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Hormonal Control of Scent Marking Behaviour in Indian Gerbil

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Investigations to study the association between hormones and scent marking behaviour in the Indian gerbil. *Tatera indica indica* Hardwicke, 1807 revealed that castration reduces the frequency of scent as well as urine marking significantly within two weeks. The response of castrated animals to testosterone propionate therapy was gradual and the peak scent marking activity was attained after 8 weeks of administering the injection on a weekly interval. However, this hormone therapy could not enhance the scent marking activity to the level that of normal animals. The marking activity dropped no sooner the weekly injections were stopped. Such clear cut effect of hormonal therapy was, however, not observed on urine marking behaviour in *T. indica* which may indicate that control of this activity may be regulated by a number of hormones.

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1. INTRODUCTION

Scent marking is an important mechanism for olfactory communication in mammals (Eisenberg & Kleiman, 1972; Johnson, 1973; Ralls, 1971). The chemical signals originate in specialized cutaneous glands which are rubbed against objects in the animal's environment (Muller Schwarze, 1971, 1974; Mykytowycz, 1970; Schultze-Westrum, 1969; Thiessen, 1973) or in the secretions of the sex accessory glands or anal glands which may be deposited with urine and feces (Ewer, 1968; Kleiman, 1966; Muller Schwarze, 1971; Mykytowycz, 1970). The Indian gerbil, *Tatera indica indica* Hardwicke, 1807 possesses a mid-abdominal scent marking gland, the frequency of occurrence of which varies in solitary and gregarious populations. In the former 91.4% male and 38.5% female possess it whereas in the urban gregarious population, it occurs only in 85.6% male and 3.2% female (Idris & Prakash, 1983). The male gerbils scent mark at a higher (16.13 ± 1.62/15 mins) frequency than the female (8.86 ± 0.80/15 mins) in a new environment (unpublished data), the females which posses the ventral marking gland significantly enhance their scent marking intensity during oestrous (Prakash & Idris, 1982) which indicates that they advertise their ready-to-mate stage (Idris & Prakash, 1982). The frequency of scent marking as well as urine marking was found to be correlated

with the dominance hierarchy (Kumari & Prakash, 1981). However, a comparison of mean monthly gland area of male *Tatera indica* and the incidence of pregnancy indicated quite an inverse relationship between the two (Kumari & Prakash, 1983). This lack of relationship led us to investigate whether scent marking is androgen controlled in *T. indica* as reported in *Meriones unguiculatus* (Blum & Thiessen, 1971, Lindzey, Thiessen & Thecker, 1868; Thiessen, Lindzey & Friend, 1968).

II. METHODS

Thirty sexually mature, Indian gerbils, *Tatera indica indica* Hardwicke, 1807 (Body weight 130.0 to 155.0 g; age 35—45 weeks as estimated from Jain, 1970) were collected from sandy habitat around Jodhpur (26°18'N—73°01'E). After acclimatising them to laboratory conditions, the experimental rodents were drawn and lodged singly in glass cages (90×30×30 cm). Each rodent was observed for 15 minutes every night under red light to facilitate recording of behavioural activities without disturbing the gerbils. The frequency of ventral scent marking, perineal rub (urine marking), grooming, urination and defecation were recorded for individual rodents.

18 male *T. indica* were castrated by drawing out their testes through a small incision in the scrotum. Two weeks later, recording of behaviour activities was resumed at a fortnightly interval. Gland measurements were also recorded. A group of 6 *T. indica* was sham operated and another group of 6 animals was maintained as control. All the observations (Table 1) were recorded on the three groups.

Table 1

Frequency of behavioural activities of *Tatera indica* before and after 14 weeks of castration (Mean ± S.E.).

Groups	Ventral marking	Perineal rub	Grooming	Urination	Defecation
Pre castration (N=30)	16.02 [3] ±0.26	2.69 [1] ±0.27	52.25 ±8.57	1.27 ±0.27	0.99 ±0.08
Post castration (N=18)	3.05 ±0.59	1.76 ±0.65	60.55 ±9.03	0.50 [1] ±0.20	0.75 ±0.20
Sham operated (N=6)	18.66 ±4.44	2.83 ±1.01	63.10 ±11.70	0.66 ±0.33	0.83 ±0.54

Level of significance between, pre castration & post castration: [1] $P<0.05$. [3] $P<0.001$ (Student's t test)

After 14 weeks of castration, 100 µg and 800 µg doses of Testosterone Propionate (TP) were administered sub-cutaneously to two groups of six animals each at a weekly interval; continuing for 8 weeks. 6 castrated animals were maintained as control. After a lapse of 4 weeks, TP therapy was restored in first two groups. It continued for 8 weeks (Fig. 1). The sham operated and control groups were simultaneously administered injection of safflower oil. The frequency of various behavioural acts was monitored in all the groups.

The data were subjected to Student's t test (Snedecor & Cochran, 1967) for evaluating statistical differences between various observed parameters pertaining to normal, castrated, sham operated and TP administered Indian gerbils.

III. RESULTS

1. Effect of Castration

Behavioural aspects. A fortnightly recording of various behavioural acts revealed that the decline in the frequency of various activities occurred within two weeks after castration and it stabilised after a month. It is observed that, after castration, the frequency of

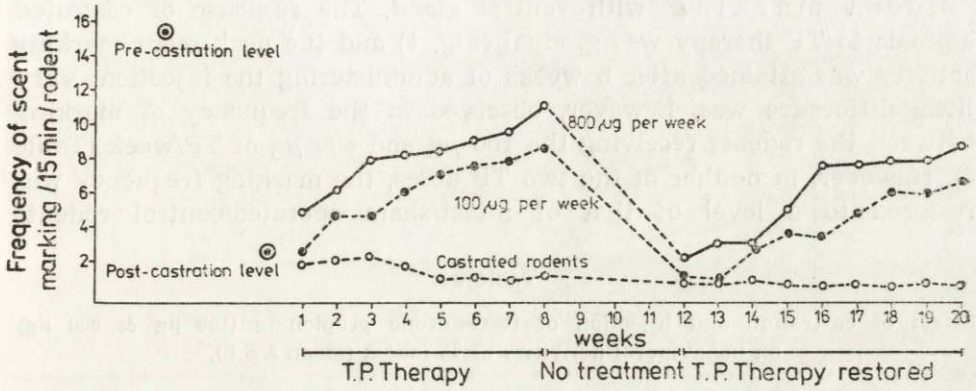

Fig. 1. Restoration of marking activity in castrated *Tatera indica* after hormonal therapy.

scent marking activity of the male *T. indica* diminished significantly ($P<0.001$) as compared to that of intact animals or that prior to castration (Table 1). Similar significant decline ($P<0.05$) was also observed in the frequency of other activities associated with marking like perineal rub

Table 2

Size of ventral scent- marking gland before and after 14 weeks of castration of *Tatera indica* (Mean±S.E) (all measurements are per 100 g body weight).

Groups	Gland length, mm	Gland width, mm	Gland area, mm²
Pre castration (N=18)	15.23 ±0.63	3.68 ±0.13	64.11 ±3.17
Post castration (N=18)	12.88[2]±0.54	2.82[3]±0.12	50.80[2]±2.57
Sham operated (N=6)	15.10 ±1.15	3.17 ±0.25	74.16 ± .23

Level of significance between pre and post castration: [2] $P<0.01$, [3] $P<0.001$ (Student's t test).

(urine marking) urination and defecation (Table 1). There was, however, no change in the frequency of grooming activity of intact and castrated rodents as this activity is obviously not connected with marking.

Gland size. All the dimensions (length, breadth and area) diminished gradually after castration and after 14 weeks stabilised at

a significantly lower size ($P<0.01$, $P<0.001$, $P<0.01$ respectively, Table 2). In a few *T. indica* the ventral scent marking gland totally disappeared. There was, however, no recognisable change in the gland measurement of sham operated and intact animals which confirms that the reduction of gland size was due to castration and its consequences.

2. Restoration Due to Hormone Therapy

Scent marking with ventral gland. The response of castrated animals to TP therapy was gradual (Fig. 1) and the peak scent marking activity was attained after 8 weeks of administering the injection. Very little difference was, however, observed in the frequency of marking between the rodents receiving the 100 μg and 800 μg of TP/week (Table 3). However, in neither of the two TP doses, the marking frequency was restored to a level of that of intact/sham operated/control rodents

Table 3

Effect of castration and injection of testesterone propionate (100 µg & 800 µg) on behavioural activities of *T. indica* (Mean ± S.E).

Groups	Ventral marking	Perineal rub	Grooming	Urination	Defecation
Pre-TP treatment	2.33 ±0.89	1.00 ±0.51	63.50 ±14.04	0.66 ±0.33	1.00 ±0.26
8 weeks after treatment of 100 µg	9.00 [3] ±1.26	2.96 [1] ±0.61	95.56 [NS] ±8.47	1.33 [NS] ±0.49	0.66 [NS] ±0.33
Pre-TP treatment	2.00 ±1.06	0.83 ±0.30	79.83 ±15.18	0.83 ±0.98	0.50 ±0.54
8 weeks after treatment of 800 µg	11.66 [3] ±1.23	3.16 [2] ±0.47	96.83 [NS] ±7.72	1.83 [NS] ±0.16	1.00 [NS] ±0.50
Pre treatment	1.55 ±1.22	1.00 ±0.44	38.66 ±14.81		1.16 ±0.40
8 weeks after control operation and 2 ml safflower oil administration	1.83 ±0.65	1.33 ±0.49	79.66 ±20.66	0.83 ±0.16	0.66 ±0.26
Pre treatment	19.50 ±3.62	3.66 ±1.08	80.66 ±8.22	1.16 ±0.30	1.00 ±0.36
8 weeks after sham operation and 2 ml safflower oil administration	17.16 ±1.25	3.16 ±0.30	105.50 ±1.64	1.16 ±0.12	0.50 ±0.33

Level of significance between pre and post TP treatment: [1] $P<0.05$, [2] $P<0.01$, [3] $P<0.001$, NS=Not significant. (Student's t test).

receiving safflower injection, though TP administration enhanced the marking activity significantly ($P<0.001$) as compared to that of control castrated *T. indica* (Table 3). It is also evidenced that no sooner TP administration was stopped after 8 weeks (Fig. 1) the scent marking activity dropped even below that at the castration level. The second

sequence of TP administration for 8 weeks did enhance the frequency of scent marking but it was not restored to the level before the first administration of TP. It is relevant to mention that the second TP administration had also no apparent effect on other behavioural activities.

Perineal rub (urine marking). The results of our observations on this aspect are not very consistent as compared to those on scent marking. Urine marking frequency of the rodents receiving 100 μg as well as 800 μg doses of TP indicated a rise till third week whereafter there was a significant ($P<0.05$) fall in fourth and fifth week respectively (Fig. 2). The urne marking frequency further decreased up to 8 th week with a slight peak in the 7th week (800 μg). During the period of no treatment the frequency of urine marking declined further. These fluctuations in

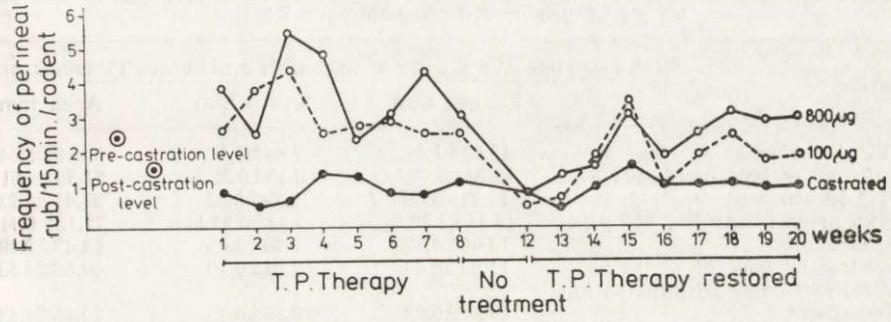

Fig. 2. Restoration of frequency of perineal rub (urine marking) in castrated *Tatera indica* after hormonal therapy.

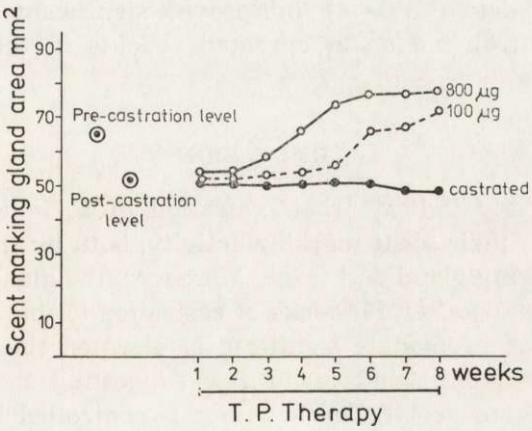

Fig. 3. Restoration of the size of scent marking gland in castrated *Tatera indica* after hormonal therapy.

urine marking frequency in response to TP doses in *Tatera indica* indicates that urine marking is probably not as much under androgen control as is scent marking. During the second sequence of TP therapy, similar results were observed (Fig. 2). It is interesting that such fluctuations in the frequency of urine marking are also observed in the castrated animals.

Gland size. The effect of TP administration was apparent on the gland size of castrated animals only after 5 weeks (100 μg) and 2 weeks (800 μg), whereafter a gradual increase was observed (Fig. 3). After 8 weeks of TP administration the increase in gland size was statistically significant ($P<0.05$, Table 4) as compared to the initial level.

Table 4

Effect of castration and injection of testosterone propionate (100 µg & 800 µg) on gland size of *T. indica* (Mean ± S.E.).

Groups	Gland size per 100 g body weight after and before TP treatment		
	Length mm	Width mm	Area mm^2
Pre-TP treatment	13.00±1.94	2.64±0.17	52.19±5.84
8 weeks after treatment 100 µg	15.92±0.77 [1]	3.16±0.22 [1]	71.39±4.91 [1]
Pre-TP treatment	12.31±0.68	2.84±0.23	54.41±4.22
8 weeks after treatment 800 µg	16.11±1.22 [1]	3.92±0.37 [1]	77.15±6.74 [1]
Pre-treatment	13.00±0.52	2.70±0.05	52.42±2.08
8 weeks after control operation and 2 ml safflower administration	11.50±0.64	2.84±0.10	49.08±2.53
Pre-treatment	15.87±0.93	3.25±0.25	70.45±4.52
8 weeks after sham operation and 2 ml safflower oil administration	15.88±1.35	3.26±6.36	73.97±4.26

Level of significance between pre and post TP treatment: [1] $P<0.05$ (Student's t test).

A comparison of data (Table 4) indicate no significant changes in the gland size in control and sham operated rodents in the experimental duration.

IV. DISCUSSION

The results clearly indicate that castration of *T. indica* significantly reduced ($P<0.001$) their scent marking activity, both by the sebum of the ventral scent marking gland and urine. Moreover, the gland area shrinked significantly ($P<0.01$) after 14 weeks of castration (Table 2). Administration of testosterone propionate significantly elevated the scent marking, urine marking frequency and gland size suggesting that the marking activity of the Indian gerbil, *Tatera indica* is controlled by hormones in males, more so by testosterone. Glandular activity has also been reported to be controlled by sex hormones in rabbit (Mykytowycz, 1970), and in

the Mongolian gerbil, *Meriones unguiculatus* (Blum & Thiessen, 1971; Thiessen, Lindzey & Friend, 1968). In *Rattus norvegicus*, urine marking has also been found to be controlled by hormones (Price, 1975). Our experiments also clearly indicate a hormonal control of scent marking and gland size but the fluctuations in urine marking (Perineal rub) (Fig. 2) after administering TP do indicate that, in addition to testosterone, some other hormone also affects urine marking in *T. indica*. Such a difference in androgen control of two behavioural activities has also been indicated by Yahr, Newman & Stephens (1979) who observed that sexual behaviour of mongolian gerbil (*Meriones unguiculatus*) was maintained more effectively than scent marking by hormone injections.

Another observation made is that no sooner the addition of testosterone to gerbil bodies is stopped, all the marking activities slump down to a level which compares with the level of castrated animals (Fig. 1 & 2). In other words the effect of testosterone therapy does not last long, as also observed in *Rattus norvegicus* (Price, 1975).

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REFERENCES

1. Blum S. L. & Thiessen D. D., 1971: The effect of different amount of androgen on scent marking in the male Mongolian gerbil. Horm. Behav., *2:* 39—105.
2. Eisenberg J. F. & Kleiman D. G., 1972: Olfactory communication in mammals. Ann. Rev. Ecol. Syst. *3:* 1—32.
3. Ewer R. F., 1968: Ethology of mammals. Plenum: 1—418, New York.
4. Idris M. & Prakash I., 1983: Response of male Indian gerbil, *Tatera indica* to urine from females. Indian J. exptl. Biol., *21:* 97—98.
5. Idris M. & Prakash I., 1983: Social and scent marking behaviour in Indian gerbil, *Tatera indica*, Hardwicke. Biol. Behav., *10:* 31—39.
6. Jain A. P., 1970: Body weights, sex ratio, age structure and some aspects of reproduction in the Indian gerbil, *Tatera indica indica* Hardwicke, in the Rajasthan desert India. Mammalia, *34:* 415—432.
7. Johnson R. P., 1973: Scent marking in mammals. Anim. Behav., *21:* 521—535.
8. Kleiman D. G., 1966: Scent marking in the *Canidae*. Symp. zool. Soc. Lond., *18:* 167—177.
9. Kumari S. & Prakash I., 1981: Observation on the social behaviour of the Indian desert gerbil, *Meriones hurrianae*. Proc. Indian Acad. Sci., *90:* 463—471.
10. Kumari S. & Prakash I., 1983: Seasonal variation in the dimension of scent marking gland of three desert rodents and its possible relationship with their reproductive performance. Proc. Indian Acad. Sci., *92:* 299—304.
11. Lindzey G. D., Thiessen D. D. & Thecker A., 1968: Development and hormonal control of territorial marking in the male Mongolian gerbil (*Meriones unguiculatus*). Develop. Physiol., *1:* 97—99.
12. Muller Schwarze D., 1971: Pheromones in black tailed deer, (*Odocoileus hemionus columbianus*) Anim. Behav., *19:* 141—152.

13. Muller Schwarze D., 1974: Social function of various scent glands in certain ungulates and the problems encountered in experimental studies of scent communication. [In: "The behaviour of ungulates and its relation to management", Eds. Geist. V. & Walther F.]. IUCN Publication: 107—113.
14. Mykytowycz R., 1970: The role of skin glands in mammalian communication. [In: "Advances in chemoreception", Eds. Johnston J. W., Moulton D. G. & Turk A.]. Appleton Century Crofts: 327—360, New York.
15. Prakash I. & Idris M., 1982: Scent marking by female Indian gerbils *Tatera indica* from two distinct desert habitats during oestrus. Indian J. exptl. Biol., *22:* 915—916.
16. Price E. O., 1975: Hormonal control of urine marking in wild and domestic Norway rat. Horm. Behav., *6:* 393—397.
17. Ralls K., 1971: Mammalian scent marking. Science, *171:* 443—449.
18. Schultze Westrum T. G., 1969: Social communication by chemical signals in flying phalangers (*Petaurus breviceps papuanus*). [In: "Olfaction and taste", Ed. Pfaffmann C.], Rockefeller Univ.: 268, New York.
19. Snedecor G. W. & Cochran W. G., 1967: Statistical Methods. Ames, Iowa State University Press.
20. Thiessen D. D., 1973: Foot for survival. Amer. Sci., *61:* 346—361.
21. Thiessen D. D., Lindzey G. & Friend H. C., 1968: Androgen control of territorial marking in the Mongolian gerbil (*Meriones unguiculatus*). Science, *160:* 432—434.

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REGULACJA HORMONALNA BEHAWIORU ZNAKOWANIA ZAPACHOWEGO U *TATERA INDICA*

Streszczenie

Kastracja *Tatera indica* Hardwicke, 1807 istotnie obniża aktywność znakowania, zarówno zapachowego, jak i przy pomocy moczu, w ciągu 2 tygodni po operacji (Tabela 1). Obszar gruczołów zapachowych ulega istotnemu zmniejszeniu w ciągu 14 tygodni (Tabela 2). Wstrzykiwanie zwierzętom propionianu testosteronu wzmaga aktywność znakowania zapachowego i poprzez mocz (Ryc. 1, 2). Reakcja kastrowanych zwierząt na propionian testosteronu była stopniowa i szczyt aktywności tego znakowania, osiągnięty został po 8 tygodniach kuracji. Nie dorównywał on jednak poziomowi aktywności u normalnych zwierząt. Terapia hormonalna powoduje także odtworzenie wielkości gruczołów zapachowych (Ryc. 3). Po zaprzestaniu podawania testosteronu cała aktywność związana ze znakowaniem obniżyła się do poziomu takiego jak po kastracji (Tabela 3, 4).