

**A STUDY ON ECOLOGY AND BEHAVIOUR OF
BUDGERIGAR (*MELOPSITTACUS UNDULATUS*)
UNDER CAPTIVITY AT EDAVANNA,
MALAPPURAM DISTRICT, KERALA**

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Abstract

Budgerigars (*Melopsittacus undulatus*) are the third most popular pet around the world, after the domesticated dog and cat, due to their small size, low cost and ability to mimic human speech. Budgerigars are bred in captivity with colouring of bluish, whites, yellow, grey, greenish and with small crests. The ecology and behaviour of budgerigars were carried out in captivity at Chathalloor, Edavanna, Malappuram district, Kerala, during 02/03/2019 to 28/02/2020. The study was intended to know the behavioural changes during feeding, breeding, various colour varieties and genetics behind it; nest selection and cage management. To study about nest selection, territory and seasonal variation in breeding; a main cage of 1m x 1m x 1m with plastic coated iron wire mesh was used. Four test cages of 30cm x 30cm x 30cm was used to know the best feed for them. An interview was carried out with budgerigar's breeders and veterinary doctors to get details on colour varieties, diseases, parasites and their remedies. A survey was conducted among budgerigars pet shop owners who were doing budgerigars breeding to get data on popularity, variety choice, quality

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selection etc. Nutritious food increases the fertility rate, clutch size and colour qualities of budgerigars. The albino budgie (53%) is the most demanded variety than others. The nutritious food, spring season, cage with fewer pairs favours the fledge size. The common diseases affect the budgerigars are the eye infection and coccidiosis. The study will help to get an awareness on the management of budgerigars as pets.

Introduction

Budgerigars are highly social and fast flying birds. They are affordable pets and easy to care. It is one of the smallest parrot species in the world and very easy to determine their sex. Male and female budgies can be identified by the colour of their cere. The male budgie has blue cere while the female budgies cere is brown in colour. An exceptional case is albino and lutino budgerigars, where males have pink cere and in females it is white or cream (Adajar, 2001). The budgerigars (*Melopsittacus undulatus*) are included in the class: Aves and order: *Psittaciformes*. It is commonly known as pet parakeet or shell parakeet, which are small, long tailed and seed eating parrot. They are commonly found in Australia. These gregarious species was discovered in 1805 by George Shaw and now it becomes the third popular pet in the world. The English zoologist Dr. George Shaw (1751-1813) documented the existence of the species in 1794, but they were not yet able to make a good study on budgerigars, since they were still living in the wild. Shaw was the first to describe the small parrot which named, "*Psittacus undulatus*" (undulated grass parakeet). The English ornithologist John Gould (1804-1881) was clearly fascinated by these small birds, referring to them as the most animated, cheerful little creatures. Gould was able to take a few budgies home with him. In 1840 he published the first detailed report on budgerigar behaviour in his work 'Birds of Australia'. He was also the one who came up with current scientific name, *Melopsittacus undulatus* (melodious parrot, but also meaning the best of all grass parakeet)

Budgerigar are good examples of monogamy. It is the simplest type of mating system in which every adult individual mate only with one member of the opposite sex throughout life. They mainly communicate with vocalization and the song of the budgie is quite loud. Budgerigars use their voices to communicate with one another as they are very sociable birds (Eda Fujiwara et al. 2011). Average size of a budgerigar is 18cm long and 30-40 gram in weight and average wingspan is 30cm. They exhibit sexual dimorphism. Some of the key terms required definitions are presented below.

- Ecology: include all ecological aspects related with cage; biotic and abiotic factors.
- Behaviour : means behavioral changes during breeding, feeding, maintaining territory etc. of Budgerigar
- Captivity: is a state wherein animals are confined to a particular space and prevented from leaving or moving freely. Here budgerigars are in the cage.

Materials and Methods

The study was conducted in the captivity at West Chathalloor, Edavanna of Malappuram district, Kerala, from 02/03/2019 to 16/02/2020. Various methods were adopted to study different aspects related with habit, cage management, colour varieties, breeding, feeding, territorial behaviour and common diseases, parasites and their control. Observations are made directly and photographs are taken by Nikon 1300 D, vivo dual camera and Redmi note 4 camera. The main cage was 1m x 1m x 1m (Plate 1) with plastic coated wire mesh. In addition four test cages of 30cm x 30cm x 30cm (Plate 2) were made of the same material. Different types of food and supplements were given to budgies in four test cages to know the influence of food on breeding. Budgies weights were recorded monthly with help of an electronic weighing machine. Their average weight was measured.

Average weight of budgerigars = $\frac{\text{sum of weight measured monthly}}{\text{number of weight measured monthly}}$

Number of eggs, clutch size, fledging size and clutch gap were calculated by direct observation. Average number of eggs in clutch was calculated .

Average number of eggs in clutch of budgerigars = $\frac{\text{sum of number of eggs in each clutches}}{\text{number of clutches measured}}$

Average fledging size of chicks were calculated,

Average fledging size of budgerigar chicks = $\frac{\text{sum of number of chicks fledged}}{\text{number of fledge size measured}}$

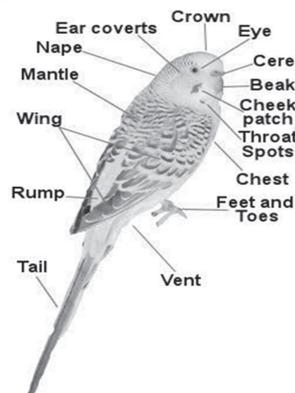
Two clay nest pots were placed in each of the four test cages. To study the nest selection, clay nest pots and plastic nest pots were placed in the main cage. The preference of birds on nest, based on the dimension, nest pot hole size, distance between wire mesh and nest pot were observed. Preference for the position of nest, top, bottom and middle were also noticed. The clutch gap is period from the first egg laid date of the first clutch to the date of first egg laid of the second clutch. The rearing by parents during first day of chick hatching to chick fledging was recorded. The nest was inspected every day during the transition of nestling stages. Clutch initiation date was determined either by direct observation of egg laying or by calculation made using known hatching dates and mean developmental periods. Clutch size measured as the total numbers of eggs laid and duration of developmental period was calculated based on visual inspection of nests.

An experiment was conducted to see, if there was any difference in their clutch size, fledging size, hatching size, and number of incubation days during summer, rainy, spring and winter seasons. In order to know the day of hatching the eggs a new method was adopted, the egg marking method. With help of a marker pen, the eggs were marked in the order of which they were laid. The weight of the eggs were calculated with the help of an electronic weighing machine and size by using thread and scale; thus morphology was studied by morphometric analysis. The cage was monitored every day at morning (05.00am to 06.00am) and evening (05.00pm to 06.00pm). In holidays (06.00am to 05.00pm), the hours were divided into four sections (06.00am to 09.00am, 09.00am to 12.00pm, 12.00pm to 03.00pm, 03.00pm to 06.00pm). Nest with at least single fledged young one was considered successful. Interviews were conducted with budgerigar breeders and veterinary doctors to get details on colour varieties of budgerigars, diseases, parasites and their remedies. Investigator conducts a survey among budgerigar pet shop owners who were doing budgerigar breeding. A questionnaire include various aspects like popularity, most varieties chooses, quality selection, why you choose budgies as pet?, about varieties, about food, which is the most prevalent disease?, precautions and remedies for diseases, parasitic attack and about cage selection. The sample size was 30, a copy of questionnaire is shown in Appendix. After conducting the survey with sample size of 30 the data was analyses on various conclusions were made.

Result

The study entitled "**A study on ecology and behaviour of budgerigar (*Melopsittacus undulatus*) under captivity at Edavanna, Malappuram district, Kerala.**" was carried out to know the various aspects in the behaviour of budgerigar, behavioural change during the feeding, breeding, analyse the morphology, identify various colour varieties, cage management, diseases, parasites and their remedies etc.. The following results were obtained.

Morphometry of Budgerigar



Colour varieties and genetics

The various colour varieties are normal, spangle (single factor spangle & double factor spangle budgerigar), opaline, pinnamon, albino, lutino, creamino, latewing, fallow, clearwing, greywing, pied (recessive pied, dominant pied (single factor dominant & double factor dominant), clear flight pied, mottled pied), crusted & rainbow budgerigar.

1) Feeding behaviour

Table no: 1 – table showing the list of various foods given to budgerigars

Seeds	Vegetables	Fruits	Minerals (supplements)	Leaves
<i>Setaria italica</i> (foxtail millet)	<i>Daucus carota</i> (carrot)	<i>Malus domestica</i> (apple)	Internal skeleton of cuttle fish (calcium)	<i>Spinacia oleracea</i> (spinach)
<i>Triticum</i>	<i>Solanum lycopersicum</i>	<i>Magnifera indica</i>	Agri-min fort (mineral mixture)	<i>Centella asiatica</i>
<i>Vigna radiata</i>		<i>Psidium guajava</i>	Plaster of paris	<i>Ocimum tenuiflorum</i>
<i>Zea mays</i> (maize)			Egg shells	<i>Capsicum annuum</i>
<i>Cocunut dried cake</i>			Lugols iodine	<i>Moringa oleifera</i>
<i>Peanut cake</i>			Groviplex (liquid supplement)	<i>Solanum lycopersicum</i>
<i>Wheat bran, maize bran</i>			Osomin+Vimeral (liquid supplements)	<i>Coriandrum sativum</i>

They were very actively fed in early morning and evening. But budgerigars have chicks in the nest, the parents take food every time. Breeding pair also consume more food than non breeding pair. Female ate more amount of food than male. But at the time of incubation female consume very low amount of food. Most of the time male regurgitate the seeds to female, while she was in incubation. At the breeding time female consumes mineral block like cuttlefish. They also consume egg shell and white wash on wall. Juveniles also eat mineral block for getting calcium and it helps to trimming or sharpening their beak. Their favorite foods are foxtail millet and *Ocimum tenuiflorum* leaves. They also shows neophobia, that is a condition when new type of food is introduced to them. They flew up and observing the new food. When any of them taste it, others encouraged and started to eat it. They can be breed throughout the years, when they get proper and high amount of food in all time.

When immature chick (having no feathers) dropped out from nest, other budgerigars start to eat them. So it leads to death of chick. In wild, budgerigars feed various herbs and seeds.

Experiment to find most nutritious food for Budgerigars

We conducted an experiment to find which food is better for budgerigars. Four pairs of adult budgerigars with same ages were chosen and introduced them

into four separate cages with 30cm×30cm×30cm. Four cages were numbered as test cage 1, test cage 2, test cage 3 and test cage 4. Foxtail millet, water, internal skeleton of cuttlefish, leaves were given the test cage 1. Foxtail millet, wetted wheat, water, internal skeleton of cuttlefish, leaves were given the test cage 2. Foxtail millet, dried concentrated feed powder(wheat powder + wheat bran + maize powder + maize bran + coconut cake + peanut cake + second quality gram powder) without agrimin forte mixture, internal skeleton of cuttlefish, leaves and water were given the test cage 3. Foxtail millet, dried concentrated feed powder with agrimin forte mineral mixture(vitamin A, zinc, magnesium, manganese, iron, iodine, vitamin E, methionine, cobalt, potassium, sodium), internal skeleton of cuttlefish, leaves, fruits, vegetables, sprouted grams (twice in a week), boiled egg(once in a week), water, groviple(2 ml mixed with 250 ml Of water containing calcium, phosphorus, cobalt chloride, vitamin D3, vitamin B12), ostovet forte(calcium, phosphorus, vitamin D3, vitamin B12, carbohydrate) + vimeral(vitamin A, vitamin D3, vitamin E, vitamin B12) (2ml mixed with 250 ml of water)were given the test cage 4. Different foods given to budgerigars in four test cages are listed in table no: 2.Various feeds for budgerigars .

Table no: 2 - table showing the list of different foods given to budgerigars in four test cages.

<i>Number of cage</i>	
<i>Food materials</i>	<i>Foxtail skeleton leaves</i>

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Table no: 3 - table showing comparison between clutch size and weight of budgerigars in four test cages.

<i>Number of cage</i>	<i>Cage 1</i>	<i>Cage 2</i>	<i>Cage 3</i>	<i>Cage 4</i>
<i>Average weight of male</i>	28g	28g	33g	36g
<i>Average weight of female</i>	26g	27g	30g	33g
<i>Number of eggs in clutch 1</i>	6	6	8	6
<i>Number of eggs in clutch 2</i>	7	7	9	9
<i>Number of eggs in clutch 3</i>	6	7	9	12

The result from this experiment is(Table no:3 & 4), the food materials in cage four is better for budgies growth and breeding. Compared to the first one, the fourth cage

showed the best growth. When compare the first and fourth cage, the chicks were weaned first from the fourth cage. The growth of chicks in cage 1 was very poor. The chicks in the first cage weaned only after 36 days and chicks in fourth cage weaned only after 30 days. In first, second and third cages, females lays eggs in one day gap. But in cage four, they also lays eggs in one day gap but sometimes they lay eggs daily without any gap. The clutch gap is high in cage one and two. But in case of cage three and four, it is very low.

Table no: 4 - table showing comparison between fledge size, clutch gaps and number of days taken for weaning of budgerigars in four test cages.

<i>Number of cage</i>	<i>Cage 1</i>	<i>Cage 2</i>	<i>Cage 3</i>	<i>Cage 4</i>
<i>Average number of chicks weaned</i>	(2, 2, 1) 1.6	(2, 2, 2) 2	(3, 3, 4) 3.9	(4, 4, 5) 4.3
<i>Average number of days taken for weaning</i>	36.2	35.8	33.2	30
<i>Number of days between clutch 1 and 2</i>	75	70	60	55
<i>Number of days between clutch 2 and 3</i>	72	73	61	56

Number of days taken for laying first egg in first clutch after introducing them in four test cages were 18, 15, 13 and 10 in cage 1, cage 2, cage 3 and cage 4 respectively.

Comparison of the number of successfully weaned chicks in four test cages -

Breeding behaviour

In pair formation the effort is taken by males. Males kept close to the female and always tried to chase the female. She is not interested in this activity and flew away. The male chases the female and he bob his head up and down showing his feathers to the female. He flew from one corner of the cage to next corner and repeated the head bobbing to attract the female. This activity may last for hours and even days. Then she convinced with the activity of male and sit close to him. The male rub the female's beak and bob his head up and down, this may be repeated for several times. After that they sit very close and feed together. This is the sign of pair formation. She finally accepts the male and the pair were bonded.

After pairing the male start to dance by bob his head and rub his beak with female and jumping from one twig to another by making a chirping sound and show all excitement. After this the female may move along with the male, they sit together, feed together, auto- preening and allo-preening may be seen.

Courtship behaviour

Various courtship behaviour are courtship feeding/regurgitation, Closeness, Preening, Grooming.

Mating process

The male budgerigar makes a sound like 'click click kli' and move around the female. He is dancing very much. He boops his head continuously by facing female. She attracted and starts to sit like an arch. He put his foot on her wings and grab to climbing on her back. She perch like a arch shaped position and rise the tail in order to make comfort in the mating process. The female opens her wing to balance his weight. The male mounted on the female and down the tail in order to keep the mating process. In that time male vibrate and bend his body and make a crack sound like 'cra cre cra'. The process last only for 2 minutes, but repeats several times in a day. The peak mating is seen on early morning and evening. The intensity of cere colour in male is increased while mating. At the time of mating the eye rings are more visible in both sexes. There will be a noticeable change in cere colour of the females. The light cream coloured cere changed to dark chocolate brown colour.

Nest Selection

Selection of nest pot is carried out by female only. In case of a new pair, the selection of nest site starts two days after the mating happened. In case of old pair they select one nest pot for throughout their life, so they clean their nest after weaning the previous clutch. The nest pots were arranged in a row with an average distance of 20cm and also placed some nest pots on bottom and middle of cage. The distance between top and middle nest pot is 33cm, distance between middle and bottom is also 33cm.

After mating she starts to focus on nest site selection. There are 14 pots are given in the main cage. Females continuously enter all nest pots and they are little confused. All of them rejected the plastic pots and majority of them select top most nest pots and they reject nest pots which placed on middle of the cage. They also reject nest pot without upper covering. The female took three to four days to select the nest site.

Table no: 5 - table showing various measurements, positions and nature of nest pots(NP) in main cage for budgerigars.

<i>Nest pot number</i>	<i>Nature of NP</i>	<i>Circumference of NP (cm)</i>	<i>Height of NP (cm)</i>	<i>Hole size of NP (cm)</i>	<i>Distance from side wall of cage to NP (cm)</i>	<i>Position of NP on cage (cm)</i>	<i>Presence of Upper covering in NP</i>	<i>selected/ rejected</i>
NP-1	Clay	54cm	15cm	17cm	10cm	Top	Yes	Selected
NP-2	Clay	54.5cm	15cm	16 cm	11cm	Top	No	Rejected
NP-3	Clay	53cm	14cm	17cm	8.6cm	Top	Yes	Selected
NP-4	Clay	54cm	13cm	17cm	9.4cm	Top	Yes	Selected
NP-5	plastic	34cm	13. cm	18.3cm	3cm	Top	Yes	Rejected
NP-6	Clay	87cm	15cm	18.6cm	14. cm	Bottom	Yes	Rejected
NP-7	Clay	33.2cm	10cm	16cm	10cm	Top	Yes	Selected
NP-8	Clay	54cm	15. cm	17.6cm	12cm	Middle	No	Rejected
NP-9	Clay	77cm	14cm	16cm	8cm	Middle	Yes	Rejected
NP-10	Clay	54.6cm	12.4cm	13.2cm	7cm	Bottom	Yes	Rejected
NP-11	Clay	67cm	14cm	13cm	12.8cm	Middle	No	Rejected
NP-12	Clay	54.4cm	15cm	17.1cm	6cm	Middle	Yes	Selected
NP-13	Plastic	37cm	15cm	19cm	8.9cm	Middle	Yes	Rejected
NP-14	plastic	34.8cm	16.3cm	16.5cm	9cm	Bottom	Yes	Rejected

Table no: 5 indicate the factors affecting the nest site selection in captivity are hole size, medium sized pot, easiness to enter, less distance from the cage side walls to the nest pot hole, nest pot with upper covering, nature of nest pot.

Table no: 6 - table showing nest site selection factors of budgerigars.

<i>Factors</i>	<i>Inference</i>
<i>Circumference of nest pot</i>	<i>Medium sized</i>
<i>Height of nest pot</i>	<i>Medium sized</i>
<i>Hole size of nest pot</i>	<i>Medium sized</i>
<i>Distance from side wall to nest pot hole</i>	<i>Less</i>
<i>Easiness to enter</i>	<i>They prefer easiness</i>
<i>Position of nest pot</i>	<i>Top</i>
<i>Upper covering of nest pot</i>	<i>Having upper covering</i>

Various nest selection factors are listed in table no: 6

When the first chick weaned, mother started to second clutch. She continuously mated. When the last chick take more time for fledging, she become little confused and searching another nest near previous nest. When the last chick fledged early, mother not searches any other nest pots. In studies 90% females lays eggs after the last chick fledged out of the nest. In studies females select one nest throughout their life.

Nesting Behaviour

Normally budgerigars lay eggs in bare nest, there is no any nesting materials. An experiment was conducted to study nesting behavior by introducing some paper strips, wooden chips and coconut fiber into nest pot. All the females reject these nesting materials. They cleaned their nest by beak and legs. She spends more time in nest for cleaning. She picks dried droppings of previous clutch and thrown out. It was amazing to see. She patiently clean the nest and make it naked. Male sits close to the nest. Female started to ate internal skeleton of cuttlefish and scratches the wall which is white washed to get the calcium. Cuttlefish bone helped in beak trimming and a source of calcium and minerals. She becomes more aggressive. She gave only permission to her partner to sit near their nest. She prepared for the egg laying process. She spends more time in the nest. The male always follow the female and regurgitate the food. When she was came outside from the nest. Courtship behaviour may be seen. Mating also occurs continuously. She drops off her abdominal feathers and make it as nesting material.

Egg Laying

It was noticed that female's abdomen was swelled, vent becomes reddish and droppings become big. She vibrates her tail continuously. The rump become bulged up, her cloaca becomes so reddish and swollen. She looks so beautiful at this time and also looks so fatty and busy. Really she looks like a pregnant lady. She consumes more calcium resources. Mating continued and spends more time in nest pot.

The first egg was laid which is usually takes place nine to ten days after mating. The egg was oval and white in colour without any markings. After laying her first egg, she started to drop off her feathers rapidly.

There will be one day gap interval between egg laying, it also depends on food. When she came out from the nest, male sit very close to female and allo-preening may be seen. Feeding and mating will be seen regularly. After laying the second egg, she spend more time in the nest, it may be because she started to incubate the eggs.

Table no: 7 indicates various characteristics of budgerigar's egg.

<i>Egg colour</i>	<i>Average egg weight</i>	<i>Average egg circumference</i>	<i>Shape of egg</i>
<i>White</i>	<i>1.34gram</i>	<i>5.3cm</i>	<i>oval</i>

The colour of cere becomes more dark chocolate brown in female. The number of mating process gradually decreases, because she spends much time in the nest. She fed calcium resources and takes plenty of food. From this study it was conclude that after 15 days of incubation, they stop their mating. When she came out from nest, male regurgitate food and gives to female. She preens her body very fast and suddenly back to the nest pot. When she enters the nest, the rolling sound of eggs may hear.

Incubation

Incubation is continuous. Only female incubates the eggs. she started incubation after the second or third egg was laid. The eggs hatched on 18 days of incubation. But due to alternate egg laying, she never stops her incubation after first egg were hatched. So the incubation period of female is increases to 25 - 28 days. At the time of incubation female consumes low amount of food from the male. After the first egg hatched, she started to take more amount of food from the male. Female gave proper temperature to newly hatched chicks. After 25 days of incubation, female become more active to conceive food from the male. Female depend the male for food and she seek food her own also.. At the time of incubation, she is very responsible to maintain proper humidity, so she takes bath in water and maintain the humidity properly. In incubation, there is great chance for the ectoparasites. So that, when she came from the nest pot, wipes her body with 'ocimum leaves('thulasi' leaves). During incubation, she came out, two or three times from the nest pot daily for mating, consumes calcium, rubs her body with 'ocimum' leaves, water bath and feeding.

Egg Hatching and Parental Care

The hatching of budgerigar egg was synchronous. The first egg was hatched after 18 days of incubation. Out of nine eggs, five were hatched so the hatching success may be 55%, other 4 eggs were un-hatched due to movement of elder chicks, being unfertilized, death of embryo. The hatchling had a transparent and bulging abdomen. The body is flesh coloured and they hatch as blind and naked(without feathers). The food is partially digested seeds from the female's crop. Female

regurgitates to the hatchling's mouth through beak. Female fed more food and crop was bulged. Cleaning the nest was a continuous process. In this study, one female never clean her nest pot, it leads to sticking of droppings in chicks beak and foot, it becomes dried and sometimes it cover the cere may cause death of chicks due to suffocation.

When female enter the nest, the chicks were loudly cried and begged for food. The male gives food to chicks after six to seven days, when the first chick was hatched. Parents feed the chicks and female clean the nest daily. In this study it was observed that chicks opened their eyes on seventh or eighth day of hatching. The primary or pin feathers start to grown on seventh day of hatching. Chicks fledged nest after 30 days(depends on food) of hatching.

Vocalization

Syrinx is a bony structure at the bottom of trachea. Syrmechanism.

Budgie songs evolved through sexual selection and experiments. It suggest that quality of bird song is a good indicator of fitness. At the time of mating or breeding, male makes a special sound like 'click click kli', it attracts the female and she ready to mate. When any danger occurs or arrival of predator, they make a noisy sound like 'cralk cralk klki'. When the pair having chicks, female makes a 'ki ki ki' sound, that indicates female wants food and male gives the food. So she makes 'ki ki ki' sound continuously, when she takes regurgitate food from the male's beak. Female marks her territory and only allow her mate to come her space. She makes a 'cri cri' warning sound, when others enter her territory.

Conduct an experiment, that separated a budgerigar pair of distance about 100m . They are set in such a way that, they don't see each other. Female makes a sound, when the male makes sound from the separate cage. So they communicate through sound. They never select other partners. After 30 days, they were placed in same cage. They were paired again, so vocalization is very important for bonding.

Territorial Behaviour

Territorial behaviour of territoriality is a form of defense for food sources, home sites or other resources against the members of the same species. In case of budgerigars they are gregarious. But in their breeding time, they show territoriality. For testing their territoriality, I choose a pair and after 10 days, introduce few budgies on their cage. When any one sit near their nest, female become so aggressive and make loud voice and starts attack. The breeding pair considers their nest and few areas near the nest as territory. Female is more active for protect their territory. She only gives permission to her partner. Territory is a defended area of a habitat occupied by a breeding pair. Territoriality is the behaviour pattern used to identify, established and defend a territory. So budgerigars have very small territories of only a few square

meters. This is because they use the territory only for breeding purposes and most of the time they are outside territory for feeding. It considered as home range. They chew the nets and branches near their nest for mark the territory.

Best Breeding Season for Budgerigars

An experiment was conducted to see whether budgerigar breeding influenced by the seasons in Kerala (Table 8,9,10,11). Compare their clutch size in summer, rainy, spring, and winter seasons. Compare, how many chicks were successfully weaned outside. For this experiment main cage was selected and the same nutrient food that was given in test cage four was provided.

TABLE: 8 - Table showing the clutch size, incubation days and fledge size in summer season (March to May) of budgerigars

Budgie Pairs	Clutch size (total number of eggs in a clutch)	Number of marking egg in the order in which they laid	Date of egg laying	Date of hatching	Incubation days	Number of successfully weaned chicks.
1 st pair	8	1	30/03/2019	19/04/2019	20	4
		2	01/04/2019	21/04/2019	20	
		3	03/04/2019	20/04/2019	17	
		4	05/04/2019	22/04/2019	17	
		5	07/04/2019	Not hatched	-	
		6	09/04/2019	Not hatched	-	
		7	10/04/2019	Not hatched	-	
2 nd pair	6	1	01/05/2019	21/05/2019	20	2
		2	03/05/2019	23/05/2019	20	
		3	05/05/2019	Not hatched	-	
		4	07/05/2019	Not hatched	-	
		5	08/05/2019	Not hatched	-	
3 rd pair	6	1	28/03/2019	16/04/2019	20	3
		2	30/03/2019	18/04/2019	20	
		3	01/04/2019	22/04/2019	18	
		4	04/04/2019	24/04/2019	18	
		5	06/04/2019	26/04/2019	18	
4 th pair	9	1	30/03/2019	18/04/2019	20	3
		2	01/04/2019	20/04/2019	20	
		3	03/04/2019	21/04/2019	18	
		4	05/04/2019	Not hatched	-	
		5	07/04/2019	25/04/2019	18	
5 th pair	8	1	30/03/2019	19/04/2019	20	3
		2	01/04/2019	20/04/2019	20	
		3	03/04/2019	Not hatched	-	
		4	05/04/2019	22/04/2019	17	
		5	07/04/2019	25/04/2019	18	

Table no: 9 - table showing the clutch size, incubation days and fledge size in rainy season (June to August) of budgerigars

<i>Budgie Pairs</i>	<i>Clutch size(total number of eggs in a clutch)</i>	<i>Number of marking egg in the order in which they laid</i>	<i>Date of egg laying</i>	<i>Date of hatching</i>	<i>Incubation days</i>	<i>Number of successfully weaned chicks.</i>
<i>1st pair</i>	9	1	25/05/2019	15/06/2019	21	4
		2	27/05/2019	17/06/2019	21	
		3	29/05/2019	17/06/2019	19	
		4	31/05/2019	19/06/2019	19	
		5	02/06/2019	21/06/2019	18	
		6	03/05/2019	Not hatched	-	
		7	05/05/2019	Not hatched	-	
<i>2nd pair</i>	8	1	21/06/2019	11/07/2019	20	4
		2	23/06/2019	14/07/2019	21	
		3	25/06/2019	Not hatched	-	
		4	27/06/2019	15/07/2019	18	
		5	29/06/2019	17/07/2019	18	
<i>3rd pair</i>	9	1	25/05/2019	15/06/2019	21	4
		2	27/05/2019	16/06/2019	20	
		3	29/05/2019	16/06/2019	18	
		4	31/05/2019	18/06/2019	18	
		5	02/05/2019	20/06/2019	18	
<i>4th pair</i>	9	1	26/05/2019	16/06/2019	21	4
		2	27/05/2019	16/06/2019	20	

Table no: 10 - table showing the clutch size, incubation days and fledge size in spring season (September to November) of budgerigars

<i>Budgie Pairs</i>	<i>Clutch size(total number of eggs in a clutch)</i>	<i>Number of marking egg in the order in which they laid</i>	<i>Date of egg laying</i>	<i>Date of hatching</i>	<i>Incubation days</i>	<i>Number of successfully weaned chicks.</i>
<i>1st pair</i>	<i>10</i>	<i>1</i>	<i>23/07/2019</i>	<i>12/08/2019</i>	<i>20</i>	<i>5</i>
		<i>2</i>	<i>25/07/2019</i>	<i>14/08/2019</i>	<i>20</i>	
		<i>3</i>	<i>27/07/2019</i>	<i>14/08/2019</i>	<i>18</i>	
		<i>4</i>	<i>29/07/2019</i>	<i>16/08/2019</i>	<i>18</i>	
		<i>5</i>	<i>31/07/2019</i>	<i>18/08/2019</i>	<i>18</i>	
		<i>6</i>	<i>01/08/2019</i>	<i>Not hatched</i>	<i>-</i>	
		<i>7</i>	<i>02/08/2019</i>	<i>Not hatched</i>	<i>-</i>	
<i>2nd pair</i>	<i>12</i>	<i>1</i>	<i>18/08/2019</i>	<i>07/09/2019</i>	<i>20</i>	<i>6</i>
		<i>2</i>	<i>20/08/2019</i>	<i>09/09/2019</i>	<i>20</i>	
		<i>3</i>	<i>22/08/2019</i>	<i>10/09/2019</i>	<i>19</i>	
		<i>4</i>	<i>24/08/2019</i>	<i>11/09/2019</i>	<i>18</i>	
		<i>5</i>	<i>26/08/2019</i>	<i>13/09/2019</i>	<i>18</i>	
		<i>6</i>	<i>28/08/2019</i>	<i>15/09/2019</i>	<i>18</i>	
<i>3rd pair</i>	<i>9</i>	<i>1</i>	<i>26/07/2019</i>	<i>15/08/2019</i>	<i>20</i>	<i>4</i>
		<i>2</i>	<i>28/07/2019</i>	<i>17/08/2019</i>	<i>20</i>	
		<i>3</i>	<i>31/07/2019</i>	<i>18/08/2019</i>	<i>18</i>	
		<i>4</i>	<i>02/08/2019</i>	<i>20/08/2019</i>	<i>18</i>	
		<i>5</i>	<i>04/08/2019</i>	<i>22/08/2019</i>	<i>18</i>	
<i>4th pair</i>	<i>9</i>	<i>1</i>	<i>26/07/2019</i>	<i>15/08/2019</i>	<i>20</i>	<i>4</i>
		<i>2</i>	<i>28/07/2019</i>	<i>17/08/2019</i>	<i>20</i>	
		<i>3</i>	<i>30/07/2019</i>	<i>17/08/2019</i>	<i>18</i>	
		<i>4</i>	<i>01/08/2019</i>	<i>19/08/2019</i>	<i>18</i>	
		<i>5</i>	<i>03/08/2019</i>	<i>21/08/2019</i>	<i>18</i>	
<i>5th pair</i>	<i>9</i>	<i>1</i>	<i>26/07/2019</i>	<i>15/08/2019</i>	<i>20</i>	<i>4</i>
		<i>2</i>	<i>28/07/2019</i>	<i>17/08/2019</i>	<i>20</i>	
		<i>3</i>	<i>30/07/2019</i>	<i>17/08/2019</i>	<i>18</i>	

Table no: 11- table showing the clutch size, incubation days and fledge size in winter season (December to February) of budgerigars

<i>Budgie Pairs</i>	<i>Clutch size(total number of eggs in a clutch)</i>	<i>Number of marking egg in the order in which they laid</i>	<i>Date of egg laying</i>	<i>Date of hatching</i>	<i>Incubation days</i>	<i>Number of successfully weaned chicks.</i>
<i>1st pair</i>	6	1	30/11/2019	Not hatched	-	3
		2	03/12/2019	25/12/2019	22	
		3	05/12/2019	25/12/2019	20	
		4	08/12/2019	27/12/2019	19	
		5	10/12/2019	30/12/2019	20	
		6	12/12/2019	Not hatched	-	
		7	13/12/2019	Not hatched	-	
<i>2nd pair</i>	9	1	01/12/2019	21/12/2019	20	3
		2	03/12/2019	23/12/2019	20	
		3	05/12/2019	24/12/2019	19	
		4	07/12/2019	25/12/2019	18	
		5	09/12/2019	27/12/2019	18	
<i>3rd pair</i>	6	1	04/12/2019	Not hatched	-	2
		2	06/12/2019	Not hatched	-	
		3	09/12/2019	27/12/2019	18	
		4	11/12/2019	30/12/2019	19	
		5	13/12/2019	01/01/2020	19	
<i>4th pair</i>	6	1	24/11/2019	Not hatched	-	2
		2	26/11/2019	16/12/2019	21	
		3	30/11/2019	18/12/2019	19	
		4	02/12/2019	Not hatched	-	
		5	04/12/2019	Not hatched	-	
<i>5th pair</i>	9	1	27/11/2019	16/12/2019	20	3
		2	29/11/2019	18/12/2019	20	
		3	01/12/2019	20/12/2019	19	
		4	04/12/2019	22/12/2019	18	
		5	07/12/2019	Not hatched	-	

The months of March to May are summer in Kerala. The clutch size of five pairs are less. The first, second, third, fourth and fifth pairs were laid 8,6,6,9 and 8 eggs respectively. The first, second, third, fourth and fifth pairs having 4, 2,3,3 and 3 chicks respectively were successfully fledged out. The average fledge size in summer season is three. In hot weather condition they panning and wide spreading their wings. In addition, eggs hatch early and were more chance to damage of eggs. It takes 17 days to hatch.

The months of June to August are rainy season in Kerala. The clutch size of five pairs are high. The first, second, third, fourth and, fifth pairs were laid 9, 8, 9, 9, 9 eggs respectively. Then the first, second, third, fourth and fifth pairs having 4, 4, 4, 4, 4 chicks respectively were successfully fledged out. As compared with summer season more chicks fledged in rainy season. The average fledge size in rainy season is four.

The months of September to November are spring season in Kerala. The clutch size of five pairs are very high. The first, second, third, fourth and fifth pairs were laid 10, 12, 9, 9 and 9 eggs and having 5, 6, 4, 4 and 4 chicks respectively were successfully weaned out. The average fledging size is five, so fledging size is very high in spring season.

On 07/10/2019 a snake entered the cage. Budgerigars makes a warning sound like 'cri cri kra' and fly along the cage and after they stay on one corner of cage and become silent and inactive. Due to fear two pairs lay eggs on cage floor and others throw their eggs from nest pot and some others not incubate their eggs. They had no interest in breeding for a month. Then 43 to 54 days later, they were lay eggs on nest pot. So predators and stress is very much influencing their breeding.

The months of December to February are winter season in Kerala. The clutch size of five pairs are very less. The first, second, third, fourth and fifth pairs were laid 6, 9, 6, 6 and 9 eggs and having 3, 3, 2, 2 and 3 chicks respectively were successfully weaned out. The average fledge size is 3. They fluffed up their feathers due to cold. In addition eggs were hatch too late than normal incubation day. It takes 19 days to hatch.

Average incubation days of budgerigars during various seasons in Kerala

Winter - 21

Summer - 17

Spring - 18

Rainy - 18

Nutritional deficiency Diseases

The data on nutritional deficiency, parasites, bacterial, viral, protozoan and fungal diseases were obtained from an interview with veterinary doctors and breeders.

Parasites

Ectoparasites

The main ectoparasites seen in budgies are mallophaga(budgie lice), scaly leg and face mite(Cnemidocoptis mutans), red mites(Dermanyssus gallinae).

Prophylaxis for ectoparasites

- Spray avian insect liquidator, poron and clear ticks spray on the corner of cages and nest pots.
- Smoking the cage with turmeric powder and dried neem leaves.
- Hang tobacco leaves in the cage.
- Give clean drinking water
- Clean the cage and nest pots once in a week.
- Give ocimum leaves to eat and they applied it on their feathers.
- Add ocimum and neem leaves extract to the bath water.

Endoparasites

The main endoparasites seen in budgerigars are roundworm, tapeworm and Sternostoma tracheacolerum.

Treatment for endoparasites

- Deworm the budgerigars at regular time.
- Put aloe vera gel in the drinking water.
- Give ocimum and neem leaves extract.
- Use ivermectin oral and injection.
- Major deworming medicines are fenbendazole, albendazole, fentaplan.

MAJOR BACTERIAL, VIRAL, PROTOZOAN AND FUNGAL DISEASES are Budgerigar candidiasis, budgerigar sneezing, Parrot fever (psittacosis), budgerigar fledging diseases, French molt, Budgerigar beak and feather disease, Coccidiosis, conjunctivitis, bird flu.

Discussion

According to the animal welfare view, humans should be able to breed and use pets for our purposes, but animals should have their 'interests satisfied', including their health and wellbeing (Gruen-2011). Now a days, pet rearing is becoming a trend. Budgies have become a commercially popular pet, because of their beauty and high productivity. But in closed cages they don't get sufficient nutrients. At the same time they don't get comfortable cages. Another important thing is preparing a good cage. The cage should be constructed in the open air, in the presence of light and wind. Sunlight has a major role in their breeding. From this study, it is possible to

make a good nutrient rich feed. It increases their productivity and boosts their immune system. Vegetables, fruits, boiled eggs, leaves, cereal mixture, oil cakes, maize, calcium block and supplements increase their rate of production. Ullray et al. (1991) compared the nutritional content of seeds commonly used in commercial avian diets with estimated requirements of psittacine birds and concluded that they were typically deficient in aminoacids, calcium, phosphorus, sodium, manganese, zinc, iron, vitamins A,D,E and B12, riboflavin, pantothenic acid, choline and niacine. Complete diets are usually based on ground grains, such as corn, supply energy and ground grains, such as soybean meal or peanut meal for protein, vitamins, minerals, vegetable oil and purified amino acids and added in appropriate amount to make up for deficiencies in the grain and protein sources(Elizabeth .A.Koutos, Kevin D Matson et al. 2001)

Another important thing to do with food is to make their nest pots. In this study, it was found that they choose the nests that are best suited to nature. They choose the clay pot by avoiding the plastic nest pots. They want to lay their eggs in top most nest pots. They select medium sized nest pot. They choose to lay eggs in a nest pot that was easy to enter and no nesting materials were used. They choose nest pot once in a life time will be used throughout their lives in captivity. But, when the chicks don't come out of the nest pot in time, they will lay their eggs in another nest pot near the previous one. Overcrowding is an important problem. It leads to great competition for maintaining the territory and it leads to death of female. The females maintain the territory. Female spend more energy to care her chicks than male. With such females, we get good production and good quality chicks. The consequence of overcrowding is inbreeding, which negatively affects the quality of new generation. The abandonment of inbreed result in higher productivity and quality. Decide to make a pair and place in a separate cage, before they reach maturity. After pairing, put them in to the main cage. This will prevent inbreeding. Coccidiosis and conjunctivitis are the common diseases affect them. So clean the cage daily or twice a day. Try to include ocimum, murunga, spinach, centalla, *Plectranthus barbatus* leaves in their daily feed. Scaly leg and face mite is most common ectoparasites in budgerigars. The popular medicines for these parasites are ivermectin oral and ivermectin injection. Ascabiol is an ointment and applied to the dried lesions. To remove the mites they often rubbed the feathers with ocimum leaves. Use ocimum and neem extracts in their bathing water to control the mites and ticks. Endoparasites like roundworm, tapeworm also creates some health issues in budgies. The newly introduced budgies are quarantined and dewormed only after that there are no other diseases and parasites. Be careful to deworm the budgies at regular intervals. In the lab, it is known that females and male budgerigars recognize each other after being separated for 70 days (Felicity Muth-2011). In the study females recognize the sound of separated mate. She responds with a loud noise, when he makes noise.

then they are put together and then they become pairs again. They are monogamous and mainly communicate through vocalization. In the survey, it was found that albino(53.3%) budgerigar variety were the most demanded and second priority for spangle(20%). Demand is also high for rainbow budgies but their numbers are very low in Kerala and not many people know about it. Pied variety was very less in demand(2%). The albino's characters like white feather, red eyes, pink cere and pink foot make them highly demanded.

Learn the sex beforehand to prevent inbreeding. The male chicks cere is light pinkish in colour and light white or bluish colour in female chicks. So they must be separated and allow pairing with other budgies having no blood relations. Otherwise it may lead disabilities, reduce the productivity, stunted growth, uncontrolled growth of beak and nails and premature death. In the study, the breeding season for budgerigars in Kerala is from September to November. Since they are in captivity, they breed and produce chicks throughout the year. But high number of chicks fledged from September to November, this period is spring in Kerala. Less number of babies were fledged from the December to February, which is winter in Kerala. Although the rainy season does not produce as much in the spring but compare to other seasons the productivity is high in rainy season(June-August). Egg hatches early in the summer. Normally the egg incubation days are 18 days. But in summer it hatches on 17th days of incubation. But in winter season it is too late to hatch the egg, it hatches on 19th day of incubation. Most eggs are damaged during winter and summer. Perhaps excessive heat and excessive cold are one of the reasons for the damage of eggs.

Budgerigar chicks are altricial. The female lays eggs on alternate days, so that it hatches on alternate days. The first hatched chick is very powerful and therefore it is very easy for them to get food from the mother. The last hatchling is very small and unable to compete with the other chicks and chick dies due to inadequate food. When eight eggs are laid, five of them will hatch and other three eggs were damaged due to uncontrolled movement of elder chicks. In the study 95% of last chick were died. Due to captivity, they cannot survive outside the cage. In the study, it was noticed that they are released from the cage due to the carelessness, the crows and other birds were catch and kill them. The chicks learn every lessons of survival from their parents, a learned behaviour. When the baby is fledged from the nest pot, the father will be closer and protect the chicks than female. He also feed the chicks properly. Unfortunately, if chicks ever fall to the ground before being fledged, the rest of adult/juveniles will kill the chicks. They ate chicks meat and blood. It is a cannibalistic behaviour. So avoid overcrowding. They are afraid of what they see new, the condition is called neophobia. Their conservation status is least concern, that's why they are 3rd popular pet in the world. Budgies are highly sensitive to predator. They gives a certain kind of voice and instruct others. Accordingly, everyone is on the alert. The main problems in captivity were the attack of dog, cat, civet, rat

and snakes. So try to keep the cage in height. Budgies are feared in presence of snakes and they were thrown their eggs from the nest pot to outside. And most of the time, they sit outside the nest pot. Their active nature will be greatly reduced. The consequence lasts not only for one or two days but for months. They stayed away from breeding and not show any breeding activities. They stayed away from breeding and not show any breeding activities. They may know that their eggs is unsafe and that's why they thrown eggs from their nest. A few months later, their next breeding began. Therefore, the predator plays a major role in their breeding. They only breed, if the condition is safe and not stressful. Animals housed in artificial habitats are confronted by a wide range of potentially provocative environmental challenges. Many of the potential stresses that may adversely affect animals living in captivity(Kathleen N. Morgan, Chris T. Tromborg-2006). So construct a cage with thick and small hole sized wire mesh.The fledge size can be increased from one or two to three during summer or winter. If provided nutritious food, competition and diseases are seen in main cage due to overcrowding than in test cage 4, which accommodate only one pair with no overcrowding. A conclusion that can be reached after conducting two experiments- experiment to find most nutritious food and experiment to find fledge size in various seasons in Kerala. The fledge size was reduced when budgies were fed with less nutritious food and increasing the fledge size is observed in the test cage 4, when providing nutritious food. In the experiment to find fledge size in various seasons in Kerala. The same nutritious feed given in test cage four is provided in the main cage. If so, the fledge size must should be increases. Suppose, if the non nutritious feed was provided in winter and summer, the average fledge size would be one or two. In the study, even in that harsh climate, the average fledge size was three. It is because of the nutritious feed that we provided. In addition, the population of the main cage is very high, in short, overcrowded. Therefore, competition as well as diseases and parasites will increases. So this can adversely affect the fledge size. But there is only one pair in the test cage four, so there was no competition and no overcrowding. So diseases and parasites will be very high. If there is a nutritious diet, spring season, cage with fewer pairs and no stress, then the fledge size will be very high.

Conclusion

The study entitled "A STUDY ON ECOLOGY AND BEHAVIOUR OF BUDGERIGAR (*Melopsittacus undulatus*) UNDER CAPTIVITY AT EDAVANNA, MALAPPURAM DISTRICT, KERALA", was carried out from 2/3/2019 to 28/3/2020. Various aspects like morphometry, behavioural changes during breeding, feeding; maintaining territory, comparison of fledge size in various seasons of Kerala, colour varieties and their genetics; nest selection; diseases, parasites and their control and cage management were studied. By observing the cere colour of budgerigar, we can predict the sex.

Male has bluish cere and female has light cream colour except albino and lutino. Male has pink cere and female cere is light cream or whitish. So they show sexual dimorphism. Courtship behaviour include courtship feeding, closeness, preening, grooming. During mating there will be a noticeable change in the cere colour of the female. The light cream coloured cere changed to dark chocolate brown colour.

The most demanded budgerigars variety is albino(53.3%). The highest fledge size of budgies is from September to November in Kerala. This period is spring season in Kerala. Nutritious feed also enhances the productivity. Coccidiosis, conjunctivitis (eye infections) are the major diseases that affect them. Keep the cage hygiene. Don't forget to include ocimum leaves, muringa leaves, centalla leaves are in their daily feed, as this will give the immunity. Overcrowding is a main problem in captive breeding, which leads to inbreeding. Accomodate only a maximum of 10 pairs in a one meter squared cage. They should be dewormed at regular intervals. 90% of last hatchlings were died. Budgies prefer clay pots for laying eggs and the nest pots on the top and select less distanced hole from the mesh for easy entering. Eggs are more damaged during summer and winter season. Normally the egg incubation days is 18 days, but in summer it hatches in 17th days of incubation. But in winter season it is too late to hatch the egg, it reaches in 19th days of incubation. Now a days pet rearing is becoming a commercially popular pet, because of their beauty, productivity and easy to care. Nutritious food will increases the productivity. The nutritious feed, spring season, stress free environment and cage with fewer pairs will favour the fledge size.

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