

REVIEW ARTICLE

Male camel behavior and breeding management strategies: How to handle a camel bull during the breeding season?

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Abstract

The present article reviews male camel behavior and breeding management strategies, providing an insight into the handling procedures and the most relevant welfare issues on these topics. Furthermore, it suggests some procedures for rearing, handling and collecting semen from camel bulls, based on results that have been achieved in the last twenty years and, recently, literature published with the aim of optimizing dromedary camel breeding. Camels are seasonal breeders and their breeding season (BS) is confined to the coolest winter months of the year; during the BS, also called "rutting period" or "rut", males exhibit morphological, behavioral and endocrinological peculiarities. Short breeding season, low libido and high aggressiveness are still some of the major cause of economic loss, poor reproductive performance and injuries, for camel breeding and industry. The application of ethology to approach, to train and to study camel bulls may be useful in the future to improve camel welfare and productive performances. Strong knowledge of animal learning and correct management procedure could be useful for camel technicians, owners, breeders, but also for veterinarians and others scientists.

Key words: Dromedary camel, Handling, Management, Sexual behavior, Welfare

Introduction

Male camel sexual behavior and physiology

The "Ethology" is the observation and description of behavior that leads to improved understanding of its mechanism, function, development and evolution (McGreevy, 2004). References about dromedary camel (DC) behavior mainly described camels observed in field and reared in extensive or semi intensive breeding system (Gauthier-Pilters and Dagg, 1981; Dioli, 2013). Camels are seasonal breeders and their breeding season (BS) is confined to the coolest winter months of the year; during the BS, also called "rutting period" or "rut", males exhibit morphological, behavioral and endocrinological peculiarities (Table 1; Padalino et al., 2013). Depending on the genetic and health condition of

the sire, the geographical location and environmental parameters, management and nutritional factors, the duration of the breeding season ranges from 2 to 6 months. Out of the breeding season, usually, male camels lose their libido, do not copulate with females, and show testicular size and weight decrease and very low blood testosterone level (Deen et al., 2008).

When a rutting male approaches a female in estrous it sniffs her genital region, urine or feces, then performs the typical flehmen gesture of artiodactyls by lifting his head and curling back his upper lip (Gauthier-Pilters and Dagg, 1981) (Figure 1). Another typical sign is a notably and profuse secretion of the poll glands of the neck, which contains androgen concentration similar to blood (Ebada et al., 2012). Camels are the only ungulates that copulates in a couched position; in nature the mating usually takes around one hour, the copulation time lasts about 10-20 minutes, with ejaculation occurring three or four times (Al-Hazmi, 2000). After each copulation, the male generally falls sideways and then stands over the female, blowing out his soft palate "dulaa", doing flehmen, sniffing, touching and biting her neck (Yagil and Etzion, 1980) (Figure 2). During the BS dromedary bulls increase pacing and anxiety,

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becoming very aggressive towards other males and humans; due to this aggressiveness rutting camels are usually tied with ropes and kept in single pens or boxes and their handling is considered very difficult over this period (Abu-Zidan et al., 2012).

Male camels have been traditionally reared under semi extensive conditions and kept in herds with 40 to 60 mature females, while, nowadays, in order to improve their reproductive performances, male camels are often reared in breeding centers. In the latter case, they are used for selective mating or for semen collection, the latter used for artificial insemination (Skidmore et al., 2013) or for the development of assisted reproductive technologies (e.g. Freezability studies, *In vitro* Fertilization, etc.) (El Bahrawy et al., 2013; Skidmore et al., 2013; Russo et al., 2014).

Unfortunately, Skidmore (2011) reported that males kept in herds tended to start breeding earlier and that the rutting period was longer than that of confined males, so there is the need to investigate the relationship between confinement and sexual behavior, as well as early rutting enhancement systems. Consequently, the major complains for housed camels bred for semen collection are: low libido and mating desire, short breeding season and high variability in term of semen quality and quantity (El-Hassanein, 2003; El-Bahrawy 2005). Latter abnormal behaviors could be related to low animal wellbeing.

Indeed, intensive production system could affect animal welfare, which is considered related to animal's needs, concentrating on nutrition, behavior, reproduction, physical and social environment (Waran, 2007). With respect to the actual well-being of the animal, most issues are centered on how the animal "feels" when managed within a specific level of confinement, during special agricultural practices and handling (Swanson, 1995). In the last twenty years many papers have been published about the effects of intensive management on livestock behavior and welfare (Haskell et al., 2003; Babu et al., 2004) and ethologists have already standardized the study of their behavior, proposing how to measure it in other species (Martin and Bateson, 1993). An "Ethogram" is a detailed description of the behavioral features of a particular species and collected behaviors are distinguished according to their duration in: "events" and "states" (McGreevy, 2004). The events are behaviors of instantaneous duration (e.g. vocalizations), which are best described by their frequency, while the states are behaviors of relatively long duration (e.g. feeding), which can be best described by their total or average duration. Therefore, a correct ethogram should include the frequency of events and the duration of states (McDonnel, 2003). In 1974, Altmann wrote an observer's guide where sampling methods for use in direct observation of human and animal behavior are presented.

Table 1. Description of typical sexual behavior in male dromedary camel (Padalino et al., 2013).

Behavior	Definition
Sniffing	The dromedary male sniffs female perineal region and/or the vulva
Nervousness	Increased pacing, anxiety and sound loading
Flehmen	After sniffing the female vulva the male raises the head and curl the upper lip for few seconds
Grinding of teeth/whistling	The male moves the lower jaw on left and right side, with closed mouth, grinding the teeth and producing a typical squeaking/whistling sound
Yawning	An involuntary sequence consisting of mouth opening, deep inspiration, brief apnea and slow expiration
Urinating	The dromedary male assume the urinating position, with spread hind leg and emits small quantities of urine
Opened legs	Before, during and after urination the sire stands with opened hind legs
Tail flapping/beating	The tail is held under the prepuce and then it is beaten up and down 4 to 5 times, spreading urine over the croup and surrounding areas
Poll gland secretion	The occipital poll glands become thick and large and produce a tarry and dark secretion that colors occipital area and first part of the neck
Neck Rubbing	The male rubs the neck, particularly the occipital area, on walls, trees, fence bars etc
Blathering	Emission of typical metal and gurgling sounds
<i>Dulaa</i> extrusion	Exteriorization of the soft palate, usually named " <i>Dulaa</i> "



Figure 1. Dromedary camel flehmen: male dromedary camel usually show flehmen after sniffing dam's perineum.



Figure 2. Male dromedary camel extruding his "dulaa" after mating.

Since the behavior of camel reared in semi intensive system have been poorly investigated and due to the need of relating the behaviors (i.e. libido, mating time, semen quantity and quality) with other

parameters (i.e. climatic factors, husbandry, diets), Padalino et al. (2013), recently, proposed the following procedures to collected data about male dromedary camel worldwide.

Ethogram for camel general behavior

To fill this kind of ethogram the best record technique may be the “Focal animal sampling”: observing each camel, reared in his single box or pen, for a fixed time window. It should include as states: feeding, rumination, standing, resting, standing with head outside the box, walking; while as events: head outside/looking through the window, legs movement, number of steps, head up, head down, explorative behavior (sniffing), sound emission, defecation, urination, scratching, occipital glands scratching, yawning, teeth grinding, blatering, dulaa extrusion, flehem, tail beating/flapping, open legs. As intensive housing system may limit the normal expression of animal behavior, even camels could develop stereotypy (Padalino et al., 2014) (a stereotypy is a repeated, relatively invariant sequence of movements that has no obvious function - McGreevy, 2004), therefore this kind of abnormal behavior should be included in the recorded states or events, accordingly with their duration.

Ethogram for camel sexual behavior

As the major stimulus for expressing sexual behavior is the presence of the partner (Haupt, 2011), it is essential to bring a female in estrus, near the box, for a limited time window (e.g. 12 min). The sampling rule could be a behavior sampling and, during female presence, the observers must note down the occurrence of following behaviors: sniffing, flehmen, whistling, urination, dulaa extrusion, tail flapping. Furthermore the grade of salivary production, nervousness, poll gland secretion should be scored (absent, low, high, very high) (Figure 3).

Camel sexual behavioral score

After the female passage the observers may score the camel sexual behavior according to Table 2.

In addition, since it is reported that a stud male is capable of mating with and fertilizing an estrus female at any time of the year (Al-Qarawi, 2005) and Skidmore (2011) stated that the presence of female led to the increase of male’s libido and of its behavioral signs, Fatnassi et al. (2014a) tried to stimulate the enhancement of the rutting period

stimulating males through a female parade. Latter authors concluded that dam could provide a good olfactory and visual cue stimulating the onset of rutting behavior in housed male bulls. Thus, accordingly with their experience, it seems that the assessment of male camel behavior during female parade by means of an ethogram represents a useful tool to monitor camel bull sexual behavior. Fatnassi et al. (2014b) work is a proof that the ethological approach is useful and could be easily adopted by camel industry in other countries.

Handling procedures

One definition of learning is "a process in which an individual's experience results in a relatively permanent change in behavior" (McGreevy and McLean, 2010). As a process, learning is not directly measurable, what can be measured is what has been remembered as a result of learning (i.e. when the association is remembered). Learning theory establishes clear guidelines and training protocols for correct training practices and methods of behavior modification. It is truly fascinating, easy to relate to and really quite simple to understand (McGreevy and McLean, 2010).

Animals are able to learn by “non associative” or “associative” processes.

Non-associative learning occurs when exposure to a single stimulus results in either habituation or sensitization. Both are fundamental to effective animal-training and are interconnected at almost every stage of training. Habituation is learning to not respond to a repeated stimulus that has no consequences. Whereas, sensitization is the opposite of habituation in that there is an increase in a response after repeated presentation of the stimulus by itself: the stimulus has to be intrinsically unpleased or aversive. For example, if while completing his training, a police horse is involved in a road accident every day for a month, he would reliably become sensitized to motor vehicles and perhaps even become phobic so that just the sound or sight of them, might be sufficient to send him into a flight response (McGreevy, 2004).



Figure 3. Recording of focal animal sampling ethogram of male camel sexual behavior during female passage: using "positive reinforcer" the female accept this procedure easily and she does not need any kind of restraint.

Table 2. Behavioral criteria for scoring the sexual behavior of male dromedary camel during a female passage (Padalino et al., 2013).

Behavioral Score	Criteria
1: not interested	The male does not show any sexual behavior parameters.
2: low interested	The male goes near the female and shows low frequency of sniffing and flehmen.
3: interested	The male goes near the female, it shows sniffing, flehmen, grinding of teeth/ whistling, yawning.
4: high interested	The male goes near the female, it shows sniffing, flehmen, grinding of teeth/ whistling, yawning (more than 3) , urination and tail raising. It is very agitated, stands with open legs, poll glands secretion and neck rubbing are observed.
5: excited	Like 4, but the male shows blatering and <i>dulaa</i> extrusion, is very excited, stands with open legs, high poll glands secretion and neck rubbing are observed.

Associative learning occurs when a animal creates an association between two stimuli or a behavior and a stimulus. There are two forms of associative learning: the classical and the operant conditioning. The classic conditioning was defined by Pavlov in 1927 as the process whereby the unconditionated or conditioned response becomes elicited from a conditioned stimulus. Another definition of classical conditioning is "the acquisition of a response to a new stimulus by association with an old one" (McGreevy, personal communication).

Operant conditioning is distinguished from Pavlovian conditioning in that operant conditioning deals with the modification of a "voluntary behavior" through the use of consequences. For example, a cat can learn to direct its behavior to get out of the cage by pressing a lever (Thorndike,

1898). In another experiment, mice had to press a lever to obtain food (Skinner, 1938). The cat and the mice learned a behavior to get reward. The cat tries to get out because being locked in a cage (stimulus) is a discomfort, for which it performs a certain behavior (response) to exit (reinforcement). In the same way, hungry mice (stimulus) perform the behavior of pressing the lever (response) to obtain food (reinforcement). Escape and food are both reinforcements. The reinforcement needs to be something biologically relevant for the animal, such as the removal of discomfort or the appearance of food, so the animal is highly motivated to obtain it. Therefore, operant conditioning works by giving or taking away rewards or punishments when the animal performs a desired/undesired behavior, respectively (Kratzer et al., 1977) through the chain: stimulus - response - reinforcement (Pavlov,

1927). "Reinforcer" and "punishment" are applied in animal training, the first used for increasing the occurrence of the desired behavior and the second for limiting the occurrence of the undesired one. We can apply a positive reinforcer adding a reward or a negative reinforcer removing aversive stimulus. We can apply a positive punishment adding an aversive stimulus or, in the case of negative punishment, removing a positive reinforcing stimulus. It has been found that punishment is often used incorrectly in animal-training, particularly when not immediately contingent with the undesired behavior (McGreevy and McLean, 2010). Incorrect use of punishment can affect the animal behavior, desensitizing the animal to the punishing stimulus and creating fearful associations (Mills, 1998). Non-associative and associative learning processes in the animals must be taken in account to be successful in handling and training (Murphy and Arkins, 2007). To know the animal learning abilities is important, to apply the rules of the "classical and operant conditioning method" for handling and training dromedary bulls, particularly during the breeding season, when they become more aggressive and can be dangerous toward other males and humans. Camels, as other animals, must associate the relationship between behavior and punishment/reinforcement within 3-5 seconds and usually they could quickly learn. By this method camel bulls' handling could become easy, and injuries and accidents, both for humans and animals, could be prevented and avoided. Moreover, animals, which could properly understand human requests, are usually calmer and less stressed by any handling procedure, so in a better welfare living condition.

Semen collection method

Semen collection could be carry out by different methods: electro-ejaculation, by using an artificial vagina (AV) and a female teaser, or by using AV and one El-Hassanein camel dummy.

For collection by electro-ejaculation, the male camel kneels down and its front legs are tied to the shoulder and neck. The male is forced to turn on its side and its hind legs are tied together (from the shin region) to facilitate receiving semen in the rubber cone and collection tube. Collection may be done with or without sedation with detomidine hydrochloride (30 - 35 mg/Kg B.W., IV, or 70 - 80 mg/Kg B.W., IM). A bovine probe (2 inches, 12 volts and 180 mA) is introduced rectally, after lubrication with jelly, and two sets of stimulation are generally used, each of 10–15 pulses of 3–4 s

duration with a rest of 2 - 3 minutes in between. Ejaculation often occurs after about 15 minutes of manipulation. Semen obtained by electro-ejaculation is often reduced in volume and has high percentage of dead and tail-less spermatozoa and sometimes is contaminated with urine, due to the short duration of ejaculation (El-Hassanein, 2003). In addition, the use of electro-ejaculation for semen collection does not respect animal welfare and has other many disadvantages: consuming a lot of time and many workers to restraining the bull, sedation or general anesthesia of the animal, possible injuries to the bulls, sensitization of the bulls toward humans and consequently fear of humans, inability of male to mount normally (El-Hassanein, 2003; Skidmore et al., 2013).

A bovine AV of about 40 cm in length is usually used for collecting semen from adult males (over 10 years of age), while a shorter AV of about 30 - 35 cm length, is suggested for the collection from younger males (less than 10 years of age). The jacket of the AV is filled with water warmed to about 55 - 60°C (Skidmore et al., 2013).

During the last two years we have developed a good method for semen collection procedure (Padalino et al., 2013), then adapted and better scheduled, explained in the following paragraphs. During semen collection using AV it is of fundamental importance that animals are not disturbed particularly by unknown persons because camel bulls are extremely territorial and tend to defend their female herd toward other males or humans. The semen procedure should be ritualized and performed always in the same place. A receptive female must be lead to a open paddock near males' stall and restrained in sternal recumbence; once all operators are ready for the semen collection, the door of the male's stall are opened and the male brought near the female. If the male do not start copulating and walk around the female on the collection area, it should be gently again guided toward over the female, after 4 minutes; if he refuses, for three times, to approach the female and to mate, it would be better to stop the session, avoiding any kind of punishment and negative association with the semen collection procedure. If the bull start to copulates, it is important that the approach of the technician to the male is slow and cautious and that the penis is gently guided into the artificial vagina. The copulation must be not disturbed until the bull ends and falls sideways. As one typical behavior is standing near or over the female between two copulations, the male can show this behavior for a maximal time of 20 minutes. If the bull does not

want to copulate again after that time, it is better to stop the session and bring the male into the stall. Dromedary bulls usually copulates several times during a semen collection session and sometimes can start walking around; in this case, after 4 minutes of walking, it is useful to bring the male near the female, in order to focus its attention on the mating. Anyway, after three refuses, it would be better to stop the session. A good semen collection session should last approximately 45 minutes; such session time provides many semen collections and mimics the natural mating behavior thus avoiding any kind of forcing. Sometimes, after the ending of the collection session, the bull male could refuse to leave the collection area and stands over the female protecting her from intruders; in this particular situation it is fundamental to avoid any positive punishments on the male, and it is suggested to untie the female and lead her far from the male. The sexual attraction and mating desire, usually decrease if the female is standing and not in the couched position. Any stress or painful situation, felt by the bull, during the collection/mating session could be associated with the place or with the procedure of collection thus compromising all efforts of the trainers and the successful of the subsequent collection session.

Following this recommendation, and applying the classical and operant conditioning, dromedary camel bulls could be well trained and accustomed to the semen collection procedure their welfare accomplished and large amount of good quality semen (could be) easily collected. This procedure has however some disadvantages, particularly related to the welfare of the female teaser: injuries of the neck and on the hump could be produced by the tight ropes and by the male's sternal pad. So, to avoid these problems the females should be protected by a blanket on her back (Figure 4) and the ropes should be replaced by fine harness leather hobbles. The last disadvantage is the discomfort of the technician who must hold the artificial vagina for the whole duration of the mating sitting beside the hind region of the teaser female keeping his arm in a fixed position (Figure 5).

A camel dummy with an AV inside was conceived by El Hassanein (2003) trying to overcome the above-mentioned disadvantages. The dummy is in the same shape and size of a female camel in sternal decumbency and has a strong iron skeleton, with a hollow core, to withstand the weight of the male (about 400 - 500 Kg) during copulation. The iron skeleton is covered with a strong smooth wooden sheath that was the same symmetrical shape as a

normal female camel and the entire dummy surface, in addition to the head and neck, are covered with a camel hide (El-Hassanein, 2003). Anyway, the use of the dummy require a particular training method for the bulls, that is not standardized yet, as usually is made for stallion, bulls and pigs.

Ethogram for mating behavior and libido score

Mating behavior could be recorded by a "Focal animal sampling". In this case it is useful, the mating time may be divided into three parts according to the different states that the the male could show: copulation/service time, standing over/near the female time, walking around time. Moreover, to standardize the procedure, the sample session may be scheduled at a predetermined time, before starting: a maximal latency time (from when the male is free to the first mating attempt) of 15 minutes, a maximal mating time of 45 minutes, a maximal time between two copulations of 30 minutes, maximal standing over the female of 20 minutes and as previously mentioned, with maximal three refuses to approach the female. Finally, it is important to note down the frequency of the following events: mounting attempts, number of mounts, blatering, defecation, dulaa extrusion, flehmen, jumping, neck-touching, sniffing, sound emission, tail flapping, teeth-grinding and yawning.



Figure 4. An example of how to protect the dam's back during a semen collection session.

In 1986, Chenoweth proposed a libido score (from 1 to 10) to evaluate the breeding potential of bulls used for semen collection. Sieme et al. (2004) adapted this scoring for stallions (from 1 to 4: excellent, good, moderate, low) according with their sexual interest and correlated it with their fertility. Padalino et al. (2013) adapted those scoring for dromedary camel bulls and proposed a libido score from 0 to 5 (Table 3).

The libido could be easily scored, after the evaluation of the filled ethogram.



Figure 5. Semen collection procedure.

Effects of different management system on camel welfare

Captivity imposes to animal different kind of constraints (e.g. limited space, social isolation) which could alter behavioral repertoire and it is up to us, as scientists, to evaluate enclosures and husbandry practices for ensuring the optimal wellbeing of animals and, consequently, their health status and productivity. Moreover, it is important to remind that the welfare notion includes physical (diseases or wounds), but also psychological aspects (Dawkins, 2003), while “stress” has been defined as “the inability of an animal to cope with his environment” (Dobson and Smith, 2000).

In intensive management, animals are confronted by a wide range of potentially provocative environmental challenges (potential stressors) that may adversely affect their living (Morgan and Tromborg, 2007). Glucocorticoids have been designated as the main hormones of the stress because their level sharply rises in response to stressful situations. One of their effects is the decrease of the Leydig cells’ testosterone production which finally affects the male’s libido and fertility (Phillips et al., 1989; Orr et al., 1994). Therefore, living and no-welfare conditions could

activate stress responses that can influence reproduction (Moberg, 1987).

A feral camel bull, naturally would roam wide areas of land, moving over pastures with his female herd (Döriges et al., 1992), contrariwise a camel bull kept isolation during intensive management, could show abnormal behavior or breeding problems. As mentioned above, El-Hassanein (2003), reported that housed camel sires, bred for semen collection, showed low libido and mating desire, short breeding season and low reproductive performances; these data were confirmed by El-Bahrawy (2005), who stated that the signs of sexual behavior in housed males varied, in strength and frequency, within rutting months and within individual camel bulls thus bearing to a variable production in terms of semen doses.

Low sexual motivation/libido or poor mating ability are common reproductive complaints also in the breeding stallion. Sexual desire and mating performance are complex traits affected by management, psychological, hormonal and physical factors (Stout, 2005) thus the evaluation of captive animal’s welfare and its improvement through management practices could be not only an ethic issue but also a useful strategy in term of productivity. Morel (2003) stated that many problems encountered in the reproductive management of the stallion could be overcome by consistent discipline, and alleviating boredom providing social interaction and activity. Dinger and Noiles (1986) emphasized the importance of exercise for reducing boredom due confinement and social isolation. The same authors proved that the improved basic fitness and muscle tone aids in maintaining the physical and psychological well-being of the stallion, with effects on libido, performances and behavior (Dinger and Noiles, 1986). Performing observational studies on social organization and reproductive behavior of equine breeders under feral, semi-feral, and domestic conditions, McDonnel (2000) concluded that placing the stallion under the natural light with chances to have social interaction with mares and to perform lot of exercise, can improve reproductive efficiency and fertility or overcome specific breeding problems.

Table 3. Libido score of male camels during mating (modified from Padalino et al., 2013).

Libido Score	Criteria
0: absent	Camel shows no sexual interest (latency time more than 15 minutes).
1: low	Camel approaches the female, sniffs her, mount on it, sit for copulation then dismount (only 1 attempt to mount).
2: moderate	Camels approaches the female, sniffs, take position and copulates only 1 time (more than 30 minutes between two mounts).
2,5: medium	Camel mates more time, but the mating time is less than 45 min.
3: good	Camels copulates more time and between two mating stands over/near the female showing flehmen, whistling, neck touching, but sometime spends time walking around (complete mating time).
4: very good	Camels copulates more time and between two mating stands over/near the female showing flehmen, whistling, neck touching, blatering, <i>dulaa</i> extrusion, tail beating and spends time walking around sometime (complete mating time).
5: excellent	Like 4 but it walks around rarely (complete mating time).

Table 4. Stereotypical behavior of male dromedary camel (Padalino et al., 2014).

Behavior	Description
Head-shaking	"The camel raised his head to the vertical in a very fast movement (this behaviour included a movement of the head up to 90°)"
Pacing in a circle	"The camel walked to the other side of his box (and sometimes stopped and looked through the window), and walked again until he was at his initial position (by doing this the camel always followed the same path which described a circle)"
Self biting" or "self-mutilation	"The camel bitted his own forelegs (right or left) at different part of the legs (to the shoulder to the feet)"
Bar-mouthing	"Licking, biting or playing with the lips on the bars"

In the framework of ENPI CBCMED "PROCAMED" project (Promotion des systèmes camelins innovants et des filières locales pour une gestion durable des territoires sahariens du bassin méditerranéen), Fatnassi et al. (2014b) studied and compared the effects of following management systems: i) housing in single box for 24 hours (H24), ii) housing in single box for 23 hours with one hour of free in the paddock (H23) and iii) housing in single box for 22 hours and 30 min with 1 h of free in the paddock time and 30 min of exposure to a female camel's herd (ExF). One hour of paddock time was chosen, as set out in a study by Freire et al. (2009) who proved that one hour or regular exercise in a paddock has positive effects on horse welfare. However, to enhance the male camel breeding season, 30 minutes of exposure to females had already been adopted by Bhakat et al. (2005).

During the above mentioned trial, camels were filmed for thirty minutes mornings and every evening during a female passage; the videos were analyzed by two ethologists for filling a focal sampling ethogram and for scoring male sexual behavior during the female passage. There were no statistical differences among H24

and H23, whereas EXF improved the sexual behavior score of the male camels and their behavioral repertoire. Traditional management (H24) affects negatively sexual behavior of male camels, causing also an increased production of cortisol. From those preliminary data it seems that the management system that allows movements and the interaction with female (ExF) had positive impact on camel rutting behavior and welfare. So, Fatnassi et al. (2014b) proposed the freedom to move and to express social behavior as "behavioral needs" for camel reared for semen collection, safeguarding their wellbeing.

Moreover, when the male were kept daily long in their stall, Padalino et al. (2014) identified and targeted some stereotypical behavior in the male dromedary camel (Table 4). Latter authors tried to reduce their manifestation varying the management, and suggested that when the male were reared with one hour free for walking around and thirty minutes of the exposition to the female herd the occurrence of the stereotypies decreased.

Conclusion

The application of ethology to approach, to train and to study camel bulls may be useful in the future to improve camel welfare and consequently their breeding performances and semen quality. This review was for everyone who spends time with camels and we wanted to share our approach to camel management, handling and training in order to move toward the best possible outcome for humans and dromedary camels. Anyway, further studies are needed regarding camel behavior, welfare, management and breeding strategies to identify dromedary "behavioral needs" and to optimize reproduction performances: these are our aims in the future.

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Author contributions

B. P., D. M. and G. M. L. conceived the work. Figures were provided by D. M. B. P., D. M. and G. M. L. wrote and revised the manuscript.

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