CHAPTER 4

METHODOLOGY

4.1 Determination of morphology and scientific name of the study species

4.1.1 Morpholgy

Morphological measurements of birds at Si-Ha Islands, Phatthalung Province were conducted in June 2000. Birds were captured using mist net under the permission of the concessionaire, measured and released. Two individuals were collected as specimens. At Samut Sakhon Province, it was studied in October and November 2000 and January 2001 by the same obove method. Morphology of birds from the two sites were compared using *t*-test.

4.1.2 Scientific name

To determine the scientific name of the study species, morphological characters of birds (wing length, tarsus length, tail length, and body weight) at two study sites were measured and compared with reference specimens at Raffle Museum of Biodiversity Research, Department of Biodiversity Science, The National University of Singapore, Republic of Singapore.

The scientific name used in the study was from Lekagul and Round (1991); Eve and Guigue (1996); Chantler (1999) and Wells (1999).

4.2 Determination of population size, diet of nestling and foraging area of the White-nest Swiftlet at Samut Sakhon Province

4.2.1 Population size

Bird census was carried out every two months during April 2000 to February 2001 by counting the number of birds from photographs taken at all nesting and roosting sites in the building. Photographs were taken after dusk when all birds returned to their nest-sites.

4.2.2 Diet of nestling

To determine the diet of nestling, 15 food-balls from the returned feeders were collected. The collection was done in March, July and October 2001. Food-balls were preserved in 70% ethanol and all preys in each food-ball were identified into Orders or Families using a compound microscope at Thai turtle Lab., Chulalongkorn University. The following litteratures : Clausen,1940; Bland,1978; Borror, De Long, and Triplehorn, 1981 were used for identification. The amount of each food item was recorded and the percentage of occurrence was calculated. A food-ball is shown in Figure 4.1.

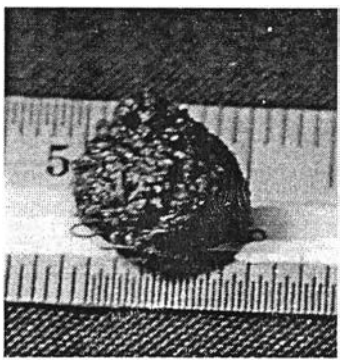


Figure 4.1. A food-ball which was collected from feeder at Suthiwatwararam Temple, Samut Sakhon Province in March 2000.

4.2.3 Foraging area

To determine the foraging area and the foraging distance of this population, vehicle surveys through all accessible areas by road in Samut Sakhon and nearby provinces were conducted. These areas comprised of urban and industrial areas, coastal areas (e.g. mangrove forests, salt fields, aquaculture areas) and agricultural areas (e.g. paddy fields, coconut plantations, orchards, swamps and etc.). The survey was done at one-month interval during March 2000 and January 2001. Thus, twelve surveys were made. Each trip was started in the early morning until dusk. During a given survey period, the number of birds and the position of birds seen were plotted in the topographic map (scale 1: 50,000) provided by the Royal Thai Survey Department. The map also used to interpret the distances between foraging positions and the breeding site. The average number of birds seen in all areas of Samut Sakhon Province

and the nearby were shown in the map which was modified from the Land Use map of Samut Sakhon Province. Foraging height was also estimated.

4.3 Breeding biology

The data of breeding pattern and breeding biology of White-nest Swiftlets were obtained from 53 breeding pairs at 4 different nest-site types in the sacred building during September 2000 and October 2001.

4.3.1 Breeding pattern

To determine the breeding pattern, the number of nesting attempts of each breeding pair was recorded. The occurrence of nesting attempts during a given period would indicate the timing and the pattern of breeding.

4.3.2 Breeding activities

Breeding activities were focused as follows.

4.3.2.1 Time spent for nest building, egg laying, incubation and nestling feeding

To record the time for nest building, egg laying, incubation, nestling feeding, a brood was recorded through a serie of nest checks every one to three-day intervals. The monitoring of 53 breeding pairs was carried out for 14 months. During the nest status monitoring, the periods of nest building, egg laying, incubation and nestling feeding were noted. The appearance of the first egg indicated that nest building period was complete and indicated time of egg laying. To avoid any disturbance to either incubating breeders or feeders, the nest checking was done in the early morning (0700-0830) when the feeding activity was low. Since nesting White-nest Swiftlets are less sensitive to the disturbance from nest checking, the missing nestling at a particular check would be considered that it was fallen or fledged.

For the analysis, the mean difference between two different clutches and seasons including among the subsequent brood were tested using *t*-test and ANOVA-DUNCAN. Nest checking is demonstrated as in Figure 4.2.

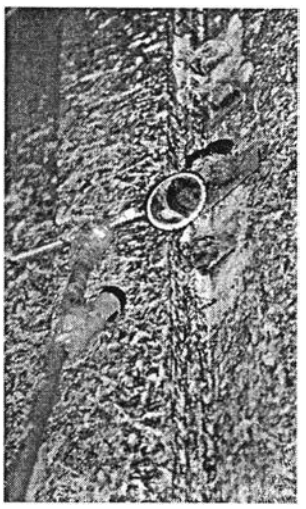


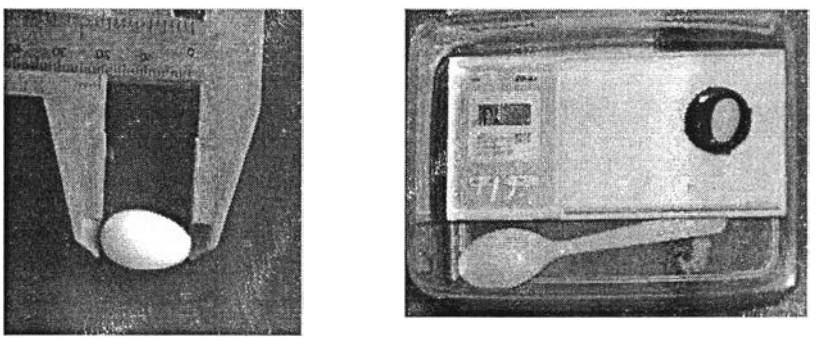
Figure 4.2. Nest checking, using a long stick binding one end with a mirror and a touch light.

4.3.2.2 Breeding success

The parameters for the breeding success were clutch size, hatching success(%) and fledging success (which was used in term of breeding success at fledging,BSF (%)) and production (number of fledging per pair per year). The parameters were recorded during brood monitoring. Fledging success was determined either by observing or by nest checking. Nests were checked in the day around the expected date of fledging. The check was done before dawn (0500-0600) when all members were roosting at the nest. Another evidence was the presence or absence of the nest. The entire clutch of eggs or broods of young that suddenly disappeared was considered that they were fallen and that clutch was considered as unsuccessful clutch. The breeding successes of 262 clutches performed by 53 breeding pairs were pooled and analyzed using ANOVA-DUNCAN.

4.3.2.3 Morphology of eggs

The mean difference of egg morphology within/between clutches during the breeding time was conducted by measuring the dimension of the eggs (length and breadth) with a vernier caliper, 0.01-mm accuracy (Figure 4.3,a). Eggs also were weighed using digital balance at nearest to 0.01 g (Figure 4.3,b). The difference was tested by ANOVA-DUNCAN



(a) (b)

Figure 4.3. Egg measurements : (a) egg length, using vernier caliper; (b). weighing, using digital balance

4.3.2.4 Morphology of nests

Nests from Samut Sakhon Province were compared to those of White-nest Swiftlets from caves at Phatthalung Province. All nests harvested were white-nests which were collected in March, April and August 2000 for the first, second and third harvesting, respectively. All nests were weighed using a digital balance at nearest to 0.01g. Height, width and thickness was measured using vernier caliper (Figure 4.4). Data were compared using ANOVA-DUNCAN.

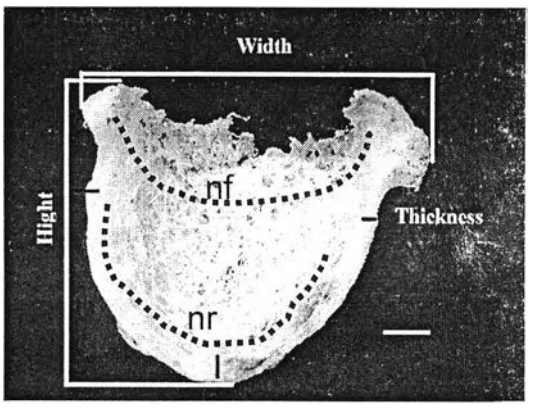


Figure 4.4. Nest morphology, showing the height, width and thickness. Thickness was measured at 3 points as indicated by (-). In addition areas of nest feet (dot line,nf) and nest rim (dot line,nr) were shown. Bar= 10 mm.

4.4 Determination of parental care

The study on parental care in White-nest Switflets at the sacred building, Samut Sakhon Province was carried out during November 2000 and October 2001. Focuses of the study were as following;

4.4.1 Parental investment for egg incubation

4.4.2 Parental investment for nestling incubation

4.4.3 Parental investment for nestling feeding

4.4.4 Equitability of parental care

The parental investment in incubation (egg and nestling incubations) and nestling feeding were recorded from pairs that were in the stages of incubation and nestling feeding by continuous watching. Each observation day started from 0500 to 1930 (equally 870 min). The equitability of care was recorded from 15 tagged pairs by the same above method.

For the analysis, the breeding cycle was partitioned into 16 age classes (ac). The laying day was equal to "egg day 1" and the hatching day was equal to nestling day1. Sixteen age classes were ac1 (egg day 1); ac2 (egg day 2-5); ac3 (egg day 6-10); ac4 (egg day 11-15); ac5 (egg day 16-20); ac6 (egg day 21-25); ac7 (nestling day 1); ac8 (nestling day 2-5); ac9 (nestling day 6-10); ac10 (nestling day 11-15); ac11

(nestling day 6-20); ac12 (nestling day 21-25); ac13 (nestling day 26-30); ac14 (nestling day 31-35); ac15 (nestling day 36-40) and ac16 (nestling day 41 or more). The nest contents in different stages are shown in Figure 4.5.

All activities were recorded in relation to the age of nest contents. Data of all clutches were pooled and analyzed across age classes of the nest content. ANOVA-DUNCAN and *t*-test were used to test whether the incubation and nestling feeding times and the feeding rate varied between clutch sizes and across the age classes.

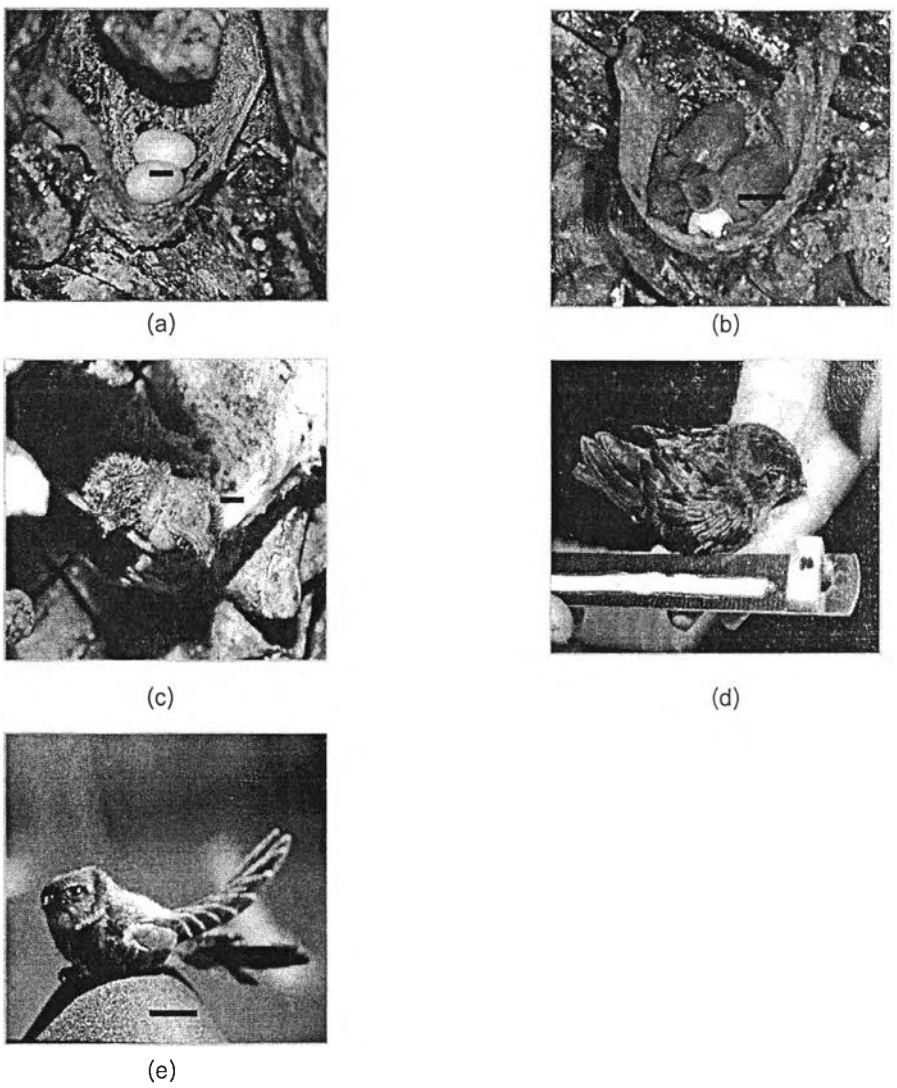


Figure 4.5. Stages of the nest content, showing : (a) egg stage, age class 1-6; (b-e) nestling stages at different age classes and; (e) fledging stage, age class 16. Bar=10 mm.

4.4.1 Parental investment for egg incubation

Egg incubation time was considered as a period of time a breeder sat or presented on its nest during 0500 and 1930 of each observed day. This activity started from the egg laying stage to the hatching stage or from the age class 1 to the age class 6.

4.4.2 Parental investment for nestling incubation

Nestling incubation was considered as a period of time a breeder sat or covered on its nestling which was taken place during the rearing periods. This activity started from hatching stage to fledging stage or from age class 7 to age class 16.

4.4.3 Parental investment for nestling feeding

Nestling feeding which is called the rate per nestling feeding (trip·nestling^{-1} · h^{-1}) is considered as times parents backed to delivery food to their nestlings. The data were reported in terms of number of daily food-ball, feeding rate or feeding trip (trip · h^{-1}), and feeding rate per nestling (trip · h^{-1}· nestling^{-1}). This activity started from hatching stage to fledging stage or age class 7 to age class 16.

4.4.4 Equitability of parental care

The equitability of parental care is the difference in the time spent for the incubation and nestling feeding within a pair. To permit individual identification, a primary feather of wings of each breeder was tied with a unique combination of color bands. Fifteen pairs out of 53 White-nest Swiftlet breeders were tagged. To examine the morphological difference between the male and the female, the lengths of right wing, right tarsus and tail were measured during tagging. Body masses of both sexes were recorded. The morphology of both sexes was compared using *t*-test.

Watching were carried out during 0500 and 1930 of each observed day from November 2000 to August 2001 (at the beginning of tagging to the time of tag lost, dued to molting). Times that the male/female presented on the nest and times they took turn including times they returned to feed were recorded. By tagging, the sex of the parents

were distinguished by their behaviours (the female would sit on the nest before the onset of laying period for 1 to 3 days). The time of incubating breeder leaves nest in any uncertain cause was considered as "temporary leave" and was excluded from the analysis. The stages of nest content were also divided to 16 age classes as above. The data were analyzed using *t*-test and Chi-square test.

4.5 Test for the loyalty in pair and nest-site fidelity

By observing the tagged breeders, the royalty in pair and nest-site fidelity can be investigated. Times that the breeders bond pair could indicate the type of the mating system (e.g.monogamous, polygamous etc.). To investigate the royalty in pair (pair bonded for a long period of time or for life) of the White-nest Swiftlet, the duration of the association of each tagged pair from the beginning of tagging and the last day that tag lost were recorded.

The evidence of nest-site fidelity indicated by a new nest has been built subsequently at the same site by the same pair after the previous nest was absent. Normally, if nest is built at the suitable site, the nest will survive for a long time and will be reused by the same pair for its subsequent brood.

4.6 Determination for nest-site characteristics of White-nest Swiftlets in caves and in the sacred building.

4.6.1 Nest-site characteristics of White-nest Swiftlets in the sacred building, Samut Sakhon Province and the effect of nest-site qaulity on the breeding success

Because the environment of the nesting site in the building differs from those in caves, therefore, the different method was used. The parameter measured as following,

4.6.1.1 Determination of the preferred nest-site

To determine the preferred nest-site, all nests selttled at each nest-site type were counted. The preferred nest-site was indicated by the density of nests at each nest-site type.

4.6.1.2 Determination of the effect of nest-site quality on the breeding success of nests at 4 nest-site types

To examine the effect of nest-site quality on the reproductive success, the breeding success at fledging,BSF(%) of 53 White-nest Switflet breeders at 4 different sites (1 at sm1; 12 at sm2; 15 at sc1 and 25 at scs2) were monitored by nest checking. The detail of nest checking and breeding success monitoring were described in 4.3.2.1 and 4.3.2.2. The data presented in the result section were for all given nests that displayed nesting attempts during this study. The number and causes of nesting failures were recorded during the observation of breeding activities. The issue concerning the nest-site quality is whether suitable nest-sites are optimal in term of yielding higher reproductive success. Furthermore, if the nesting site in the building is limited, new breeders will accept the artificial nest-site.

4.6.2 Deternmination for nest-site characteristics of White-net Swiftlets in caves

The study was conducted after the nests were collected by commercial collectors in October 2000. The study focused on the nest-site characteristic of White-nest Swiftlets which nest in group. Each nesting area on the wall was called a nest-patch whereas a nest-site was defined as the area on the cave wall to which a single nest-cup was attached. Nest patches of at least 20 nest-sites with the height of < 10 m from the cave floor were examined. For this study, 25 nest-patches, ranged from 1 to 80 m^2 (average= 10.52 ± 18.34 m^2), were study of which 3 nest-patches were on celing and 22 nest-patches were on inward-incling walla. The angle of nest-patch surface were classified as : 1) the vertical wall with an angle of approximately 90 ^{o} to the horizontal line, 2) the outward-inclining wall with the angle > 90^{o}, 3) the inward-inclining wall with the angle of < 90^{o} (Figure 4.6).

Figure 4.6. A nest-patch on the inward-inclining wall with the angle of <90° in the Nong Kwai cave, Ko Ta So, Phatthalung Province.

4.6.2.1 Nest-site characteristics

Nest-site characteristics were examined from 5 nest-sites of each 25 nest patches which were selected systematically, starting with one nest-site at the center of each patch and four others at approximately 1 m away at right angles to the center (Figure 4.7).

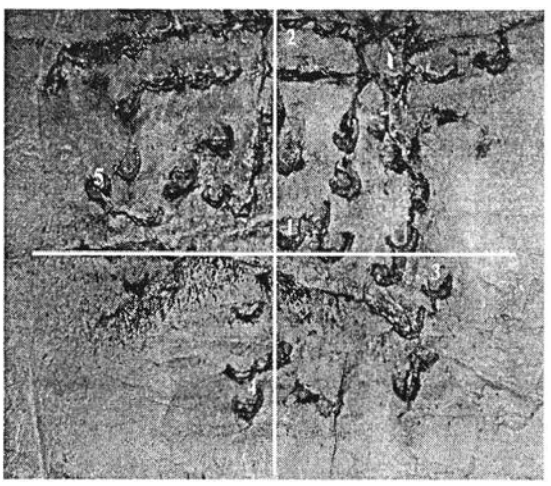


Figure 4.7. Demonstration of the systematic sampling, showing 5 sampling nest-sites selected from the patch.

Nest-site characteristics recorded were the surface of the cave-wall. The surface to which the nests of *A. fuciphagus* were attatched was noted as smooth or rough, concave or flat; and with or without supporter (Figure 4.8). A supporter is a protruding rock of U-shaped form on the wall surface (Figure 4.8, d). The number of supporters and the number of nest-sites in each of 25 nest patches were counted in order to examine whether there was any correlation between them.

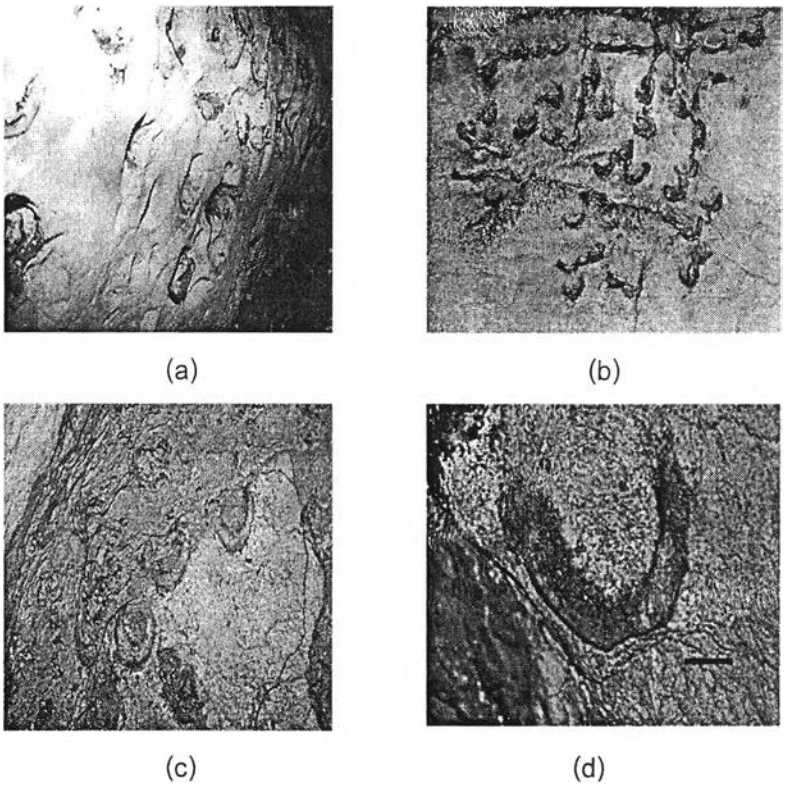


Figure 4.8. Types of nest-sites in the caves of Si-Ha Islands, Phatthalung Province, (a) smooth and concave with no supporter sites, (b) smooth and flat with supporter sites, (c) rough and concave with supporter sites, (d) rough and flat with supporter site, focusing the protruding U-shaped rock. Bar=10 mm.

4.7 Experiment on the use of artificial nest-sites by White-nest Swiftlets living in the sacred building

The model of the nest patch with 30 nest-sites was build to imitate the characteristics of nest-site in the natural caves that correspond to the preferable sites in the sacred building. An artificial nest-patch was made on 30-cm width, 100-cm length and 0.20-cm thick of plywood. The nest-patch consists of thirty 3-cm radius holes. One hole closes to the others for 3–10 cm. These holes imitated as a concave wall. The lower line of each hole is the U-shape of cement molding with the wire inside for strength. The molding, 3x10x3 cm^3 in width, length, and thickness, presumably plays a role as supporter. The characters of the nest-patches are smooth and concave with supporter sites, comprising of 30 nest-sites (Figure 4.9 and 4.10).

The artificial nest-patch was placed on the smooth and flat wall at 10 cm under the ceiling. The patch surface was set at 70 $^{\circ}$ to the harizontal line in which the lower line of the patch was attached to the wall. This site is located behind the sculpture wall. The artificial nest-patch was hung up on 11 December 2000. The first day that the bird has seen roosting at the nest-patch and the number of nests built at the artificial nest-site would indicate the efficiency of the model.

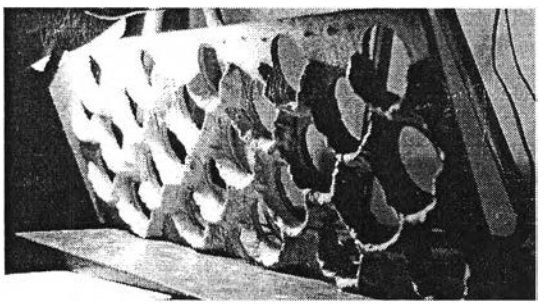


Figure 4.9. A model of artificial nest-patch comprising of 30 nest-sites and the angle of the patch was set at 70 $^{\circ}$ to the horizontal line, imitating the inward-inclining wall of the natural caves.

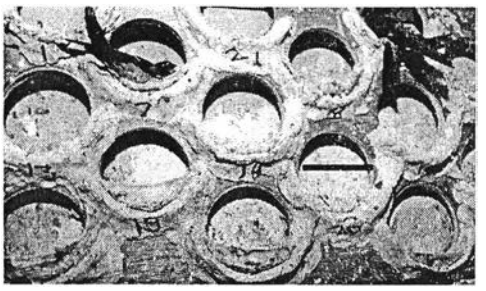


Figure 4.10. Artificial nest-sites in one artificial nest-patch showing the inter-nest site distance that was set at 3-10 cm. Bar=6 cm.

4.8 Data analysis

All variables were reported in term of means ± SD. Analyses were conducted with SPSS version 10.0. Chi-square, *t*-test and ANOVA-DUNCAN multiple-test were used, after checking for normality of the data. Results were considered significant differences if $P \leq 0.05$.