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Phenotypic characterization and documentation of Gaddi dog of western Himalayan region of India

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ABSTRACT

India has the privilege of having excellent dog populations, but efforts to recognize them as distinct breeds are far and wide. The present study was designed to undertake the phenotypic characterization of Gaddi dogs, in Himalayan region of the state of Himachal Pradesh, India. The approach used was to gather as much information available on Gaddi dogs from communities involved in their traditional rearing. Though, many anecdotal evidence about its origin exists, the most plausible relates it to the development of this distinct breed by Gaddi shepherds during migration in Himalayan ranges. The Gaddi dogs are predominately black with occasional white marking on the feet, tail, or trunk region. One of their main attributes is their massive, arched neck that protects them from predators. These dogs have harmonious build, medium stature, moderately long, robust muscular body. In bitches, age at first estrus ranged from 12-18 months with main breeding season from September to November. The number of whelping in a lifetime was reported to be 8-12 with a litter size of 4-8 pups. Shepherds usually do not follow a strict vaccination or deworming schedule of the dogs and housing is also not provided. The dog is primarily developed and used for the herding of sheep and goats by shepherds of the Gaddi tribe. These shepherds must be rewarded and encouraged to maintain the purity of the breed. The present study paved the way for recognition of the Gaddi dog and highlighted the headway options for its conservation and propagation.

Keywords: Gaddi tribe, Phenotypic characterization, Shepherd dog, Transhumance, Western Himalayas

There exists great diversity of domestic animal breeds in India (Raja *et al*. 2017). During the last two decades, there has been an increased thrust to recognize different breeds of animals leading to an increase in documented breeds and varieties. So far, the National Bureau of Animal Genetic Resources (NBAGR) has registered 202 breeds of varied species of animals. However, only three breeds of domestic dogs (*Canis lupus familiaris*) have been registered to date. In India, dogs have always been used for hunting, fighting against enemies, companionship cum guarding and the country has privilege of having excellent dog populations/ breeds (Sowmyashree *et al*. 2022). However, the efforts for their documentation and registration are scanty (Raja *et al.* 2016). Thus, there is a greater need for recognition of different breeds of dogs. Transhumance is a traditional livelihood practice that is followed by human communities in many mountainous and arid regions of the globe including the Himalayan region of India (Oteros-Rozas *et al*. 2013, Easdale and Aguiar 2018). The shepherd's dogs in these flocks are unique in the sense that they are a kind of link between the livestock and humans, communicating/ associating with the livestock by herding/protecting them and with the shepherds in many ways. One of the important groups of dog breeds present in India is the Himalayan sheepdog. This group in India includes Bhotia, Bangar, and Gaddi, sometimes called the Himalayan mastiff, a livestock guardian dog from the Himalayas, covering India and Nepal (Web reference a). Among these in the state of Himachal Pradesh, Gaddi is the prevalent one followed by a related group of Bhotia in the region adjoining Uttarakhand. This breed, like many indigenous breeds, is on the verge of extinction due to dilution in the gene pool and a lack of dedicated breeders and breeding programs. Efforts to recognize them as distinct breeds, and register them with the national repository are inadequate. Therefore, characterization of their farming along with the documentation/recognition of the animals is important from a scientific as well as societal perspective. Thus, the present study was designed to undertake the phenotypic characterization of Gaddi dogs and develop breed descriptors.

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MATERIALS AND METHODS

Data collection: The study was conducted under the project 'Characterization of Gaddi dogs in its home tract and establishment of a Gaddi dog conservation cum propagation unit' during March 2021-December 2021. A set

of questionnaires were designed to collect the information about the historical use of the breed, management practices followed from communities involved in their traditional rearing, attributes of migratory farming (socio-economic/ demographic/other trends), physical biometric traits, reproductive performance, and importance/utility of breed. The secondary data generated through other projects were used for screening the pastoral database of migratory shepherds. Four to five migratory shepherds from each prominent migratory route (Supplementary Fig. 1) through the Dhauladhar Himalayan range were selected for interview initially. The range was selected primarily since the Gaddi tribe is mainly concentrated in this region.

The physical traits were recorded on individual dogs by using graduated measuring tape. During migration, the strategy of measuring at the camping site in the morning hours was adopted to achieve maximum cooperation from animal/flock owners (Supplementary Fig. 2). The morphometric traits under study included body weight (BW), wither height (WH), height at the base of the tail (HBT), face length (FL), neck length (NL), body length (BL), tail length (TL), neck girth (NG), chest girth (CG), paunch girth (PG), head length (HL), snout length (SL), snout width (SW), muzzle length (ML), muzzle depth (MD), muzzle width (MW), ear length (EL), ear width (EW), forefoot length (FFL right and left), lower foreleg length (LFL right and left), upper foreleg length (UFL right and left), hindfoot length (HFL right and left), lower hind leg length (LHL right and left), upper hind leg length (UHL right and left). The morphometric data were analyzed and a comparison of mean biometry between sexes was done using one way ANOVA (Analysis of Variance) through SAS 9.3 software program.

RESULTS AND DISCUSSION

History, origin, and use: Gaddi dogs are excellent shepherd dogs, native to Himachal Pradesh, Uttarakhand, and Jammu Union Territory in India. There exists several anecdotal evidence about its origin but the most plausible one relates it to the development of this distinct breed by Gaddi shepherds during migration in Himalayan ranges. *Gaddi* tribes are transhumant sheep and goat herders that derive their name from *Gadderan,* the Bharmour region of Himachal Pradesh (Singh 1994). The importance of livestock in their life is reflected by the fact that they call it '*Dhan*' meaning money, primarily because of the economic benefits they derive from the sale of livestock (for meat), wool, and other products. Gaddi dog might be related to the Tibetan mastiff but over the evolutionary time scale, it got distinct owing to its distribution and use. The Gaddi dog differs from the Tibetan Mastiff with longer legs, higher hocks, less bulk, and iconic agility. One thing is certain that if we could see the use and habitat of this breed in contrast to Tibetan Mastiff, a few demarcating features like prolonged migration from higher hills to foothills, less exposure to extreme winter and food habits/exposure to human civilizations in the lower Himalayan region clearly depict the distinct identity of Gaddi breed from Mastiff. Interviews of Gaddi dog rearers revealed that since pre-independence era, the property owners or orchardists were fond of Gaddi dogs and demand for their pups was remarkable. According to them, it was of an obligatory nature as most of the tracts passes through their estates. Thus, the dog breed is surely valued as priced animal for a long time. Over the years with the fragmentation of land, infrastructure boom in the lower plains, and shifting of agriculture activities, the use of guard dogs by lower range farmers got reduced but the possession of a Gaddi dog for rearing as a companion animal is still observed. Socio-economic and flock characteristics are presented in Table 1. The average flock size revealed in the survey was 146.52±12.36. The sheep and goat proportion was 57.69 and 40.46 %, respectively.

Table 1. Flock and socio-economic characteristics of surveyed Gaddi shepherds (N=72)

Flock characteristics	
Average flock size (Mean ±SE)	146.52±12.36
Sheep%	57.69
Goat%	40.46
Dogs%	1.85
Social characteristics	
Average family size (Mean ±SE)	5.74±0.26
Landholding in Bighas (Mean±SE)	10.25±0.75
Economic characteristics	
Income from all sources (INR)	1,15,860±4704
Income from migratory farming/year	74,698±3869
Income from dog/puppies	4471±503
Proportionate income from migratory farming (%)	64.47
Income from the dog as proportionate to migratory farming (%)	5.98
Breeding management for dog	
Own flock	32(44.44)
Fellow farmer	21(29.16)
Random in pasture/migration	19(26.38)

Almost all flocks had at least 2 Gaddi dogs, while some have as many as 6 dogs per flock. Dogs contributed to about 1.85% of the total flock size. In spite of the prevalent trend of nuclear and fragmented families in societies in general, the Gaddi tribes still prefer a joint family system and the average family size was 5.74±0.26. Migratory farming accounts for 64.47% of household income, while the income from the sale of pups contributes to about 5.98% of household income.

Physical characteristics: Representative pictures of an adult male, female and female with pups are presented in Fig 1, Fig 2 and Fig 3 respectively. The Gaddi dogs are predominately black with occasional white marking on the feet, tail, or trunk region. The other major colour variation is brown and an admixture of brown and black.

Like many shepherds' dogs and mastiffs, their tail curls back over the body and is very fluffy. Gaddi dog has a solid mane and a thick undercoat. The skull of a Gaddi dog is

Fig. 1. Adult male Gaddi dog.

Fig. 2. Adult female Gaddi dog.

Fig. 3. Female with pups at farmer's flock.

broad and pointed, making them hard to grip in the jaws. Likewise, their necks are thick and hard to bite, giving them an advantage over the slighter predators they fight on the mountainsides. There is probably another type of landrace which needs to be distinguished from the Gaddi dog since it is also reared by Gaddi shepherds and other tribes involved in migratory farming. This in local dialect is referred to as *baan* or *van* Gaddi (Supplementary Fig. 3). It is not true to the type Gaddi breed but could be considered as another probable landrace, developed by migratory shepherds, and is distinguished clearly from Gaddi by a smaller build-up, the hair pattern on the head and snout region, comparatively slender and tucked-up body. On a behavioral aspect, *baan* Gaddi dogs are friendly enough to get along well with other pets and strangers, while Gaddi dogs are territorial, dominant, and reserved dogs. (Web reference b).

Peculiarity of physical characteristics and advantages in migratory farming: The physical features of Gaddi dogs helps them to survive in difficult terrains and adapt to the rapidly changing weather conditions and migratory routes. With fluffy tail and a unique double coating around the throat and shoulder, these dogs can cross glaciers and withstand snowstorms with ease. Further their massive, arched neck protects them from predators. They have long, heavy legs and large feet that are covered with hair, which makes them even more intimidating. Gaddi dogs have long pointed muzzles without any molloser semblance. They also have a wide forehead, pendulous ears and a maned neck. They are deep-chested with a wider neck that provides the power to take on large predators. Their folded ears flop at the side of their face and they have round, expressive eyes that are always alert. This dog is a perfect build for the harsh surroundings of the Himalayas. The majority of the animals studied had 20 (forelimb-5+5 and hind limb-5+5) nails and a few had 18 nails. There was a belief among the breeders that the animals with 20 nails are more aggressive than the animals with 18 nails, and are usually referred to in the local dialect as "*Beesah*". The paws of 20 nailed animals are broader which helps them in capture the prey and better foothold while moving on treacherous tracks.

Biometric traits: Mean value for studied morphometric traits for both the sexes along with standard error are presented in Table 2. Thus, it is a medium-size dog breed (adult male 32-40 kg; adult female 28-35 kg) having comparatively less build-up than Tibetan Mastiff for which range of adult body weight for male and female is 40-60 and 35-55 kg, respectively (AKC). Adult body weight of related sheepdogs of the western Himalayan region, Bhote Kukuur of Nepal and Bhakarwal of Jammu is like Gaddi dogs. The mean height at withers for male and female animals was 24.03±0.27 and 22.04±0.29 inches respectively. Whereas for Tibetan mastiffs standard height at wither is minimum of 26 inches for males and 24 inches for females (FCI, 2015). The chest girth of adult male and female Gaddi dogs was observed to be 30.68±1.01 and 28.15±0.69 inches, respectively. Out of 30 phenotypic traits studied, 15 traits were observed to be significantly higher in males as compared to females which might be due to the sex effect (Table 2). Very scanty documented literature was available for phenotypic characterization of the Himalayan sheepdog. However, as per the kennel club information and web resources, it could be clearly established that Gaddi breed of dog is a medium type dog visibly distinct from mastiff-type by being, less massive, forehead build-up and to some extent by the degree of pendulous lips (Web reference d). A typical Tibetan mastiff could easily be differentiated from Gaddi dogs, but since the admixture of the dog population is quite widespread practice especially by local breeders and kennels, sometimes the resemblances are difficult to demarcate.

Reproduction traits: The first estrous in female dogs is usually observed around 12 months of age and the range is

Table 2. Biometric trait of adult Gaddi dogs

Trait (inches)	Male (n=28)	Female (n=61)
Bodyweight (kg) (one year)	32.58±0.84	26.68±0.52**
Adult body weight (kg) (2-4 years)	38.70±0.80	32.25±0.61**
Wither height (WH)	24.03±0.27	22.04±0.23**
Height at base of the tail (HBT)	23.18±0.24	22.30±0.21*
Face length (FL)	8.3±0.26	7.7±0.16*
Neck length (NL)	7.5±0.15	6.6±0.12**
Body length (BL)	29.63±0.43	27.02±0.32**
Tail length (TL)	11.59±0.29	10.70±0.13*
Neck girth (NG)	22.05±0.69	20.23±0.43*
Chest girth (CG)	30.68±1.01	28.15±0.69*
Paunch girth (PG)	27.64±0.97	27.88±0.57
Head length (HL)	6.68±0.18	6.22±0.14
Snout length (SL)	4.36±0.37	4.35±0.16
Snout width (SW)	4.25±0.18	4.01±0.08
Muzzle length (ML)	3.92±0.30	3.18±0.22
Muzzle depth (MD)	2.68±0.12	2.73±0.06
Muzzle width (MW)	2.45±0.05	2.48±0.09
Ear length (EL)	5.01±0.09	4.33±0.08**
Ear width (EW)	4.12±0.06	3.65±0.07**
Fore foot length (FFL) right	7.95±0.14	7.70±0.13
Fore foot length (FFL) left	7.95±0.14	7.70±0.13
Lower foreleg length (LFL) right	7.18±0.30	7.20±0.18
Lower foreleg length (LFL) left	7.18±0.30	7.20±0.18
Upper foreleg length (UFL) right	7.17±0.15	7.20±0.09
Upper foreleg length (UFL) left	7.17±0.15	7.20±0.09
Hindfoot length (HFL) right	7.91±0.28	7.70±0.18
Hindfoot length (HFL) left	7.91±0.28	7.65±0.19
Lower hind leg length (LHL) right	10.59±0.26	9.88±0.18*
Lower hind leg length (LHL) left	10.59±0.26	9.88±0.18*
Upper hind leg length (UHL) right	9.34±0.25	8.66±0.19*
Upper hind leg length (UHL) left	9.34±0.25	8.66±0.19*

around 12-18 months, while the duration of estrus ranged from 14 to 21 days. The shepherds do not specifically follow the days post oestrous bleeding and it is usually natural if a male dog is available in the flock or else the mating day will be determined according to the location of migration and availability of good male dogs in nearby flocks. Shepherds used to mate the females for the first time at the age of around 20-24 months (age at first mating) while, in the case of male dogs, the first mating used to be at the age of 24–30 months. The gestation length is 2 months. The age at first whelping ranged between 22–30 months with a whelping interval of around 12 months and the number of whelping in a lifetime was reported to be 8-12. The litter size ranged from 4 to 8 pups per whelping.

Management practices

Housing: In the migratory system, housing is not provided to livestock including dogs. At the most during extreme weather conditions at night, temporary shelter is provided to the ill or injured animals including young ones. The Gaddi dog usually takes guarding position (Supplementary Fig. 4) nearby a flock and mostly they appear sleepy but in fact, are quite attentive and immediately respond to wild predators or even strangers. Neonatal Gaddi pups are taken by placing them on well-ventilated backpacks during migration.

Feeding: In contrast to the usual belief that Gaddi dogs are mainly kept on non-vegetarian diets, shepherds rear them on maize roti, flatbread, goat milk/cheese and occasionally rice which they cook for themselves. The majority follows twice a day feeding synchronously with resting and cooking at the camping site. Occasionally, shepherds also cook mutton/chevon/chicken which along with rice/roti are fed to the dogs. Only one or two pups from each litter are retained by Gaddi shepherds and these are reared primarily on mother's milk. Young growing animals, breeding and the lactating female dog are also fed with goat milk.

Breeding: Gaddi dogs were mostly seasonal breeders with one (occasionally two) breeding cycles in a year. The main breeding season as reported by the shepherds was September to November (during the initial lag of downward migration from alpine pastures). The shepherds had adopted a very ingenious strategy of mating during the initial leg of downward migration so that the whelping is usually around the final leg of migration, near the camping site and in congenial environment conditions so that the survivability of pups increases. Even then the pup mortality ranges between 30-50% owing to the basic nature of migration, which puts young ones at a greater threat from a multitude of factors.

Health management: Shepherds usually do not follow a strict vaccination or deworming schedule of the dogs. The shepherds reported that dogs get a bath on their own whenever they found an opportunity and were occasionally bathed by the shepherds during leisure time near camping sites out of compassion. Dermatitis or skin related problems are however not very frequent and occur mostly in the lower migratory tract.

Utility: The dog is primarily used for the herding of sheep and goats by the Gaddi shepherds, which is the main reason the dog was developed for. However, some people do keep it as guard or companion dogs in mid and lower foothills but it requires earnest effort and care from beginning to train for that purpose. Since by its very virtue the Gaddi dog are very alert to wild animals and unknown persons, thus sometimes create a problem for the visitors too, and being very dominant and territorial, are not suitable for apartment living. The shepherd's sometimes apart from herding, earn money by selling the puppies due to the high demand for Gaddi pups. However, many a times out of social obligation Gaddi puppies are given to the land-owner or acquaintances nearby the camping site as token money or kind of gratitude for utilizing their resources.

Recent trends affecting the transhumance, Gaddi dogs and future: Trends of transhumance of the Gaddi tribe must be understood to fathom the future of Gaddi dogs. Many studies established the fact that the younger generation

is not taking migratory farming as a preferred avocation (Singh *et al*. 2006, Suresh *et al*. 2011, Sankhyan *et al*. 2016). Looking beyond 50 years from now with a multitude of factors like reduction of adoption by the younger generation, thrust on development of tribal infrastructure, plantation activities, horticultural boom, climate change and constraints associated with migratory farming, greater impact on the system is anticipated with generation change (Ramprasad *et al*. 2020). Most of the farmers presently practicing the migratory framing are in their middle age so in contrast to their earlier generations, a sizeable number of them eventually will not be able to pass the baton of migratory farming to their next generation. However, it is difficult to outline how migratory farming will reorient in those testing times but may exhibit reorientation by adding other dimensions. One of the examples to support this hypothesis is that in the last few decades many farmers adopted strategies like pooling their flocks more often than done in the past, hiring labour with partial ownership in flocks. Thus, after a few decades when the system will be facing the greatest challenge, it may respond with operational elasticity to be resilient. Thus, the greater focus to characterize the Gaddi dog in present times is justified so as it should maintain its association with migratory farming, which will surely face greater challenges in the coming year.

The present study concluded that the information about the Gaddi dog and its population qualifies for recognition as a distinct breed owing to its uniformity, peculiarity, and importance as a herding dog in the western Himalayan region. Thus, there is an urgent need to register this dog population as a breed of indigenous dog through the National Bureau of Animal Genetic Resources, the nodal agency for livestock breed registration in the country. This study including the preliminary survey and phenotypic characterization along with the establishment of a conservation and propagation unit will be instrumental in getting the breed a well-deserved recognition and distinct breed entity. Institutional efforts are also needed to include scientific breeding, healthcare, and management aspects through ongoing sheep and goat improvement programs. The shepherds must be rewarded and encouraged to maintain the purity of their breed by promoting approaches such as shepherd society of dog breed, breed saviour awards and certification of their animal for true to the type. Thus, the present study paved the way for recognition of the Gaddi dog and highlighted the headway options for its conservation and propagation.

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