found to be 66 mm.

Winter: The numbers of sucker heads captured in this season were 1262 ranging from 30 mm to 170 mm length groups (figure 12). The distribution of length frequencies was almost continuous except for some very large mature adults. There were less fishes with the length group 30 mm to 45 mm compared to autumn may be because of the mortality or other factors. However, there were steady numbers of them from 50 mm to 95 mm length class. The number declines gradually from 100 mm to 160 mm and there was fish even up to 170 mm an indication of a normal healthy population. There was no indication of migration as well in this season. The mean total length of the species in this season stands at 69 mm.

The sucker heads (*Garra gotyla gotyla*) were found to be one of the most common fish species in Nepal as they were recorded from eight of the nine rivers sampled in this work and in sufficient number. The species was not found in Bagmati River maybe because of the altitude of the sites, which is more than 1560 masl described as its altitudinal range (Shrestha 1995). The species has a much wider distribution below that elevation and is found in the rivers and lakes on the foothills of the entire Himalayan region (Talwar and Jhingran 1991). The status of the species was found to be consistent as ‘fairly common’ described by Shrestha (1995).

No previous records of length frequency distribution of this species could be traced from the related literature. However, some authors have mentioned its maximum size. Talwar and Jhingran (1991), Shrestha (1994) and Shrestha (1995) have recorded the maximum size 140mm, 160mm and 150 mm respectively. This work has found the species measuring up to 180 mm, which is a new record. The range of lengths and the distribution of length frequencies showed some variations in space and time suggesting that the habitat conditions, stock size and health, and population characteristics too might vary in different rivers and seasons.

Among the rivers, judging by the numbers of sucker heads captured and length frequency distribution, Aandhikhola was found to hold a good and healthy population. The range of length groups and the highest mean length suggested that the habitat conditions for this species is the best in this river. However, the absence of 20 mm category suggested that the main channel might not be most appropriate for the breeding. Arungkhola and Karrakhola had different results indicating different conditions for the fish. The presence of 20 mm category in these streams suggested that the habitat conditions are good for breeding but the absence of large adults indicated that the conditions are not favorable for the optimum growth due to natural conditions or some man made disturbances and these adult may migrate to other bigger channels or may be harvested.

Jhikhukhola, which belongs to Koshi River System, also showed a narrow range of length groups just up to 120 mm considerably less than Aandhikhola. In addition, absence of 20 mm group indicated that the breeding ground is not suitable. The absence of larger adults suggested that the conditions were similar to that of Arungkhola and Karrakhola. East Rapti and Seti showed more or less similar situations. Both of these rivers didn't have 20 mm length group indicating harsh condition or disturbances for spawning. The number of the fish captured in Seti was also very low. The numbers of large adult fish were also less though the maximum sizes of the sucker heads in these rivers were 140 mm and 130 mm respectively.

Narayani, one of the biggest rivers in Nepal was found to hold a good population of this species. The range of the length groups was very high but there was a complete absence of length groups 20 mm –35 mm indicating that the river is not the site of breeding. However, presence of very large adults and the mean total length of the population suggested that the habitat conditions here are very good for the optimum growth. Tinau River perhaps was found to hold the best population of sucker heads both in terms of abundance and distribution of length frequencies. The substrate, temperature and good sequences of pools and riffles seemed ideal for this population. It was found to be good for breeding as well as for growth. There were lots of disturbances in the river but still the population was found to be healthiest. The absence of very large adults might just indicate that they are the target of anglers and fishermen.

The temporal variation of the length frequency distribution mainly gave the insight of its biology. The presence of lowest length group and the low mean length of the population normally characterize breeding season. Presence of the lowest length group (20 mm) and the lowest mean of the population in premonsoon indicated that the breeding season starts in this time of the year. However, the record of the lowest length group in postmonsoon suggested that the breeding period is quite long starting from premonsoon till the beginning of autumn including the entire monsoon period. Shrestha (1994) had also mentioned the breeding season of this species as premonsoon, but has not mentioned how long it lasts. The mean total length of the population in autumn was higher than in premonsoon.

The winter and the spring seasons completely lacked the lowest length categories and thus, should not be the time of breeding. More over, the mean total length of the population in winter increased than that of autumn and was highest in spring indicating that these seasons are mainly for the growth. Thus, there seemed to be a cycle in the life history of sucker head where the population has the lowest mean of length in premonsoon, which increases gradually in autumn, winter and till the spring.

CONCLUSION

Garra gotyla gotyla has a potential to become more than minor fisheries in Nepal as could be evident from its distribution and abundance. The information regarding its habitat condition, life history, abundance, health, biomass and other population characteristics are important to raise it into a major fishery program. The most important parameter to gather that information is the length frequency distribution. This study has tried to give some baseline information on the sucker heads regarding this parameter. Like in any natural fish population, this parameter was found to vary in space and time for this species as well. The study clearly showed that the spawning time of the species starts from premonsoon season and continues till the beginning of autumn. In the same time, this study also indicated that the habitat conditions and the water quality in Aandhikhola and Tinau were found to be very good.

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Pic.1: ***Garra gotyla gotyla*** **(Gray 1830)**

Table 1: Description of the Sampling Sites

Rivers	Sites - Upstream	Sites – Downstream	Sites - Downstream
Aandhikhola	Bayatari 27° 58' 29.6" lat. 83° 43' 1.6" long. 681 masl	Galyang 27° 56' 55.2" lat. 83° 40' 33.1" long. 670 masl	
Arungkhola	Kusunde 27° 37' 7.5" lat. 83° 57' 20" long. 148 masl	Kusunde 27° 36' 30.7" lat. 83° 57' 20.5" long. 140 masl	
Bagmati	Sundarijal 27° 46' 24.9" lat. 85° 25' 33.8" long. 1621 masl	Sundarijal 27° 46' 18.4" lat. 85° 25' 34.5" long. 1610 masl	
Jhikhukhola	Paanchkhal 27° 38' 55.3" lat. 85° 35' 28.5" long. 936 masl	Paanchkhal 27° 36' 24.4" lat. 85° 39' 33.4" long. 898 masl.	
Karrakhola	Hetauda 27° 24' 30.8" lat. 85° 03' 09.6" long. 450 masl	Hetauda 27° 24' 53.7" lat. 85° 01' 09" long. 450 masl	
Narayani	Narayanghat 27° 42 '16.1" lat. 84° 24' 50" long. 165 masl.	Narayanghat – city 27° 41' 51.1" lat. 84° 24' 50" long. 165 masl	Narayanghat -industry 27° 41' 40.8" lat. 84° 24' 7.3" long. 162 masl
Rapti	Hetauda 27° 27' 10.9" lat. 85° 02' 19.5" long. 451 masl	Bhandara 27° 34' 14" lat. 84° 38' 54.8" long. 202 masl	
Seti	Pokhara 28° 15' 12.8" lat. 83° 58' 4.5" long. 927 masl	Pokhara 28° 9' 39.4" lat. 84° 0' 56.1" long 630 masl	
Tinau	Maniphant - Agriculture 27° 49' 22.3" lat. 83° 36' 9.6" long. 680 masl	Koldanda - Agriculture 27° 47' 52.2" lat. 83° 31' 37.6" long. 616 masl	
Tinau	Butwal – Dam 27° 44' 11.6" lat. 83° 27' 52.9" long. 282 masl	Butwal - Dam 27° 43' 32.8" lat. 83° 28' 6.3" long. 207 masl	
Tinau	Butwal – city 27° 43' 18.7" lat. 83° 28' 5.6" long. 171 masl	Butwal – city 27° 41' 37.5" lat. 83° 27' 38.3" long. 152 masl	

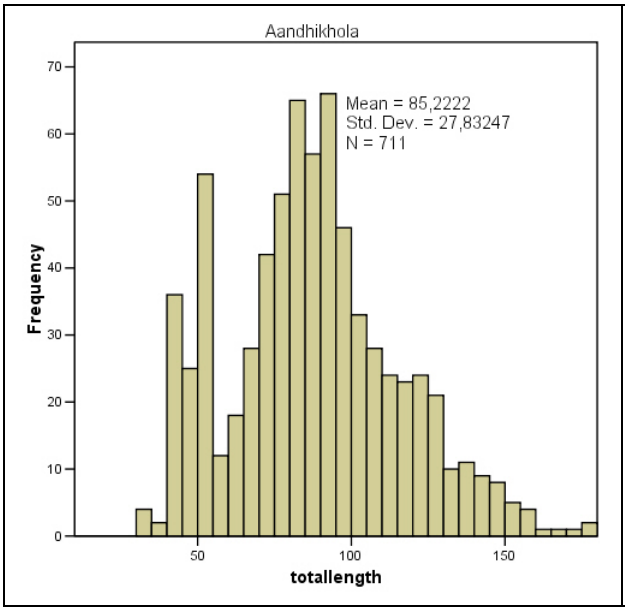

Fig. 1: Length frequencies in Aandhikhola

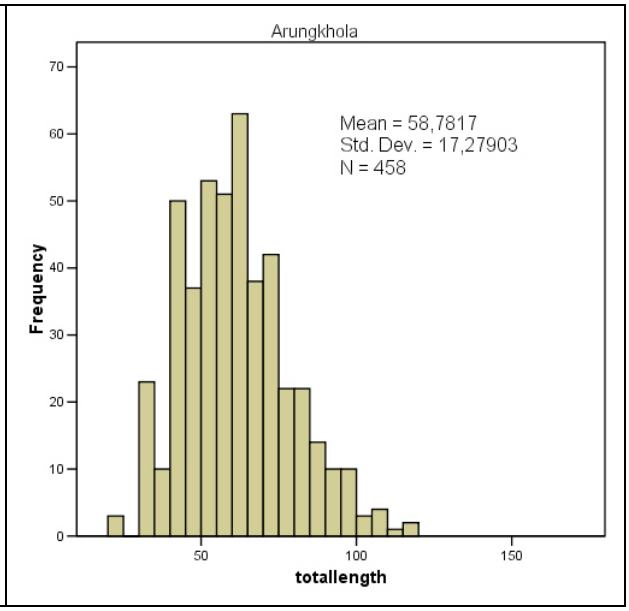

Fig. 2: Length frequencies in Arungkhola

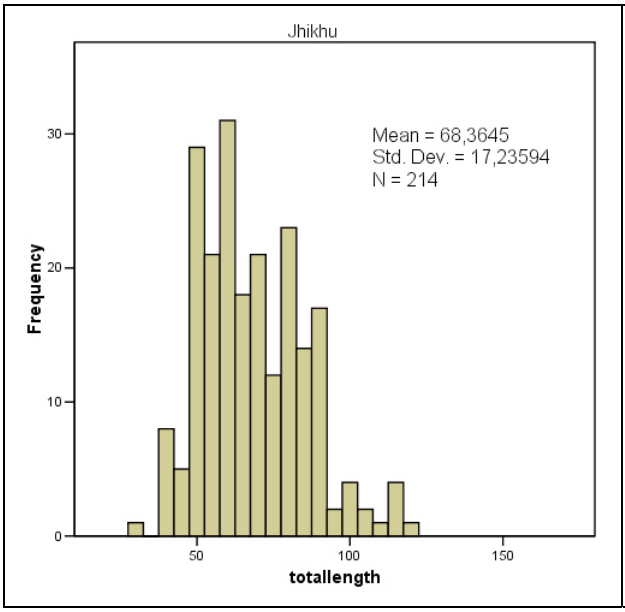

Fig. 3: Length frequencies in Jhikhukhola

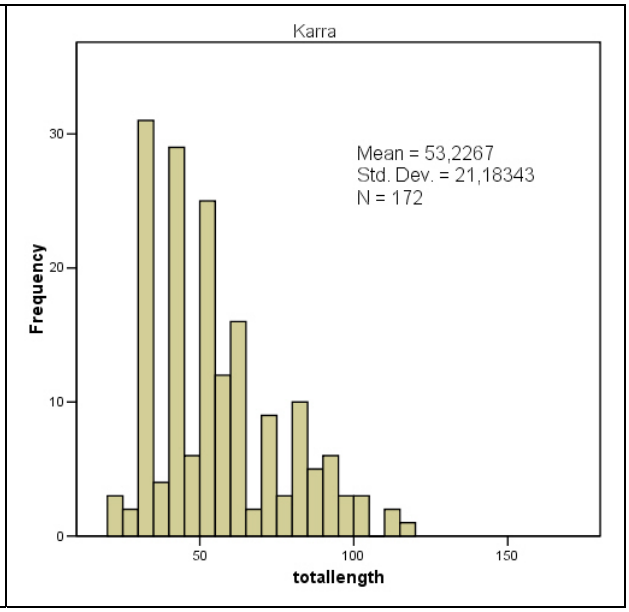

Fig. 4: Length frequencies in Karrakhola

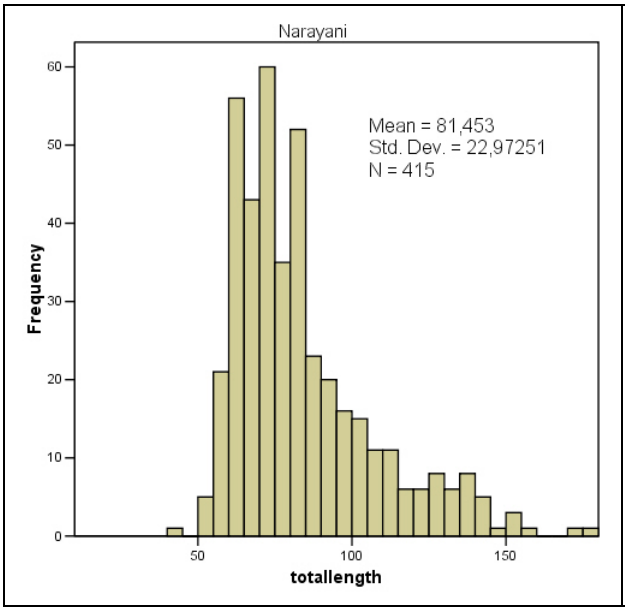

Fig. 5: Length frequencies in Narayani

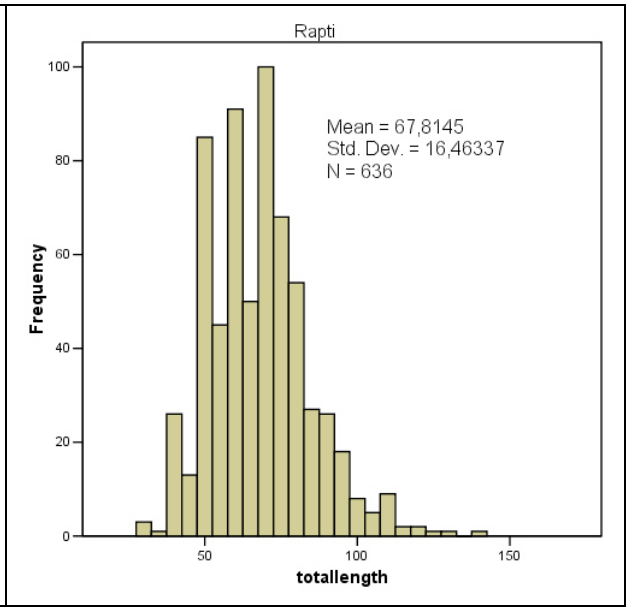

Fig. 6: Length frequencies in East Rapti

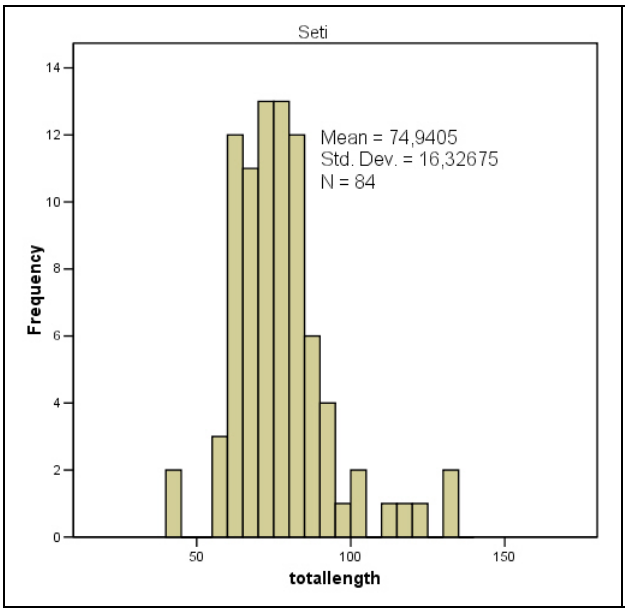

Fig. 7: Length frequencies in Seti

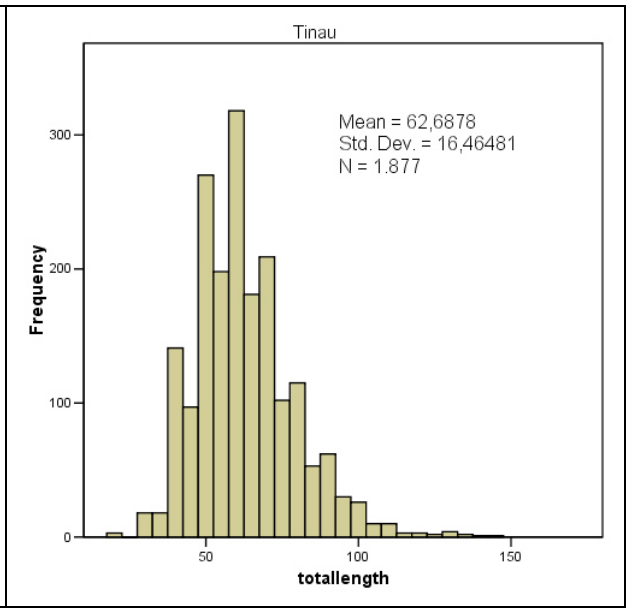

Fig. 8: Length frequencies in Tinau

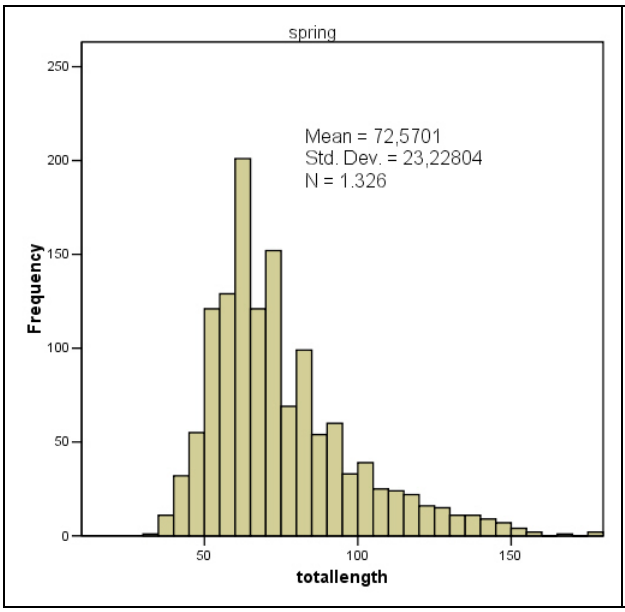

Fig. 9: Length frequencies in spring

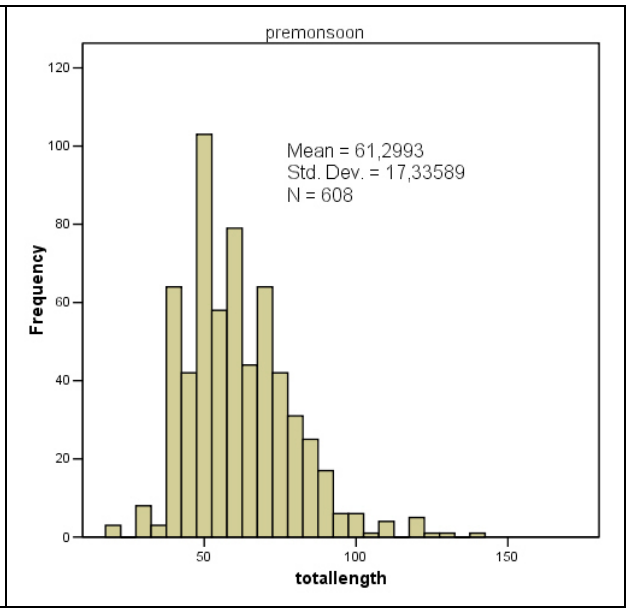

Fig. 10: Length frequencies in premonsoon

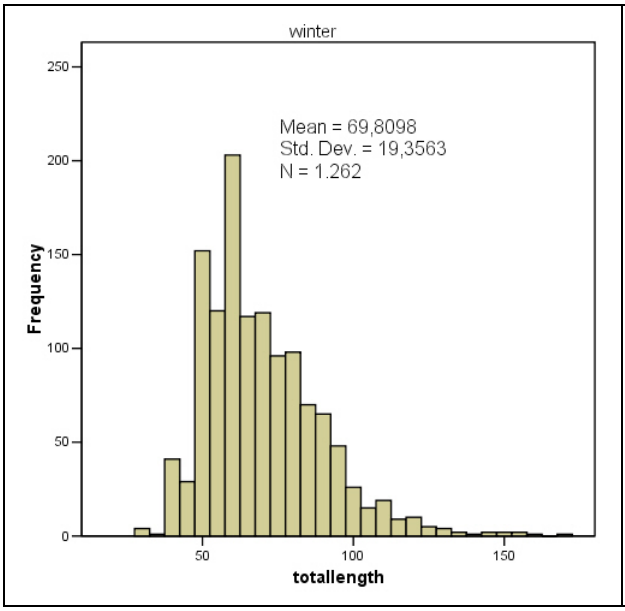

Fig. 12: Length frequencies in winter

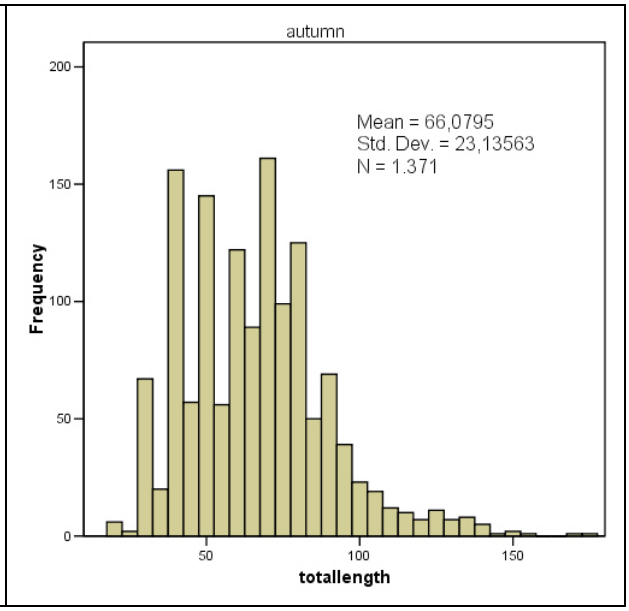

Fig. 11: Length frequencies in autumn