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Brood chronology and parental care of oriental magpie robin *Copsychus saularis* in a semi urban area in Muvattupuzha, Kerala, India

Gitanjali G[1], Gigi K Joseph[2]
[1] PG and Research, Department of Zoology, Mar Ivanios College, Thiruvananthapuram, Kerala, India
[2] PG and Research, Department of Zoology, Nirmala College, Muvattupuzha, Kerala, India

Abstract
The brood chronology and parental care of Oriental Magpie Robin (*Copsychus saularis*) was studied in a semi-urban habitat for the first time in the South Indian state of Kerala during 2020. The study revealed that the breeding season of the bird extend from February to June. The nesting period lasted for six days; the average clutch size was 4.3 eggs/clutch. Average incubation period was 13.7 days and the nestling period lasted for 14.7 days. The brood chronology of the species was recorded for the first time in one of the semi-urban conditions prevailing in Kerala. The investigation revealed an excellent adaptive nature of the bird to survive in the hostile conditions of the semi-urban to urban regions. Observations indicate that the loss of habitat may threaten the long term survival of the species in the long run. Appropriate conservation steps including planting of more trees in degraded areas, planned urbanization, nailing of artificial nest boxes should be implemented.

Keywords: oriental magpie robin, brood chronology, parental care, brood patch, nesting phenology

Introduction
Oriental Magpie Robin is a resident breeder distributed in tropical southern Asia from Pakistan, India, Sri Lanka, Indonesia, Thailand, South China, Malaysia, and Singapore (Ali and Ripley 2001) [2]. It inhabits open woodland and cultivated areas often close to human habitations. It is a common bird of urban gardens and forests and feeds on insects and other invertebrates. Males of Magpie Robin are well known for their complex song delivery (Bhatt *et al*. 2000) [3]. The females sing briefly in the presence of males (Kumar and Bhatt 2002) [3]. Other than songs, this species uses a range of different call types (Kumar and Bhatt 2001; Manshor and Gawin 2020) [21].
Magpie Robins breed mainly from January to June in south-east Asia and March to July in India. Males sing from high perches during courtship. The display of the male involves fanning the tail and strutting, raising the bill and puffing up the feathers. They nest in tree hollows or crevices in walls and even adopt nest boxes. They make the cavity with grass and natural fibres. Female birds build the nest; about after a week, they lay eggs. Usually, upto five eggs are laid at intervals of 24 hours. The eggs are oval and usually pale blue-green with brownish speckles that match the colour of hay. There are a few studies on the breeding biology of this species (Sethi and Bhatt 2007; Singh *et al*. 2017) [37, 38]. But, no such studies have been made in the tropical suburban habitats in the south Indian state of Kerala.

Study Area
Muvattupuzha (Fig.1) is a major town situated in the central region of the South Indian State, Kerala. The name 'Muvattupuzha' means the joining point of three rivers originating from the Western Ghats. The town and western parts of the region are plains; the eastern parts are mainly highlands and agricultural areas. Essentially, these lands have soils deposited by Thodupuzha and Muvattupuzha rivers over a while due to floodings of the banks. Muvattupuzha has vast flatlands and paddy fields spread as far as 30 km to the east in the foothills of Western Ghats. The town is 20m above mean sea level (MSL). It has suburban characteristics and is thickly populated.

Fig 1: Study Area. Red Line Show Boundary of Muvattupuzha. Inset [A] Location of Study Region in India. [B]. Location of Study Region in Kerala.

Materials and methods

The breeding biology of Magpie Robin was studied for five months from February to June 2020 in the suburban areas of Muvattupuzha. A breeding pair of Magpie Robin was observed frequently in a house premise in the Kizhakkekara region of Muvattupuzha. A constant record of bird visits to the nesting site was maintained. The nest site was inside an electricity-board meter box fixed inside the wall on the northern side of the house. Birds were observed from 13th February 2020 in the morning (6.00 am -8.00 am) and evening (4.30 pm to 6.30 pm). Observations were made using a binocular (Skypoint 10m X 42m). Field visits were carried out on alternate days or as required for recording different breeding activities. Birds were observed keenly with the binocular to identify their sex as the male was darker in the breast region. The belly region of the male was whiter when compared to the female.

Nest preparation activities of both sexes that include examination of nest sites and bringing nesting materials were noted. The nest size was measured with twine and scale. The difference in the song pattern was also observed especially in dawn and dusk. The nest was observed every day in the morning. Redmi 5 pro mobile phone was used to take photographs. The dates and approximate timings of egg-laying were observed. Clutch size, egg-laying pattern, colouration, incubation pattern and behavioural differences during incubation were observed whenever possible. Clutch size is the number of eggs laid by a female in a single breeding attempt. The incubation period is the time elapsed between the laying of the last egg of the clutch and hatching of the last young and the nestling period was considered to be the time elapsed between the day when the first egg hatched and the day of the last chick flew away (Skutch 1945) [40]. Opportunistic observations were made whenever possible regarding the behaviour of the birds. The arrangement of eggs was observed every day and photographed during the incubation period.

The egg hatching was monitored and photographed. The morphological and behavioural changes of the nestlings were observed. The nestling period is the time lapsed between the hatching of the first young and fledging of all young in the nest. Parental provisioning was observed for both parents. Frequency and the type of food materials brought each time was observed whenever possible. Developmental stages of young chicks were observed and monitored daily. Photographs were taken every day and growth changes were identified. The differences in the sounds produced by chicks were also monitored daily. The chronology of all breeding cycles of Magpie Robin was recorded daily from 13th February 2020 to 25th March 2020 and tabulated. After the breeding period, the nesting materials were collected and sorted.

Results

Breeding Season and Singing Behaviour of the Male

Breeding activities of a pair of Oriental Magpie Robin commenced on 13 February 2020 and continued till 10 June 2020. There were three breeding cycles in the season. The first cycle started when the female was observed

bringing nesting materials to the nest on 13 February 2020. The activity continued till 20th February 2020. Even though the male bird was always found in the vicinity, the nest-building activity was solely done by the female. The breeding pair used the space within the Electricity Board meter box (20 X 30cm) fixed in the wall of a double storied house in the suburban regions of Muvattupuzha. The birds used to enter the box through the rectangular (8 X 5cm) opening of the box. The nesting materials included different lengths of natural fibres. However, they used very fine plastic fibres also for nest building. The nest-building activity was completed in eight days. In the subsequent cycles, the same nest was utilised by the pair. However, they took only five days to modify the nest each time by bringing few more fibres for giving a fresh appearance to the nest.

The male bird delivered complex songs during dawn in the breeding season. Dawn song delivery commenced before sunrise and was of two types: continuous songs and discrete songs. The bird used continuous songs in the presence of the female. Discrete song delivery took place at any time of day throughout the breeding season; it was maximum during dawn.

Clutch size and Egg characteristics

During the first cycle, a pale green profusely blotched egg was laid on the 9th day of observation. The egg was oval-shaped with brown spots of varying sizes. However, the spots concentrated more towards the blunt end. Four more eggs were laid one each on the successive days. The fifth egg was laid on 25 February 2020. The average length and breadth of the egg was 2.4 cm and 1.8 cm. Eggs were laid in the morning hours between 7.45 am to 9.30 am. The clutch size was five in the first and second cycles. However, in the third cycle, the female laid only three eggs. The arrangement of eggs changed every time.

Incubation Behaviour

The incubation commenced on the same day when the last egg was laid. The female was observed flushing from the nest during morning or evening hours. The male bird was observed occasionally coming to the nest and returned immediately. Only the female bird was found incubating the eggs all the time. However, the male mostly remained in the vicinity of the nest. The arrangement of eggs continuously changed over the days (Fig. 2). In the first cycle, out of the total five eggs, the odd egg was found either on the left side or the right side. On few occasions, eggs were arranged in a circle or a perpendicular direction. The incubation lasted till the day when the last egg hatched. There was an increase in the incubating time in the successive days. The incubation period lasted for 13 days. In the second and third cycles, the incubation period lasted for 14 days each. The male provisioned food to the female many a time during this period. The female developed a brood patch in the breast region.

Fig 2: Egg arrangement from Day I - Day XII of incubation

Nestling behaviour

On 7th March 2020 at 7.30 am, the first egg hatched; reddish-brown young one was seen with closed eyes and almost naked. After half an hour on the same day, one more egg hatched. The female removed the eggshells from the nest immediately after hatching and dropped them far from the nest. Nestlings responded to the parental feeding calls or arrival cues by gapping and exposing a bright yellow target in their mouths. The third egg hatched on the next day at 9.30 am. All the nestlings kept their heads deeply bowed downwards. One egg was found missing from the nest on the same day. The next day, the nestlings cuddled together and put their head erect. The following day, the chicks increased in size and the colour darkened. They became more active and started opening their mouth wide. Forelimbs widened and more frequent food provisioning by parents especially in morning and evening hours was observed.

The size of nestlings increased and its colour darkened further. Forelimbs were modified as wings and the head were kept erect most of the time. Frequent food provisioning was observed on successive days. Development of wing primordia with tiny spikes on the forelimb occurred on the following day. The eyes were still closed, nostrils were visible and frequent food provisioning was observed. The chicks were silent for five consecutive days; on the sixth day, they made begging calls. On the seventh day after hatching the first egg, the eyelids of the chicks separated. Many spikes and numerous feather sprouts appeared especially on the wing. Stages in chick development are shown in (Fig. 3). The remaining egg was found unhatched till the seventh day morning. In the evening, it was found missing from the nest. The clutch size and the number of chicks raised varied in three breeding cycles (Fig. 4). The nestling period lasted for 15 days in the first and second cycles. However, it took only 14 days in the third cycle (Table 1).

Fig 3: Hatching and various developmental of *Copsychus saularis*

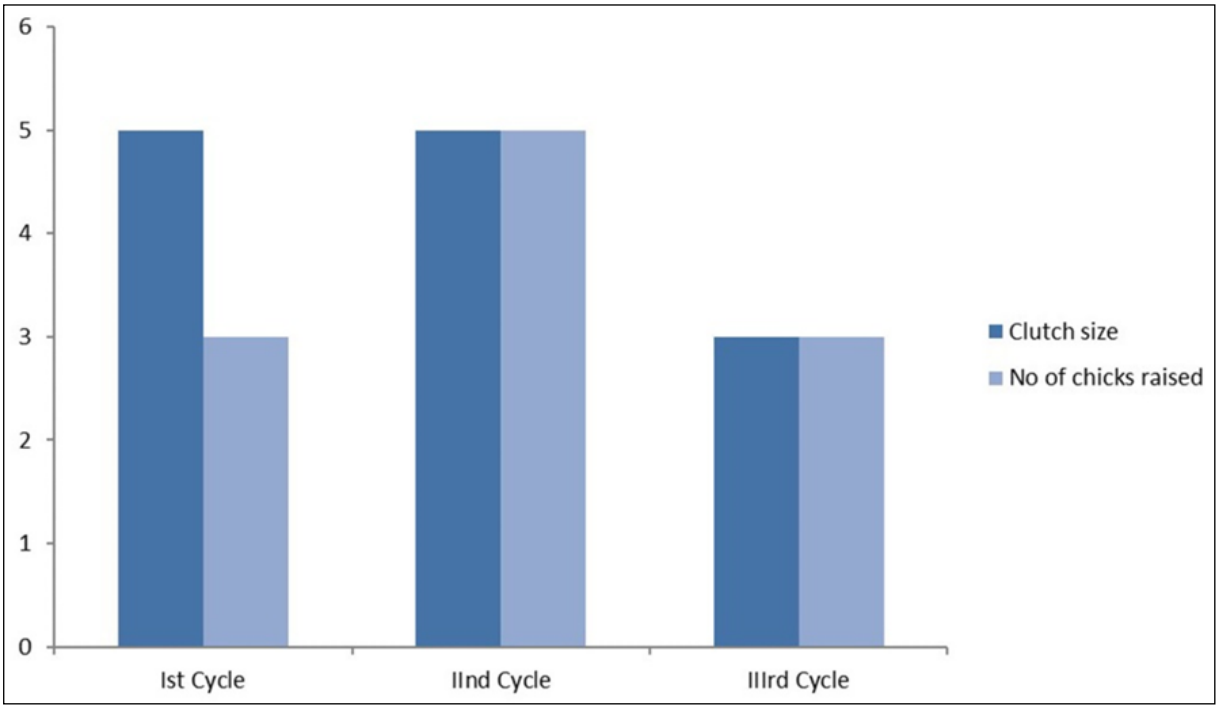

Fig 4: Clutch Size and Number of chicks raised in various breeding cycles

Table 1: Various phases in the breeding cycle of Magpie robin

Phases of cycle	No of days in Ist Cycle	No of days in IInd Cycle	No of days in IIIrd Cycle	Average
Nesting period	8	5	5	6
Egg laying period	5	5	3	4.3
Incubation period	13	14	14	13.7
Nestling period	15	15	14	14.7
Total	41	39	36	38.7

Chronology of the breeding cycle of Magpie Robin

The breeding cycle of Magpie Robin includes four main periods such as nesting period, egg-laying period, incubation period and nestling period. Of these, the nestling period (15 days) constituted maximum days followed by the incubation period (14 days). The nesting period was only eight days. The least number of days (5 days) were taken for egg-laying (Fig.5). The detailed chronology of events in the first breeding cycle is shown in (Table 2).

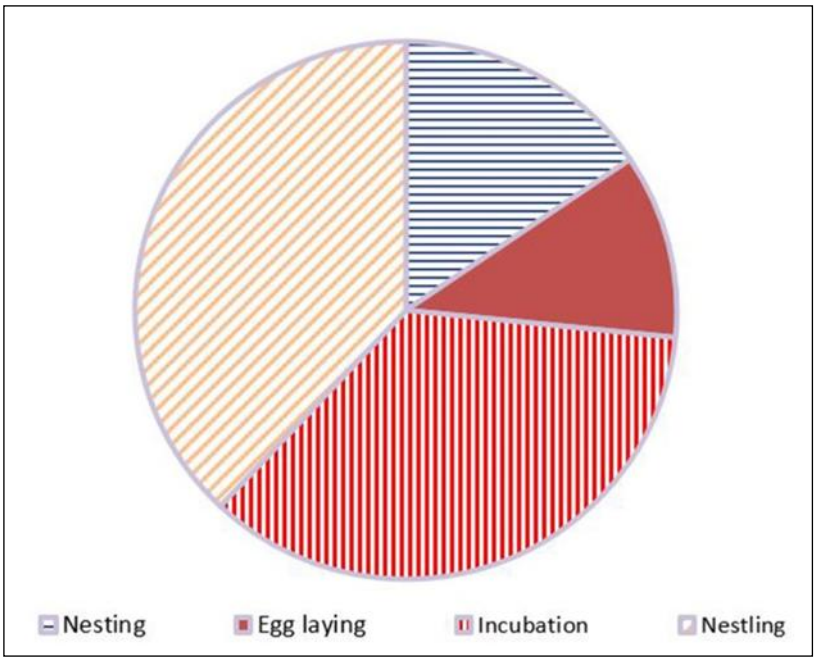

Fig 5: Breeding cycle of Oriental Magpie Robin

Table 2: Chronology of First Breeding Cycle of Oriental Magpie Robin in 2020

Sl No	Date	Observation at nest site
1	13-02-2020	Nest Examination by both the birds
2	14-02-2020	Nest preparation by bringing fibre like materials by female
3	15-02-2020	Nest preparation by bringing fibre like materials by female
4	16-02-2020	Frequent visit by female and occasional visit by male
5	17-02-2020	Bringing fibre like materials by female
6	18-02-2020	Observed bringing artificial fibres
7	19-02-2020	Arrangement of fibres in a circular way
8	20-02-2020	Empty nest and occasional visit by female
9	21-02-2020	An egg was seen at 8.00 am
10	22-02-2020	Two eggs were seen at 7.45 am;
11	23-02-2020	Three eggs were seen at 8.00 am;
12	24-02-2020	Four eggs were seen at 9.00 am;
13	25-02-2020	Five eggs were seen at 9.30 am; incubation by female
14	26-02-2020	Eggs were arranged centrally; female invest more time for incubation. Male bringing food to female
15	27-02-2020	Arrangement of eggs changed, odd egg on left side
16	28-02-2020	Arrangement of eggs changed, odd egg on right side
17	29-02-2020	Odd egg on left side. Male keep bringing food to female
18	01-03-2020	Arrangement of eggs changed to a perpendicular style
19	02-03-2020	Odd egg on right side
20	03-03-2020	Eggs were arranged in a circle
21	04-03-2020	Female spent more time on incubation
22	05-03-2020	Egg arrangement changed; incubation intensified
23	06-03-2020	Egg arrangement changed; incubation intensified
24	07-03-2020	One egg hatched at 7.30 am; one more egg hatched at 8.00am.
25	08-03-2020	Third egg hatched at 8.25 am. One egg was found missing. All the nestlings kept their heads deeply bowed downwards.
26	09-03-2020	The nestlings cuddled together and put their head erect. One egg remain unhatched
27	10-03-2020	The chicks increased in size. Colour darkened and more active; mouth wide opened; the remaining egg unhatched
28	11-03-2020	Forelimb widened, darker in colour, mouth wide opened, remaining egg unhatched. food provisioning in morning and evening
29	12-03-2020	Size increased, colour darkened, forelimb getting modified as wing, head erect most of the time, started to make low voice begging calls, frequent food provisioning, remaining egg un hatched
30	13-03-2020	Development of wing primordia; tiny spikes on the forelimb eyes not opened, nostril visible, frequent food provisioning; remaining egg unhatched
31	14-03-2020	Eyelids separated, many spikes seen on wings, feather sprouts on wings., frequent food provisioning
32	15-03-2020	Eyes of the nestlings wide opened; wings more developed
33	16-03-2020	One of the nestlings moved a distance away from rest of them inside the next box
34	17-03-2020	Tiny white feathers appeared
35	18-03-2020	Chicks started standing in their feet. The fifth and the remaining unhatched egg was missing
36	19-03-2020	Begging calls louder. Two other chicks also shifted its position, white feathers more visible
37	20-03-2020	One chick flew away from nest. Trying to fly about from two feet higher
38	21-03-2020	Two chicks remained in the nest
39	22-03-2020	Food provisioning continued to the remaining chicks in the nest
40	23-03-2020	Second bird flew away from the nest and it was more developed than the first chick.
41	24-03-2020	Third chick also flew away in the morning
42	25-03-2020	Empty nest. No sign of birds both parents and chicks in the near vicinity.

Discussion

The breeding season of the Oriental Magpie Robin started as early as mid-February in the present study. However other authors (Bhatt *et al*. 2014) reported the peak of breeding activity in June. They observed that the first batch of nestlings fledged on 23 May in 2008, 29 May in 2009 and 20 May in 2010. The long breeding season allowed breeding pairs to raise more than one brood. Almost the same length of breeding season has been reported in previous studies (Grimmett *et al*. 1998; Ali and Ripley 2001) [11, 2]. The present investigation reports the nest-building activity of Magpie Robin within an Electricity Board meter box for the first time. The nesting materials included plastic fibres and wires. This clearly shows their highly adaptive nature to urban and semi-

urban conditions. However, it is a secondary cavity nester species and nests in a variety of tree cavities such that of Mango (*Mangifera indica*), Pear (*Pyrus pyrifolia*), Loquat (*Eriobotrya japonica*), Indian blackberry (*Syzygium cumini*), Kadamb (*Neolamarckia cadamba*), Mulberry (*Morus alba*). Observations of pairs fighting for nest cavities have been recorded (Martin and Roper 1988; Bhatt *et al*. 2014) [22]. Absence of natural vegetation with old trees and the scarcity of potential nesting places in the study area may be forcing the pair to select the electricity board meter box for nesting. The area had been facing medium-scale urbanization for the last few years; agricultural lands were eventually being converted into concrete residential human settlements and business shops. Availability of cavity bearing trees are important for the fitness of the hole-nesting birds. However, the present study denotes the high adaptability of the species to artificial boxes. Former studies also showed high breeding success in nest boxes (Nilsson 1975; Van Balen *et al*. 1982; East and Perrins 1988; Alatalo *et al*. 1990; Lundberg and Alatalo 1992; Purcell *et al*. 1997) [27, 9, 1, 20, 31]. In contrast, studies (Ritter 1978; Mitrus 2003; Czeszczewik 2004) [32, 25, 7] reported higher breeding success in natural tree cavities than nest boxes. While other studies, could not report some effect of nest boxes on nesting success (Johnson and Kermott, 1994; Miller 2002) [13, 24].

The male delivered continuous songs in the proximity of the female in the present study. Dawn chorus was regular; it is a common feature of several songbirds (Catchpole and Slater 2008; Sethi *et al*. 2012; Singh *et al*. 2019) [6, 36, 39]. The intensive singing of territorial male birds occurs within the signalling range of several conspecific males (Sethi *et al*. 2011) [35]. Such singing over a long period under standardized stimulus conditions makes the dawn song potentially important information for both simple receivers and eavesdroppers (Poesel *et al*. 2004) [30]. Many studies have also shown that song complexity plays a role in female mate choice (Howard 1974; Catchpole 1980) [12, 5]. Females often prefer longer songs as evidenced by previous studies (Moller *et al*. 1998; Catchpole and Slater 2008) [26, 6]. The breeding season of Magpie robin is characterised by the dawn chorus of the male which serves to define the territorial boundaries.

The maximum clutch size was observed five in the present study. But the clutch size observed in the Magpie Robin in earlier studies ranged from 3-6 eggs (Bhatt *et al*. 2014). They reported that most nests (57.9%) had a clutch of five eggs followed by four (28.9%), 6 (7.9%) and three (5.3%) eggs. The current results for clutch size are comparable with the existing literature. The clutch size varies from 3-6 eggs for the Magpie Robin with three being an occasional number of eggs in a clutch (Ali and Ripley 2001) [2].

In the present investigation, the average incubation period lasts 13.7 days. The incubating time increased in the successive days. The male provisioned food to the female many a time during this period. The arrangement of eggs was continuously being changed over the days. The incubation period ranged from 12-14 days with a mean value of 12.4±0.5 days (Bhatt *et al*. 2014). They also observed the appearance of brood patch in females whereas none of the males developed the same. Brood patch was unmistakably observed in all the females, however, strictly during incubation and pre-nestling phases of the breeding season. Developing brood patch is comparatively a common phenomenon but the number, placement and development time of the brood patches vary widely across different bird species (Jones 1971) [14].

Even though five eggs were there in a single clutch in the first cycle, only three hatched. A couple of eggs were missing during the incubation period. A similar case was reported earlier (Singh *et al*. 2017). Nestlings continuously responded to the parental provisioning, specific feeding calls or arrival signals by gapping and exposing their mouths. The nestlings were completely dependent on their parents for their protection and feeding. To be fed by the parents, nestlings used soft begging calls almost throughout the day from nests. The nestling produced low voice begging calls on the fifth day of their hatching. Physical characteristics of the begging call of nestling of the Magpie Robin have already been studied (Kumar and Bhatt 2001; Manshor and Gawin 2020) [21]. The loud and rapid begging calls of nestling birds are cues of their hunger and stimulate parental provisioning. Parents often respond to begging calls by feeding the most intensively begging nestling (Kolliker *et al*. 1998) [17]. On some occasions, they may increase their provisioning rate for all in a brood (Ottoson *et al*. 1997).

According to Dearborn (1999) [8], the conspicuous calls of nestlings can also attract predators to the nest and subsequent risk. In such situations, it is necessary to trade off the nutritional benefits of begging call against the cost of predation (Maurer *et al*. 2003). The parent birds warn chicks of danger so that they do not vocalize when predators are in the vicinity (Platzen and Magrath 2004). Some experimental studies in various bird species proved that artificial playbacks of alarm calls suppressed begging calls of nestlings or they crouch into nests (Ryden 1978; Greig-Smith 1980; Knight and Temple 1986) [33, 10]. Biparental provisioning was observed in the current study as it was not on previous occasions. However, the female feeds the young more than the male (Sethi *et al*. 2010; Sethi and Bhatt 2007) [34]. The nestling period, time-lapsed between the hatching of the first young and fledging of all young in the nest, was observed 15 days in the present study; it corroborates with other studies. The nestling period ranged from 13-16 days with a mean value of 14.72±0.55 days (Bhatt *et al*., 2014).

Conclusion

Though, Oriental Magpie Robin inhabits in all types wooded country including parks and gardens, habitat loss, degradation and fragmentation affect their population. However the study revealed an excellent adaptive nature of the bird to survive in the hostile conditions of the semi-urban to urban regions. Observations suggest that the loss of habitat may threaten the existence of the species in the long run. Appropriate conservation measures

including planting of more trees in degraded areas, planned urbanization, nailing of artificial nest boxes are suggested.

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