A new methodology for characterization of dog genetic resources of India

Raja KN*, P K Singh, AK Mishra, I Ganguly and P Devendran[1]
National Bureau of Animal Genetic Resources, Karnal-132001 (Haryana) India

ABSTRACT

India with a total of 160 registered breeds of livestock and poultry, also possesses a large number of lesser known/ undocumented/ undefined populations of farm animals. In country, there are about eight indigenous dog populations, which are mainly utilized for guarding of agriculture farm and shepherding. However, due to lack of proper methodology specific to dog, the characterization of most of populations is remained uncompleted so far. Based on a pilot survey for Rajapalayam and Chippiparai dog breeds of Tamil Nadu, a survey questionnaire was developed for characterization and a breed descriptor for documentation of the indigenous dog breeds. Kennel club of India, Chennai has registered few of the Indian dog breeds including Rajapalayam and Mudhol Hound. However, this newly evolved survey questionnaire and breed descriptor may be universally used for characterization and documentation of indigenous dog populations/breeds and may be registered further through breed registration procedure at National level.

Key Words: Biometric traits, dog breeds, phenotypic characterization

Present address: [1]Tamil Nadu Veterinary and Animal Sciences University, Chennai

***Corresponding author:** drknraja@yahoo.co.in

INTRODUCTION

India possess 160 registered domestic animal/poultry breeds belonging to cattle, buffalo, sheep, goats, camel, horses & ponies, pig and poultry (www.nbagr.res.in). In addition to well defined and documented livestock breeds, there are numerous lesser known population/breeds including dog, which have not been properly characterized and documented, so far. In general, different dog breeds in world are classified based on their utility like protection/guarding, herding, flocking, mountain, companion, fighting, scent, toy etc. In India, some breeds of dogs viz., Caravan Hound, Combai, Chippiparai, Rajapalayam, Rampur Hound, Kanni, Mudhol Hound, Indian Mastiff (Bulli), Himalayan sheep dog, Bhutia dogs (Gandhi, 2010) etc., contributing to the domestic animal biodiversity of our country. Combai, Chippiparai, Rajapalayam and Kanni are the dog breeds of Tamil Nadu (Thiruvenkadan et al., 2012). Indigenous dog breeds are mainly utilized for guarding and shepherding of livestock and agriculture farm, in comparison to exotic breeds, which are reared a fancy and as companion animal at home. Very scanty information is available regarding the phenotypic characters of our indigenous dog breeds and their utility by the livestock keepers. Hence, characterization, documentation and registration of Indian dog genetic resources needs to be undertaken.

METHODOLOGY FOR PHENOTYPIC CHARACTERIZATION

Phenotypic characterization is the practice of systematically documenting the observed characteristics, geographical distribution, production environment and utility of these resources (FAO, 2012). It also refers to the process of identifying distinct breed populations and describing their physical, body biometry and production and reproduction parameters within their native environment including management practices, utility of the animals, as well as social and economic factors such as market orientation, niche-marketing opportunities and gender issues. The phenotypic characterization of dog breeds needs to be started with the delineation of breeding tract of breeds concerned followed by survey for native environment, physical, morphometric, biometric, reproduction parameters and management practices followed and finally the utility of the breed for which it was developed. The information about native environment like altitude, latitude and longitude, annual rainfall, minimum and maximum temperature, humidity, major agriculture crops etc., should be collected during the survey.

Delineation and survey: The breeding tract should be delineated to know about the distribution of the dog breed or population. In survey of Rajapalayam dog, Virudhunagar district Tamil Nadu was delineated as breeding tract of that dog (Raja et al., 2013), although the dogs were also available with kennels and private breeders also. Once the breeding tract is known the survey has to be conducted in the densely populated area. The breeding tracts may be given in terms of name of places along with approximate area of distribution in square kilometers.

General information: The general information like breeder/owner name, family members involved in rearing/taking care the dogs, since when the breed is known, age of the animal etc., should be collected during the survey. Age of the animal can be estimated either through the pedigree information available with the breeders (if the animal is registered with Kennel Club) or

through dentition of the animal.

Physical traits: Canine breeds are well differentiated through physical traits. The physical traits which are to be recorded for canine breed identification includes, body size, coat color, skin color, hair length, head shape, size, eye color and shape, ear length, shape and orientation; top line, tail shape, abdomen, teat numbers, nail numbers etc. The details are given in the breed descriptor format and breed survey questionnaire.

The body size of dogs can be classified as small, medium and large; coat color indicates the color of the hair which may be single or mixed colors; whereas, skin color indicates the color of the skin and both the traits may be different in any breed. For example, Rajapalayam dog of south India had pink skin with white coat color (Raja et al. 2014). The hair length may be small, medium or long. Head shape of dogs may be straight, trapezoid or wedge; with straight, concave or convex nasal bridge and short or long snout. Head shape ranges from the long-headed dogs, called "dolichocephalic" (Afghan hound or the Greyhound), broader wide-skulled dogs called "brachycephalic" (Pug or French Bulldog) and "mesocephalic" (sometimes called "mesaticephalic"), as in Golden Retriever or the Beagle (Stone et al. 2016). The muzzle, nostrils and nose may be pigmented or non-pigmented. The eyes can be classified as brown, black or golden in color. The ears can be defined based on its length viz., short, medium, long; based on shape like, round, flat or tubular; based on orientation like straight, semi-dropping and dropping. It is a myth among the breeders of Chippiparai dog that the animals with straight/erect ears will be always alert, more active and aggressive (Raja et al. 2015). The top line of the dog breeds may be straight or concave; the abdomen may tucked-up, round or complete. The hound type dogs mostly have tucked-up abdomen e.g. Saluki, Grey Hound Whippet etc. whereas, companion dogs, toys breeds usually have round or complete abdomen. The chest may be broad or narrow; hunting dogs usually have broad chest with high lung capacity.

Morphometric traits: The morphometric traits for phenotypic characterization of dog breeds may be considered as per the studies of Sutter et al. (2008) applicable for judging a dog breed. Before starting measurements, the animal should be restrained properly by applying a knot around the snout and make the animal to stand on even ground with squarely placed legs. The various measurements can be recorded using graduated measuring tape and body weight can be recorded by using a digital weighing balance with an accuracy of one or two grams. Following morphometric traits should be recorded for characterization of canine breeds:

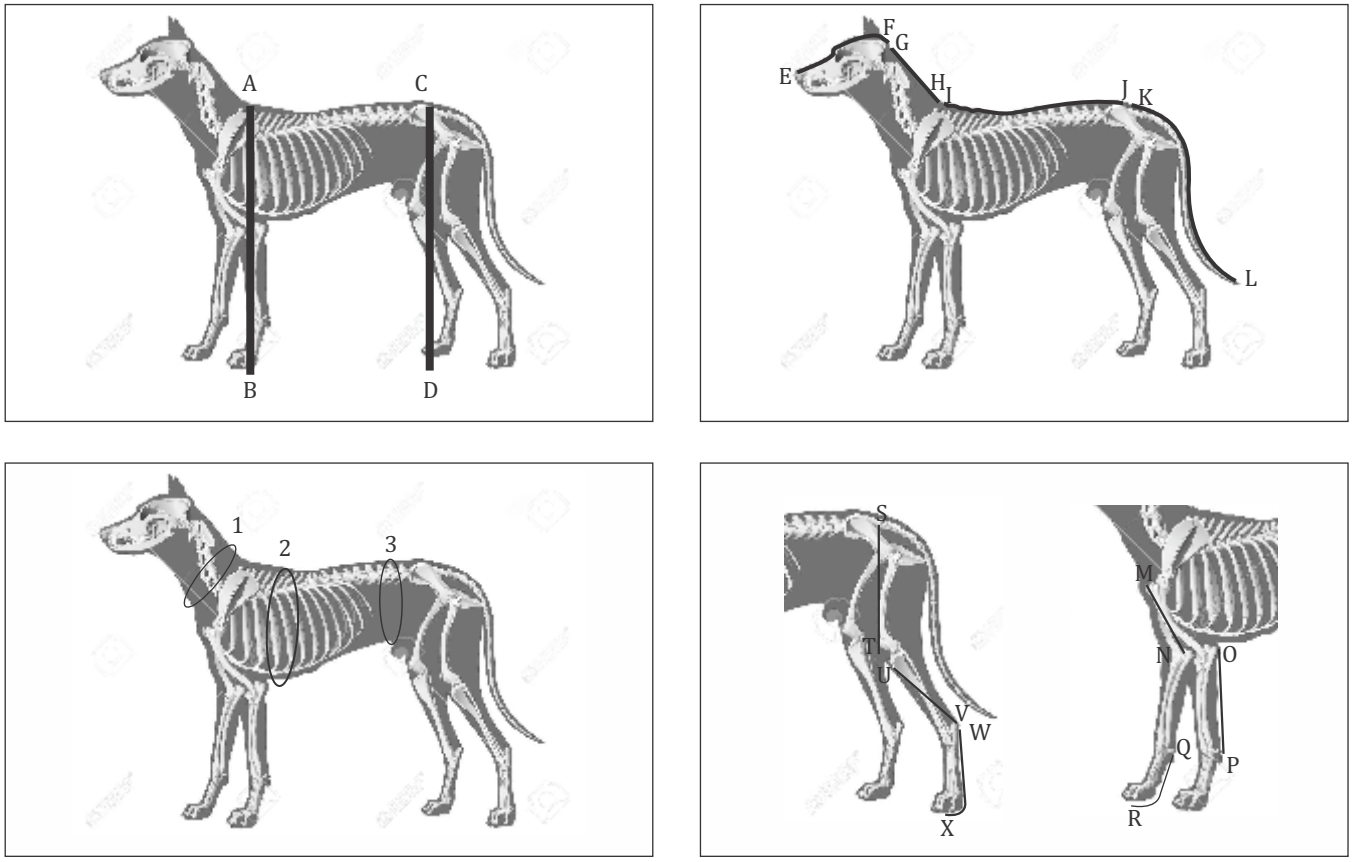

Figure. 1. Various biometric measurements of dog (Sutter et al. 2008).

Height at the withers: It is the distance from the ground up to the point where the two shoulder blades meet; measuring tape should not be curved (A-B in figure 1).

Height at base of tail: The distance measured from the floor straight up to the base of the tail i.e. where the coccygeal vertebra meets last sacral vertebra (C-D in figure-1).

Eye width: The distance measured between the inner canthus of the eyes.

Snout length: The distance measured from the tip of nose to just between the eyes, where the inside corners of the eyes meet.

Neck length: The distance measured from boney process on the back of the head down the back of the neck to the point where the shoulder blades meet on the back (G-H) as shown in figure 1.

Body length: It is the distance measured from the point of shoulder blades meet in the middle of the back (withers), down along the spine to where the lumbo-sacral vertebra meets the first coccygeal vertebra (Figure 1; I-J).

Tail length: The distance measured from the base of the tail (first coccygeal vertebra joins with the lumbo-sacral vertebra to the last coccygeal vertebra) to the tip of the tail (the extra hairs at the tip of the tail should not be included) as shown in the figure 1 (K-L). If tail docking is practiced, it needs to be recorded.

Ear length: It is the measurement from the base of the outside of the ear (where it meets the skull) straight up to the tip of the ear and don't include hairs at the tip of the ear. If ear cropping is done, it needs to be recorded with any specific reason for the practice.

Ear width: The measurement made at widest part of the ear perpendicular to orientation of the ear or the measure of length.

Neck girth: It is the measurement of the circumference or distance all the way around the neck (Figure 1; circle 1).

Chest girth: It is the circumference around the deepest part of the chest located just behind the foreleg (Figure 1; circle 2).

Paunch girth: It is the circumference around the abdomen measured just before the hind limb (Figure 1; circle 3). This measurement shall indicate the abdomen shape like, tucked-up, round and complete.

Hind foot length (Metatarsals): On the hind foot starting from the inside of the body count 3 toes out, and measure underneath the foot from the tip of the toe (the claw or fur should not be included in the measurement) to the hock (this is the boney projection off the back of the heel, W-X). For this lift the dog's foot off the ground. Measurement should be made on both the right and left feet.

Lower hind leg length (Tibia): The measurement made from the hock (heel, as in hind foot length) to the knee cap (Figure 1; U-V). Both the right and left legs should be measured.

Upper hind leg length: The maximum length measured from the knee cap to where the base of the tail meets the body i.e. up to last sacrum and first coccygeal vertebra meets (Figure 1; S-T), measurement should done on both the legs.

Fore foot length (Metacarpals): Measurement of the maximum length from the wrist bone to the end of the claw based third digit of the foot counting from inside out (the claw or fur should not be included in the measurement). The animal's foot has to be lifted off the ground to take this measurement, same procedure to be followed in right and left leg (Figure 1; Q-R).

Lower fore leg length (Radius): Measure from the wrist bone (as in fore foot length) to the elbow joint. Measure both the right and left legs (Figure 1; O-P).

Upper fore leg length (Humerus): Measure the maximum length from the elbow joint to the shoulder point most prominent in the chest (head of the humerus). The shoulder bones are the same bones used to measure chest width. Measure both right and left upper legs (Figure 1; M-N).

Body weight: The body weight should be recorded by using a weighing balance with minimum error. Digital balance with accuracy to weigh 1 or 10 grams may be used.

Reproduction traits: The reproduction traits in dogs needs to be recorded through personal interview with the dog owner as per survey questionnaire and also through the pedigree record, if the individual dog is registered in kennel club. The reproduction traits considered for characterization of dog breeds (for the bitches) includes, age at first estrous, duration of estrous, major and minor breeding season, age at first mating, gestation length, age at first whelping, litter size, age at weaning, whelping interval, number of whelping, life time litter production, litter mortality and longevity of the animal. In case of males (dogs) age at first mating, number of years in service etc., should be collected.

Information on management: Recording various information on management practices includes housing, feeding, breeding and health aspects of the dog breed. Type of housing provided to the animal, area per animal available, floor of the animal house, any special bedding material provided etc. should be collected housing management. Similarly, under feeding management recording type of food provided, quantity of food, frequency of feeding, utensils used for providing food, quantity and frequency of water provided to the animal etc. should be included. The information about deworming and vaccination, vaccination schedule, type of vaccines used against specific disease etc. needs to be collected. The information on other common diseases affected, bathing of the animal, type of soap/shampoo used for bathing, frequency of bathing, nail trimming, hair

grooming etc. should also be incorporated.

Utility: The utility of dog breed needs to be recorded in the survey questionnaire through interview with the farmer/breeder.

Genetic diversity analysis

The study unraveling the genetic basis of phenotypes and their inheritance from generation to generation and to establish relationships between breeds are referred to as molecular genetic characterization, which is complementary to phenotypic characterization (FAO, 2011). Genetic characterization of dog breeds can be done through microsatellite markers diversity analysis. International Society for Animal Genetics and Breeding has provided list of microsatellite markers which can used for genetic diversity study among the exotic dog breeds. There has not been separate set of markers developed for microsatellite diversity of Indian dog breeds. Using the reported set of markers, it is possible to study the diversity in Indian dog (unpublished data). However, it is also possible to develop new set of markers specific to Indian dog breeds, to have high utility in vetro-legal cases.

Kennel Club of India (KCI), Chennai has started registering the Indian dog breeds. The single dog registration and litter registration are being done by KCI, Chennai along with three to five generation of pedigree. The indigenous breeds are being registered by KCI, Chennai includes Rajapalayam (Tamil Nadu) and Mudhol Hound (Karnataka) dog breeds of southern India. However, Indian Council of Agricultural Research under the Ministry of Agriculture and Farmers Welfare, Government of India, a recognized body for registration of indigenous livestock and poultry breed, has yet to incorporate registration of dog breeds as followed for other livestock and poultry. It is appropriate time that the indigenous dog breeds needs to be characterized, documented scientifically and registered at National level to benefit the farmers and kennel clubs rearing the indigenous dogs.

SURVEY PROFORMA ON INDIAN DOG BREEDS

Schedule -1 General Information and Management Practices

Name of the Farmer/breeder_____ Code: _____ Date: _____

Village_____ Block: _____ District: _____

Family Size: Total: _____ Male _____ Female _____ Literate _____

No. of Animals: Dog:_____Cattle _____ Buffalo _____ Goats _____ Fowl _____Others_____

Dog: Total _____ Bitch_____ Dog _____ Pups _____

breed _____ ND _____

Income: Land _____ Sale of pups_____ Sale of adult_____ Both _____

Any other _____ Land holding _____

A. GENERAL DESCRIPTION

1. Name of the breed
2. Synonyms for breed name
3. Background for such a name/origin
4. The breed is known since-------- years
5. Grouping based on utility of the breed (Guarding/Shepherding/herding/sporting/toy/working/others)
6. a. Communities responsible for developing the breed
   b. Description of community (Farmers/nomads/isolated/tribals)
7. Kennel club registered (Yes/No)
8. Information about native environment: Altitude, latitude and longitude, district, state etc.,

B. BEHAVIOURAL CHARACTERS

1. Behaviour (excited/aggressive/play full/bold/docile)
2. Temperament (active/ dull)
3. Herding behavior (giving eye/stacking/chasing)
4. Obedience (very good/good/disobedience)
5. Trainability (easy/difficult)
6. Barking (low pitch/medium pitch/high pitch)
7. Behaviour with stranger (polite/attacks/barks)

C. MANAGEMENT

1. Housing (separate/part of the owners house)
2. Design of housing (katcha housing/pacca housing/katcha floor/pacca floor)
3. Exercise (walking/running) Duration (hrs) Time (M/E)
4. Feeding
   a. Food preference -
   b. Frequency of feeding (twice/thrice/no restriction)
   c. Feeding schedule -

S. No.	Items	Quantity	Morning	Noon	Evening

   d. Utensils used for feeding -
5. Bath & combing/grooming
   a. Materials used for bathing -
   b. frequency of bathing -
   c. cloth used after bath drying -

d. materials used for combing/grooming -
e. frequency of combing/grooming -

6. Nail cutting practised (yes/no) if yes
   a. frequency of nail cutting -
7. Restraining of the animal
   a. easy to restrain (yes/no)
   b. appliances used for restraining -
   c. animal is kept tied always/ left loose -
8. Bedding (yes/no) if yes
   a. type of bedding material used -
   b. ventilation of the room -
9. Disease prevalence & prophylactic measures
   a. Disease prevailing -
   b. Vaccination schedule -
   c. Deworming -
10. Utility
   1. Shepherding/guarding/herding ability
   2. Any other information specific to the breed
11. Any other information

Schedule-II Physical traits & Reproduction Performance

Trait/animal no./owners code
AGE/Sex
Coat Colour
Body colour
Hair length (S/M/L)
Head
Shape (straight/trapezoid/wedge)
Size (S/M/L)
Fore head (normal/prominent)
Nasal bridge
(Straight/convex/concave)
Snout (small/medium/long)
Muzzle colour
(Black/brown/greyish)
Nose colour
(Pink/black/brown)
Nostrils
(Pigmented/non- pigmented)
Eyes
Colour
(Red/black/white/golden)
Shape
(Oval/round)
Ears
Length (short/medium/long)

Orientation
(horizontal/drooping)
Shape
(Round/flat/tubular)
Ear cropping
(Yes/no)
Body size (small/medium/large)
Top line
(Straight/concave)
Chest
(Broad/narrow)
Abdomen/belly
(tucked-up/round/complete)
Tail shape
(Straight/semi -curved/curved/coiled)
Nail no.
Colour
Size
No. of teats in female
AFO (months)
Estrus cycle length
AFM-Males (months
AFM- Females
Main Breeding Season
Duration of estrus
Age at first Whelping
Whelping interval
Litter size
Age at weaning

Sire	Dam	Age/DOB	Sex	Height at Withers	Height at base of tail	Body Length	Chest girth	Paunch Girth	Head Width	Snout Length	Head Length	Neck Length	Neck Girth

BREED DESCRIPTOR FOR REGISTRATION OF DOG GENETIC RESOURCES

I. GENERAL DESCRIPTION

1. Name of the breed
2. Synonyms
3. Background for such a name/origin
4. The breed is known since
5. Group (Guarding/Shepherding/herding/sporting/toy/working)
6. a. Native tract of distribution in terms of longitude and latitude
   b. Approximate area of distribution (sq km)
   c. Place(s) State District
7. Estimated population
   a. Year of estimation
   b. Population
   c. Source / Reference
8. a. Communities responsible for developing the breed
   b. Description of community (Farmers/nomads/isolated/tribals)
9. Kennel club registered (Yes/No)
10. Utility of the breed (Shepherding/Guarding/Herding)
11. Herding (giving eye/stacking/chasing)
12. Temperament (Active/ Dull)
13. Behaviour (excited/aggressive/play full/bold)
14. Any other information

II. MANAGEMENT PRACTICES

1. Obedience (very good/good/disobedience)
2. Trainability (easy/difficult)
3. Barking (low pitch/medium pitch/high pitch)
4. Behaviour with stranger (polite/attacks/barks)
5. Exercise (walking/running) Duration (hrs) Time (M/E)
6. Feeding
   a. Food preference (Veg/non-veg type/both)
   b. Frequency of feeding (M/N/E)
   c. Mode of feeding (on the floor/special utensils)
7. Housing (separate/part of the owners house)
8. Design of housing (katcha housing/pacca housing/katcha floor/pacca floor)
9. Disease prevalence & prophylactic measures
   a. Disease prevailing
   b. Vaccination schedule
   c. Deworming

III. PHYSICAL CHARACTERS

	Male	Female
2. Coat colour		
3. Body colour		

4. Hair length (Small/ Medium/ Long)
5. Head
a. Shape (straight/trapezoid /wedge)
b. Size (Small/ Medium/ Large)
c. Fore head (Normal / Prominent)
d. Nasal bridge (straight/convex/concave)
e. Snout (small/medium/long)
f. Muzzle colour (black/brown/greyish)
g. Nose colour (pink/black/brown)
h. Nostrils (pigmented/non-pigmented)
6. Eyes
a. Colour (red/black/white/golden)
b. Shape (oval/round)
6. Ears
   a. Length (short/medium/long)
   b. Orientation (horizontal/drooping)
   c. Shape (round/flat/tubular)
   d. Cropped (yes/no) If no
7. Body size(Small/ Medium/ Large)
8. Top line (straight/concave)
9. Chest (broad/ narrow)
10. Abdomen/belly (tucked up/ round/complete)
11. Tail docking (yes/no)
12. Tail shape (straight/semi-curved/curved/coiled)
13. Number of teats
14. Any other information

IV. MORPHOMETRIC CHARACTERS/REPRODUCTIVE PERFORMANCE

. **Body weights (kg) and measurements (cm)**

Parameter		**Male**		**Female**	
		Average	**Range**	**Average**	**Range**
Birth weight					
Adult weight					
Height at the Withers					
Head Width					
Snout Length					
Head Length					
Neck Length					
Body Length					
Tail Length					
Neck Girth					
Chest Girth					
Paunch Girth					
Hind Foot Length	Right				
	Left				
Lower Hind Leg Length	Right				
	Left				
Upper Hind Leg Length	Right				

	Left	
Fore Foot Length	Right	
	Left	
Lower Fore leg Length	Right	
	Left	
Upper Fore leg Length	Right	
	Left	

Reproduction	Average	Range	N
a. Age at first mating in males (mo)			
b. Age at first mating in females (mo)			
c. Age at first Oestruos (mo)			
d. Oestruos cycle length (mo)			
e. Main breeding/whelping season (Seasonality)			
e. Duration of oestrus (days)			
f. Age at first whelping (mo)			
g. Whelping interval (mo)			
h. litter size			
V. UTILITY			
1. Shepherding/guarding/herding ability			
2. Utilized for			
Species Breeds			
3. Any other information specific to the breed			
Source:			

REFERENCES

FAO. 2011. Molecular genetic characterization of animal genetic resources. FAO Animal Production and Health Guidelines. No. 9. Rome.

FAO. 2012. Phenotypic characterization of animal genetic resources. FAO animal production and health guidelines no. 11. Rome.

Gandhi M. 2010. Breeds of Dog in India. The Bihar Times (epub: http://www.bihartimes.in /Maneka/ BreedsofdoginIndia.HTML dated 11/12/2010).

Raja KN. 2013. Rajapalayam Dog Breed. Breed Saviour Awards. Livestock Keepers' Profile, pp-59-61.

Raja KN, Singh PK, Mishra AK, Ganguly I, Devendran P, Saravanan R, Kathirvel S and Srinivasan G. 2014. Characterization of Rajapalayam Dog breed- An unexplored Canine Genetic Resource of India. In the proceedings of National Conference of SOCDAB at NBAGR, Karnal. pp: 101.

Raja KN, Singh PK, Mishra AK, Ganguly I, Devendran P, Saravanan R and Kathirvel S. 2015. Characterization of Chippiparai Dog breed- An unexplored Canine Genetic Resource of India. In the proceedings of international conference on "Sustainable Management of Animal genetic Resources for Livelihood security in Developing Countries", Madras Veterinary College. pp: 75.

Stone HR, McGreevy PD, Starling MJ and Forkman B. 2016. Associations between Domestic-Dog Morphology and Behaviour Scores in the Dog Mentality Assessment. PLoS ONE 11(2): e0149403. doi:10.1371/journal.pone.0149403.

Sutter, N. B., Mosher, D. S., Gray, M. M., & Ostrander, E. A. 2008. Morphometrics within dog breeds are highly reproducible and dispute Rensch's rule. Mammalian Genome : Official Journal of the International Mammalian Genome Society, 19(10-12): 713–723.

Thiruvenkadan, A. K, Ravimurugan, T, Devendran, P and Sivakumar, K. 2012. Dog Breeds of Tamil Nadu. A leaflet published by Tamil Nadu Veterinary and Animal Sciences University, Chennai, Tamil Nadu, India.